ESSAYS ON AQUARIUM HOBBY HISTORY

Written by Albert J. Klee, Ph.D.

Dedicated to the Aquarium Hobby Historical Society whose members understand that the history, innovations and ideas of aquarists throughout time is fundamental to our understanding of the life in the aquaria around us.

This book consists of essays written between 2003 and 2019 that appeared mostly in the Files section or posts of the *Aquarium Hobby Historical Society*. Three additional entries that are concerned with aquarium history are articles written between 2004 and 2007 that appeared in the *Buntbarsche Bulletin,* published by the American Cichlid Association.

Albert J. Klee,
January 14, 2023

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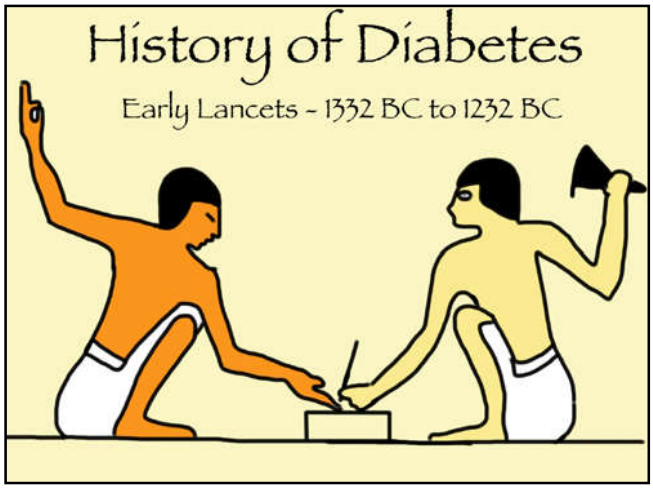
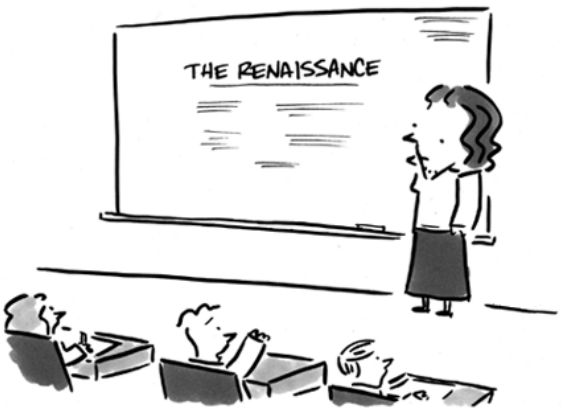
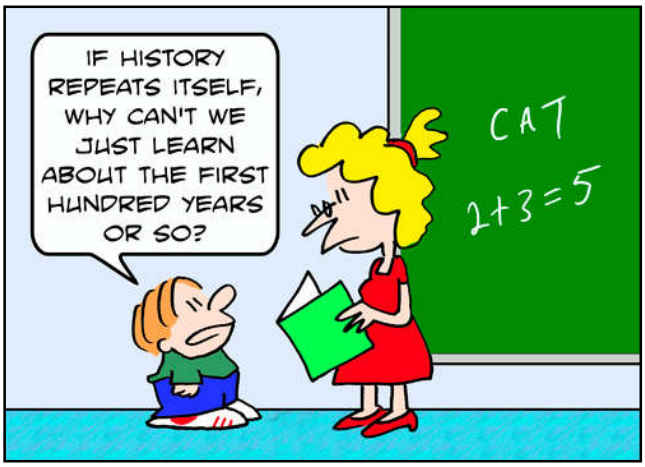




"How much more history is there?

"I'm glad they set that 140-character limit..."

"Thank goodness next week we'll be in a new dynasty and we can make some other style of pottery."



You got a "C" in History? How hard could it be?

THE BIRTH OF THE AMERICAN KILLIFISH ASSOCIATION

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, March 26, 2011)

INTRODUCTION

Until the birth of the American Killifish Association in 1961, there never had been a successful national aquarium fish specialty organization in this country. In the early 1950s, Gene Wolfsheimer started the Aquarists Internationale, a global correspondence club of restricted membership that included a number of killifish fanciers of renown, such as Jorgen Scheel and Walter Bertholdt. But, because of its restrictions and being based upon the exchange of letters (although some of these letters were published in selected aquarium magazines), by no means could it be characterized as such an organization.

In 1957, Larry Konig and John Rutkowski offered a pair of their famous strain of show guppies to any aquarium society that would form a guppy group. This soon produced a flood of guppy organizations that reproduced faster than the guppies themselves, including one that described itself as being national in scope, the American Guppy Association (AGA), Konig has been its principal architect.

This organization dealt mainly with show rules, delta tail guppies, local guppy clubs, guppy shows and Konig's guppy columns that appeared in THE AQUARIUM magazine and THE AQUARIUM JOURNAL. In essence, however, it was not a true functioning, independent national association. Its structure was modeled after that of local aquarium societies and, because traveling any distance is both expensive and inconvenient, only those elected leaders of the group who lived close to each other were able to meet physically. However, if a subgroup meets on a regular basis, then the subgroup becomes a ruling clique, and the organization quickly becomes geographically restricted. This is what happened to the AGA and so, not being a truly national organization, it disappeared within a short time.

The 1950s also saw the establishment of umbrella organizations such as the International Federation of Aquarium Societies, the Northeast Council of Aquarium Societies and the Canadian Association of Aquarium clubs, but none of these were national aquarium fish specialty organizations.

In April, 1958 in a two-page article in THE AQUARIUM the Publications Editor, Alan M. Fletcher, announced the formation of the American Panchax Association (APA) and displayed a suggested logo. This was followed throughout the remainder of the year with letters of support for the idea, and invitations to anyone who wished to be members or who had any ideas about what the APA should be and do. The July 1958 issue contained an article by Aaron Dvoskin entitled "American Panchax Association," which went on to describe the association's purposes. Dvoskin and Gene Wolfsheimer were both mentioned as club officers and in November of that year it was announced that J. Edmond Harris, President of the Northeast Council of Aquarium Societies, had accepted the position of its Executive Secretary.

In the December 1959 issue of THE AQUARIUM in the "Editor's Letter" then written by Helen Simkatis, Simkatis announced the formation of a new section of the magazine called "The Panchax Exchange." The Exchange was a series of articles about killifishes, often ending with up "Available" or "Wanted" egg listings. This offer on the part of a national magazine was unequaled and exceedingly generous. I myself contributed an article to the exchange, as did many other well-known killifish aquarists, but like my friends

considered it as a vehicle for the publication of articles devoted to killifishes, nothing more. Had the APA existed in substance, other than just names in a magazine, I most likely would have joined. But, there was nothing to join. It was an organization in name only.

In "A Guest Editor's Letter" appearing in the January 1962 issue of THE AQUARIUM written by the acclaimed killifish hobbyist, Franz Werner, Franz wrote: **"Some years ago, I was active, in concert with a number of prominent and enthusiastic Panchax fanciers, in an attempt to form an association devoted to the keeping and propagation of the killies - Panchax then. The response to the initial call published in the April issue of 1958 of THE AQUARIUM magazine was beyond expectations. Unfortunately, circumstances caused all the preliminary work and effort to be in vain."** In other words, while efforts were made, a functioning organization never evolved or existed.

Co-founder of the American Killifish Association, Albert J. Klee.

THE FATEFUL TELEPHONE CALL

In June of 1961, the author's telephone rang: **"Hello! I'm Bob Criger. I'm interested in killifishes and wonder if we couldn't get together tonight for dinner?"** With this telephone call, in effect the American Killifish Association was born. Bob, who was visiting his home offices of the Armco Steel Corporation in Middletown, Ohio (some 20 miles from where I lived, projected such bright enthusiasm over the phone that I accepted the invitation and drove out to meet him.

Robert O. Criger turned out to be a tall, friendly, personable fellow, lately interested in killies. It turned out that his telephone call to me was triggered by a series of articles I had authored for the old AQUARIUM JOURNAL (see Klee, Albert J., "A Fresh Look at the Genus *Aphyosemion*," AQUARIUM JOURNAL, August, September, and October 1960). This particular series was one in which I had invested a great deal of time and effort for at that period, little information was available with regard to these fishes. Today, I look back at some of the inadequacies of that particular material with some misgiving. We have all learned much about killies since then!

In any event, Bob had read the series with interest and, knowing that I lived in the area, took a chance, located my telephone number and called me out of the proverbial "clear, blue sky." He was prepared with a list of killy topics for discussion that could have formed the basis for a good-sized book. These were tackled with enthusiasm, for in those days, finding persons who were devoted to killies wasn't that easy.

The conversation continued after dinner. We bemoaned the scarcity, not only of information about killies, but of the scarcity of the fishes themselves (today's killifish fanciers are really spoiled by the relatively easy access of these fishes). Sometime after midnight, Bob thought out aloud: "**Wouldn't it be great if we had some sort of club devoted solely to killies?"** At first

I was reluctant, knowing full well the work involved and that ventures of this sort usually wound up with but a few people carrying the main load, ultimately to fail because of general apathy. Further, the experience of the ill-fated "American Panchax Association" was not unknown to me. However, Bob was particularly interested in developing a professionally produced publication strictly for killies, and as he had had considerable publishing experience and access to processes and printers, his suggestion became persuasive. Then, too, the challenge of developing a really successful national aquarium organization was appealing and ultimately irresistible.

By our fifth highball, we mutually agreed to attempt the formation of a national killifish association. It was decided that Bob would handle publicity, membership and correspondence, and that he would simultaneously work out plans for a publication; to me fell the task of organization, planning, operations and By-laws. On this note we parted, Bob returning to Kansas City, his home at that time.

THE LETTER THAT SUMMARIZED IT ALL

After Bob left Middletown and returned home, he sent me the following letter:

June 22, 1961
Dear Al:

I have been doing a lot of thinking since seeing you last week...and a little work, too. You know more about these things than I do, but it's possible that what I am sending you might be the starting point of the International Killifish Society. Before I explain some of the things I thought about, I would like to say that I liked you very much and was very impressed with your frank and sincere manner. I feel that I am much the same as that...and like people who don't beat around the bush.

This I.K.S. idea has to work! I know it can be done if the information can be put out to the people. It is something that we have needed for a long time... and I hope you were sincere when you indicated that you would put all your efforts behind it.

I don't know whether or not you had a chance to write to Helen Simkatis... and it is quite possible that she has already told you that such a Society already exists — or that the possibilities of such a group are rather lukewarm. I hope no one is able to discourage you. I'd hate like hell to have to try to organize a thing like this on my own.
I hope you will look over the enclosed letter and questionnaire. Naturally they won't be absolutely correct, but as I said before, they might be a starting point for us. The letter is long — I know that — but it will take quite a bit of explaining, and I couldn't see any other way. We could send it out to anyone who inquired about the proposed Society through

Co-founder of the American Killifish Association, Robert O. Criger.

articles done in the various aquarium magazines. Of course, we would want to send it out immediately to those people we know are already avid killifish breeders. They'd form a nice nucleus from which to work...and I beleive (Sp?) each would want to join. (It's believe, isn't it?) It might not be such a good idea to send these things overseas written in English, but maybe you'll have a few ideas on this.

I am certainly not a rich man, but I would be willing to absorb some of the costs of getting this thing off the ground until we could get going. I can handle the printing in Kansas City...and will come up with enough letters, questionnaires, and return envelopes to take care of several hundred inquiries (or more, for that matter, if this thing should catch on). I will also handle the postage, and if we ever get any money, you can pay me back. I would also be willing to try my hand at getting out the publication, though my technical knowledge might embarrass us if it were thoroughly checked each time. I could also handle the compilation of news letter material and get it printed and distributed. I do not want to handle the organization's funds — you could simply send me a check when I send you some bills.

Charter Committee Member of the American Killifish, Association, John L. Gonzales.

There are, of course, some disadvantages in having the Society publication based in Kansas City, Missouri rather than New York or some-place like that. But if it is necessary, I'll do most anything to give this group a chance to get started. I want nothing in return other than new friendships and new killifishes.

I am sure you will be able to improve on the letter and questionnaire, so go head and tear it apart if you like, and send me a copy of what you come up with. I don't see any reason for fooling around too long with the idea. Let's get the letter started — let's make the contacts with as many publications as possible and give them the necessary information about the proposed group — let's get our printing done — and let's start mailing out letters and questionnaires to those we already know in the hobby.

I make it sound easy, huh?

Don't let me down, boy. I've got a printer already lined up and we can even have a four -color cover on the magazine if we can come up with the transparencies. If you wish to consider the possibility of having out-side advertising in the magazine, let me know what should be done along these lines. As far as the legal matters involved in a venture of this kind, maybe I can shove that off on you. I would make a lousy lawyer.

By the way, did you write to Bruce? I did, and if you didn't, he will probably be shocked as hell when he gets my letter. It probably sounded like I've known him all his life. Is he touchy?

The Sjoestedti I got in Cleveland are beautiful and I am getting them accustomed to my

tanks. I can't think of a reason in the world why the little boogers shouldn't spawn for me so I'm plowing ahead as if I didn't have good sense. Everyone I've talked to so far says they are nearly impossible to spawn. Maybe so. We'll see.

I'll be waiting breathlessly to hear from you, old friend, so get going with the old grey matter, and let's do something for the world of the killifishes.

Thanks again for driving up to Middletown to see me. The pleasure was definitely mine.

Your friend, Bob Criger.

The "International Killifish Society" mentioned in his letter was the name we came up with during our face-to-face meeting in Middletown. However, because of the way I decided to structure the organization, it was not feasible to make it a truly international organization so I settled on the name, "American Killifish Association" and this was the name I proposed to the Charter Committee. The enclosed letter that he mentioned was a draft of the announcement of the formation of the association that we planned to send to all the aquarium magazines, the final version of which I will show shortly.

In establishing any new organization, it is necessary to formulate both a short-term and a long-term plan. The short-term plan is the one that gets the organization going, and the long-term plan is the one that keeps it going. During that historic evening in the summer of 1961, Bob Criger and I formulated the following short-term plan. (1) We would start a three-month writing campaign to appear in as many aquarium publications as we could reach, describing the aims of the organization and the hobbyists who were supporting it. (2) We would describe the quarterly magazine we intended to publish, as well as our plans for a fish and egg exchange. (3) All those joining before January 1962 would be Charter members voting for the first Board of Trustees and the choice of fish for the Club emblem. They could also voice their opinions in a questionnaire we prepared that would help the Charter Committee in shaping the directions the organization would be taking in the future; they also could nominate persons for the first Board of Trustees that would convene in January 1962. In other words, we didn't just say, "Hey folks, would you like to join a killifish club?" Rather, a carefully considered campaign was conducted to show what the organization would look like and what it would do for those who joined. The lack of a short-term plan was, in my view, the main reason why the American Panchax Association failed to get off the ground.

THE CHARTER COMMITTEE

The role of the Charter Committee has not always been understood correctly. I had four reasons for forming this committee. First, we needed a cadre of aquarists well-known in killifish circles that would lend credibility to the proposed organization. Second, we needed a small staff to publicize the new association in and to recruit Charter Members from their respective geographical areas. Third, we needed a test group to experiment with the idea of conducting business via the mails, and to work out any of the bugs encountered before the first Board of Trustees took office. Fourth, since Bob and I were not the only ones with ideas, the proposed organization needed to garner as many as possible from this select committee of well-known killifish fanciers to get it off to a rolling start.

With Bob in Kansas City and I in Cincinnati, we already had a fair start of sorts on geographical dispersion. I then initiated a search for aquarists living in other areas who were interested in participating in and contributing to such a committee. My first invitation went to John Gonzales, then of Philadelphia. John was one of the real "old-timers" in the hobby. He was, for example, the first American aquarist to breed *Rasbora maculata*; a keener mind and superior breeder of kil-

lies could not be found. Due to a chronic back injury, John was forced to retire relatively early in life, but as he could not stand to be idle, he had decided to breed selected groups of fishes for the commercial market, i.e., those fishes requiring too much individual attention for commercial hatcheries to handle. Primary among the fishes he bred were killies.

In Chicago, we found two men with excellent qualifications. One was Charles Glut, an engineer who was gaining a reputation as an "innovator" in the killifish field. The other was George Maier, who possessed an enviable record of years of experience with aquarium fishes, particularly killies. At the time, George (who, with his wife, operated a fish store) was Advisory Editor of the now defunct TROPICALS magazine. George Maier, it might be mentioned was a man for all occasions. His technical craftsmanship was flawless and his warmth for people unsurpassed.

The next to be invited was Bruce Turner, of New York City. Bruce, then a student at Brooklyn University, lived, ate and breathed killifishes (he later was to become a professional ichthyologist specializing in killies). He corresponded with collectors and professionals all over the world, and could rattle off the musty references to killifishes in the literature of a hundred years ago with the same facility the more typical teenager rattled off baseball averages. The last member of the Charter Committee was Bernard Halverson, a chemical engineer who had attained a national reputation when he persuaded the Houston Aquarium Society to sponsor the sale of dwarf white worms, a fish food then relatively unknown in the hobby. These men provided at least some of the geographical diversity I thought to be critical.

Unfortunately, I had made a serious error that I have always regretted, i.e., selecting two of the five from the same area (Charles Glut and George Maier were both from Chicago). I did this because, at the time, they were extremely well-known in the killifish hobby in the east. A much better decision would have been to include an aquarist living on the West Coast, the logical choice being Gene Wolfsheimer. Unfortunately, by the time this situation was realized it was too late, since these five had already been asked and adding Gene would have brought the Charter Committee membership to an even number. Because of ties, an even number is not ideal for any committee.

In order for a committee of seven people dispersed about the country to operate without chaos, some system of corresponding had to be devised. Thus, the Charter Committee served as an experimental vehicle in which to work out the modus operandi that basically was to be used by future Boards of Trustees of the AKA. John Gonzales was instrumental in suggesting the technique that finally proved workable. Briefly, the chairman of the group sent his letter to the others about the first of the month; by the middle of the month the others sent their letters, with copies to all. The function of the chairman was to summarize the comments, formalize motions, assign motions a number and a place on the agenda, and to conduct and record the vote. Thus, regardless of where a participant resided, he shared the involvement in policy-making equally with the others in the group. The chairman had no greater powers than his peers. He was an equal among co -equals, but traditionally acted to minimize the discord that frequently plagues voluntary decision -making bodies and to expedite the flow of business. This approach served to eliminate the one-man-show responsible for the many prior failures of national organizations.

As might be expected, many of the individual members of the Charter Committee had particular interests in the structure of the Association. Bruce Turner and I, for example, had been seriously concerned over the loss of killifish species within the hobby over time. It was not uncommon for a newly imported species to be raised by a few aquarists and, within a few years - whether because of inbreeding or loss of interest or whatever - dis-

appear from the hobby. Therefore, Bruce and I proposed that we establish something we called "The Egg Bank." The idea was that, for each species thought to be in jeopardy, we would recruit a number of volunteers to maintain and breed that particular fish. However, a majority of the Charter Committee thought that this was unnecessary, their argument being that these species would be automatically kept up through the fish and egg exchanges that were to play an important future role in the Association. This, like the name of the organization, was a friendly disagreement, and since we could see their point, Bruce and I abandoned the idea.

Charles Glut devoted much time to setting up the fish and egg exchange, Bruce Turner applied himself mainly to the organization's acquisition of new species, George Maier cultivated crucial support from aquarists in the important Chicago area (George was responsible for recruiting more members to the AKA in its first year than any other person) and I occupied myself with the preparation of the bylaws. All of us, however, actively discussed and debated all aspects of the new organization.

Co-founder of the American Killifish Association, Robert O. Criger, in his fish room.

With regard to the fish and egg exchange, a dispute arose between Charles Glut and most of the rest of the committee (as Chairman of the Charter Committee I was obliged to remain neutral) over whether or not the AKA should set the asking prices. The general thought was that a free market system would be the most efficient and that prices should be unregulated. However, Charles strongly insisted that the AKA institute a price schedule, and woe to those who disagreed with him. As a result, John Gonzales in particular, and later Bob Criger, were the major recipients of some verbal abuse. Now John had been active in the aquarium hobby longer than any of us, having started keeping aquarium fishes in 1928, a year before I was born. He therefore was not about to take any nonsense and so a real donnybrook developed, albeit conducted through the mails.

The very nature of communicating via the written word allows one to express thoughts and feelings with an openness and frankness that is unusual in face-to-face or telephone conversations. The trouble is that, without the tone and expression of a voice, or signals given out by body language, the potential for misunderstanding is considerable. Nowadays, because of electronic communication, we have "Emoticons" (e.g., the "smiley face") that can be included in a written sentence to help clarify and express one's feelings. Unfortunately, we didn't have emoticons in those days, although we sure could have used them in this instance!

During this time, Bob Criger, acting as publicity liaison officer, contacted all of the national aquarium magazines with a view towards publishing news of the proposed organization and keeping aquarists informed of the progress of the Charter Committee. All agreed to cooperate with the single exception of the TROPICAL FISH HOBBYIST. Although the AQUARIUM JOURNAL, TROPICALS MAGAZINE, and THE AQUARIUM magazine published many progress reports and announcements

regarding the AKA none ever appeared in TFH. Bear in mind that by no means am I taking to task the present editorship of TFH; all this occurred 47 years ago and many editors have since come and gone. The following is an example of Bob's PR work, published in TROPICALS MAGAZINE, Fall Buyer's issue, 1961:

NEW GROUP BEING FORMED -
AMERICAN KILLIFISH ASSOCIATION
By Robert O. Criger

It was bound to happen sooner or later… and the sooner it happens the better, according to seven killifish fanciers from many parts of the country who recently got together and discussed the possibility of forming a society for persons interested in killifish (sometimes called Panchax). The men have tentatively selected a name for the group the American Killifish Association.

"The name might turn out to be something entirely different from that," said Bob Criger of Kansas City, Mo., who is handling the publicity for the group until a permanent publicity chairman is selected when elections are held for the organization. "We plan to send a questionnaire to anyone who will write for it," he said, "and let them help select a name if they don't like the one we have already chosen."

Criger also said that the questionnaire will give anyone interested a chance to express his views and ideas on mane other matters before the club is officially formed.

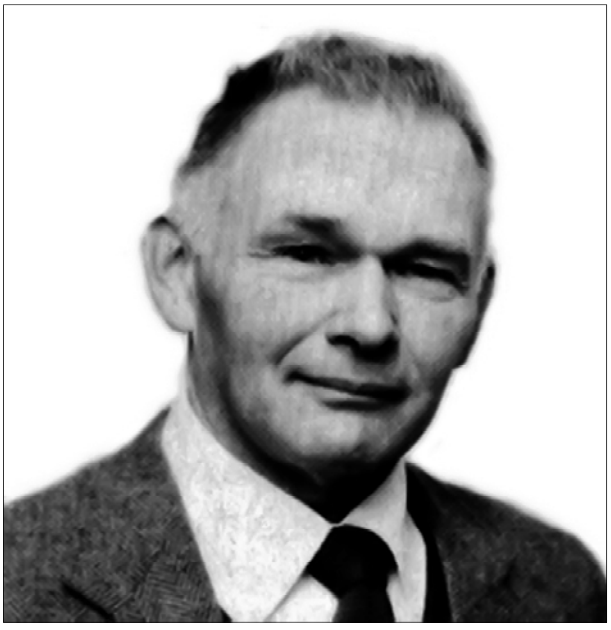
The most important ideas behind the organization, perhaps, are to increase the knowledge and skill of killifish hobbyists… to bring in many of the seldom seen species of killifish… and to distribute eggs of these species to the club members. It is the plan of the group to set up Egg Banks in the fish rooms of many of its members through-out the country to insure that once a new species is brought into America, it will always be available to members of the group.

The proposed group also plans to publish a quarterly magazine dealing exclusively with killifish, as well as a monthly newsletter through which members can buy, sell or exchange killifish and eggs. The magazine will contain articles written by advanced aquarists about killifishes and things pertaining to spawning and raising them.

The group plans to hold the membership open for the first 60 to 90 days so that all who wish to join as Charter Members may do so. Anyone joining after that will hold a regular membership.

An election for the Board of Directors and Committee Chairmen will be held after all Charter Members have joined.

Criger stressed that it was the feeling of those already interested that a large number



Charter Committee Member of the American Killifish Association, Bernard K. Halverson.

of members was not nearly as important as a "good, solid nucleus of dedicated killie fanciers." He also said, "We have even discussed having two types of memberships — one for beginners, whom we will help get started through the Egg Banks — and the other for the advanced hobbyists."

The other men who have joined their thoughts to the idea of forming an American Killifish Association are Albert Klee of Cincinnati, O.; Charles Glut and George Maier of Chicago; Bernard Halverson of Houston, Tex.; John Gonzales of Philadelphia, Pa.; and Bruce Turner of New York City. All are enthused about the idea and hope that once the American Killifish Association is formed and operating, overtures can be extended overseas regarding the possibility of forming an international group.

Complete details about the proposed group… and a questionnaire… can be obtained by writing to Robert O. Criger, 7405 East Gregory, Kansas City 33, Mo.

Compared to the egg bank controversy, a friendlier disagreement arose concerned with the naming of the new organization. The two main proposals advanced were: American Killifish Association, and American Panchax Association. The problem with "Panchax," however, was that it was based upon a scientific name long since abandoned by the profession, and one applied originally only to a very few killifishes. George Maier thought that it would be misinterpreted to mean a fish that killed others but then such fears could be applied to fishes such as "tiger" barbs, tricolor "sharks," etc. I pointed out in jest that pussycats are perfectly safe in the Catskills, and the Committee voted unanimously to adopt the AKA name.

It was a personal triumph for me when the Germans threw in the towel and abandoned their beloved, "Eierlegende Zahnkarpfen (egg-laying toothcarps)," calling their organization the Deutsche Killifisch Gemeinschaft. The French, of course, went their own way and called their organization, the Killi Club de France, but at least they got the term "Killi" in there! Since the history of the origin of the terms "Panchax" and "killifish" is a story unto itself, I present it separately in the article in this Compendium titled, "The Story of Panchax and "Killifish."

THE BY-LAWS

The by-laws of the AKA contained several novel features. A seven-man Board of Trustees was devised as the policy-making force for the Association. For continuity, three were elected in odd-numbered years, four in even-numbered years, and all served two-year terms (an early amendment to the bylaws stipulated that the Trustees had to take at least a one-year "vacation" before they could run again for office). Only members from the United States or Canada could vote or hold trusteeship office (foreigners were considered, of course, but the problems of conducting business via the mails among counties made it inadvisable).

Although Bob Criger and I had dealt with the short-term plans for the AKA, there remained the long-term problem, that of the extended survivability of a truly national association. This was resolved by the following two Articles in the by-laws. The first was an important clause read: **"...no more than two Trustees of the seven shall reside in the same State in the case of the United States, or in the same Province in the case of Canada."** With one clause then, the new organization avoided the old problem of regionalizing or concentrating power in any one particular area, an occurrence that killed many a prior national aquarium organization. Perhaps even more important was Article VII, **"Mode of Operations," which stated: "Insofar as it is applicable, the business of the Association shall be carried out by written correspondence."** Thus, in the AKA, anyone could run for the Board of Trustees and expect to participate equally with other Trustees if elected. It was no

longer necessary to be rich, retired, or both to fulfill one's obligations as a Trustee. One did not have to travel, say, from Alabama to California to vote at a national convention or in vis-à-vis committee. A $.06 stamp and a little time was all that was required. These by-laws were adopted unanimously by the Charter Committee.

All this occurred thirty years before a system was developed to simplify navigation on the Internet and another ten or so years before personal computers were common. The problems we faced in communicating in 1961, therefore, no longer exist today. I firmly believe that without these two provisions, the AKA would have been only one of many others, rather than the single, influential and international one it is today. As it turned out, the AKA's by-laws became the model for most of the specialty organizations that came after it. Indeed, shortly after the formation of the AKA I suggested to my good friend Richard Stratton, the founding fellow of the American Cichlid Association, that a national cichlid group be formed along the lines of our association, using its by-laws as a starting point. Although I had hoped that we were able to do this together, the launch of AQUARIUM ILLUSTRATED, where I was involved as its editor as well as one of its publishers, made it impossible.

Charter Committee Member of the American Killifish Association, George J. Maier.

Towards the end of 1961 Bob Criger, then acting as Secretary of the Charter Committee, asked all fourteen nominees running for the first Board of Trustees to prepare a resume consisting of no more than 50 words that would be placed on the ballot for our first election. Charles Glut objected, however, and insisted that he be allowed more. Bob, however, held his ground, the result being that Charles withdrew his nomination at the last moment. John Gonzales, who was in poor health at the time, was uncomfortable serving on a Board where such discord might erupt in the future, also withdrew his nomination at the last moment, although I tried hard to convince John to stay on the ballot. These actions could have caused us some difficulties, but there were a sufficient number of nominees so that all we had to do was to select the seven who garnered the highest number of votes.

THE ORGANIZATION BEGINS

At the beginning of 1962, prospective members had sent in $5.00 for their first year's dues and voted for seven Trustees and their choice of fish for the club emblem. Fourteen aquarists had been nominated for Trustee, based upon recommendations received by the Charter Committee and from interested aquarists during the latter part of 1961. In order that hobbyists would know who they were voting for, the bibliographic sketches noted above were prepared by the candidates, edited into a standard format by Bob Criger and distributed to the voters. Although Bob's PR announcement sent to the aquarium magazines had stated that Charter members would be able to vote on the final name for the organization, the Charter Committee decided that this would only delay getting the organization started and opted

not to have a vote on the name. If the membership objected, they could always change it later.

The top seven votes for the Board of Trustees were as follows:

Criger, Robert O.	**114**
Klee, Albert J.	**89**
Weitzman, Stanley H.	**86**
Adams, James N.	**85**
Maier, George J.	**80**
Haas, Richard	**79**
Seligmann, Edward B., Jr.	**63**

There was not enough time to remove the names of Charles Glut and John Gonzales from the ballot, both of whom requested that their names be removed, but if they had stayed on, Charles Glut would have nosed out (by two votes) John Gonzales, replacing Ed Seligmann as a Trustee. Following the AKA by-laws, the Board of Trustees elected their own officers and so I was elected as Chairman of the Board, with Bob Criger as its Secretary and Stan Weitzman as its Treasurer.

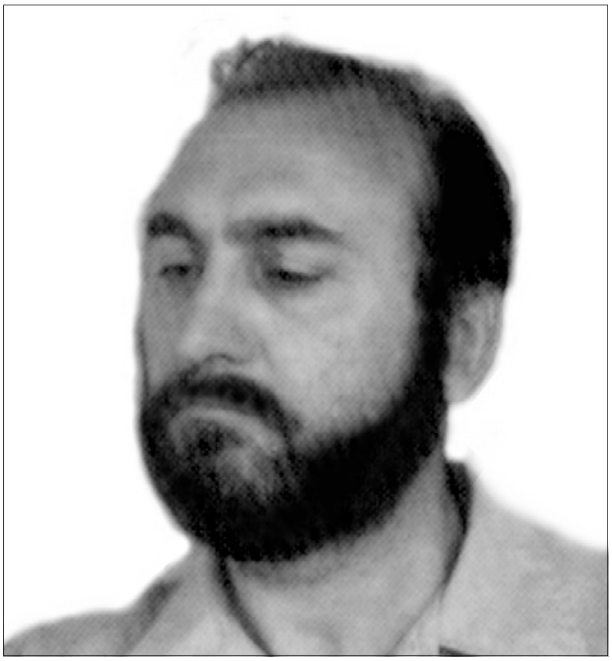
The top four votes for the AKA emblem were as follows (the names are those used at the time):

Aphyosemion gulare coeruleum (blue gularis)	**48**
Aphyosemion australe (lyretail)	**42**
Aphyosemion bivittatum	**18**
Nothobranchius rachovi	**16**

From the start, the AKA's publication program was a resounding success. KILLIE NOTES (a professionally produced offset publication) came first. This was a mixture of topical club news and technical material. It was later decided to separate the two functions, and when the Association had sufficient funds, the publication was discontinued with two new ones taking its place: the AKA NEWSLETTER and the JOURNAL OF THE AMERICAN KILLIFISH ASSOCIATION (JAKA). Because the AKA depends so heavily upon the exchange of fishes and eggs among its members, a booklet entitled "Killifish Exchanges" was published soon afterwards. A host of other specialized publications appeared, the most important of which included a beginner's guide and the KILLIFISH INDEX. In short, the publication activity of the AKA has been extraordinary — no other aquarium organization has ever matched it.

One of the most effective instruments for selling killifishes to the public and for recruiting new members proved to be the AKA's audio-visual (slide/tape) program. Sight and sound told the Association's story and the story of killifishes. It was loaned free of charge to responsible hobby organizations.

One of the really vital activities of the AKA was, and still is, its free (to members) egg and fish listings in its monthly newsletter. This enabled fanciers all over the world to obtain, exchange, and even sell many different species of killies. From a historical standpoint, two species of killies in particular spurred special interest in the hobby in the late 1950's and early 1960's. Indeed, they were partly responsible for the founding of the AKA in



Charter Committee Member of the American Killifish Association, Charles F. Glut.

that they created a general interest in the family. These species were *Aphyosemion filamentosum* (now *Fundulopanchax filamentosus*) and *Aphyosemion nigerianum* (now *Fundulopanchax gardneri nigerianus*), the former because it was a new, reasonably-sized and an easily-bred "bottom spawner" (bottom spawners being relatively rare at the time) and the latter because it was an easily -bred fish and a brightly-colored, exciting new "top-spawner" introduction. The AKA should really erect a monument to these two species! Another species important to the early AKA was the blue gularis. It was a natural "salesman" for the association.

Thus, there were two co-Founders of the AKA, Robert O. Criger and Albert J. Klee; seven Charter Committee Members, George J. Maier, Bernard K. Halverson, Bruce J. Turner, John L. Gonzales, Charles F. Glut, Robert O. Criger and Albert J. Klee; and 145 Charter Members, the last listed in the Appendix. The formation of the American Killifish Association was a labor of love for all who participated, and I for one wouldn't have missed it for anything!

An early American Killifish Association meeting in the NY-NJ area in the early 1960's. Left to Right: Peter Hall, Albert J. Klee (Co-founder), Bruce Turner (Charter Committee Member), Rosario LaCorte, Richard Blanc and John Gonzales (Charter Committee Member).

Appendix: Charter Members of the American Killifish Association (i.e., Members who joined prior to December 31, 1961).

Adams, Dr. James N.
Allen, Franklin C.
Arnold, Herbert
Avaritt, Vernon K., Jr.
Bailey, Clyde Lee
Barron, William E.
Batson, Rev. Schuyler M.
Bezzek, Henry
Bishoff, Edward J.
Blackburn, Mrs. Dorothy G.
Blanc, A. Richard
Blomeley, Mrs. Helen J.
Boboricken, Stephen
Bode, George M.
Borchers, Curtis E.
Boxley, Adelbert
Britton, Leonard C.
Burns, Herald A.
Buttner, Richard
Chambers, Horace F.
Christiansen, Chris
Church, Edward A.
Collier, Glen
Collins, John P.
Cook, William Richard
Criger, Robert O.
Curran, William E.
Dahlin, George K., Jr.
Daly, Joseph J.
Daniel, James H.
Diehl, Robert F.
Dillard, Kenneth A.
Dramstad, A. Gordon
Dyer, William
Edwards, Gary
Emery, Dr. Frederic B.
Epstein, Dr. Eugene U.
Erichsen, Robert
Eyles, Philip
Fitzpatrick, Martin John
Foster, Gordon T.
Foster, Neal R.
Fox, Barry L.
Fuqua, Francis H., Jr.
Gardner, John E.
George, John E., Jr.
Glut, Charles F.
Gonzales, John L.
Greer, Lemuel Judson
Greig, Dr. Jack L.
Haas, Richard
Hallenbarter, Edwin
Halverson, Bernard K.
Hanisco, Edward
Hayter, Lyle Wm.
Hess, Chris
Hild, Norbert G.
Hill, Stanley W.
Hosford, Harry E.
Imshaug, Henry A.
Ingham, Ray W.
Irby, Bill C.
Jacobson, Ronald P.
Jagielski, Edwin
Jauer, Mervin B.
Johnson, Harold E.
Jurewicz, Michael
Kelly, James J.
Kemper, Bryan
Kenny, Thomas Eugene
King, Albert
Kitchen, T.L.
Klee, Albert J.
Knapple, G. Rex
Kowalski, Joseph P.
Krys, Gene A.
Kuhn, Grant L.
Kuhn, Mrs. Lorraine L.
Lally, Kenneth P.
Law, Richard W.
Ledecky, Emanuel
Locke, Gordon A.
Lorbiecki, Bunny
Lorentz, Lyle J.
Loria, Michael
Lugenbeel, R.G.
Lyle, Robert J.
Mackie, Lorne William
Mahken, Conrad
Mahoney, Francis W.
Maier, George J.
Mara, Frank J.
Markis, Alan Chas.
Marshall, James W.
McCoy, Herschel G.
McAninch, Lt. Col. W.T.
McDonald, Mrs. Frank P.
Newell, Robert J.
Newton, Robert L.
Overton, Mrs. Mary E.
Parish, Vernon L.
Paugh, Guy I.
Phillips, Lawrence E.
Plummer, Ralph R.
Potter, William T., Sr.
Prindle, Austin L.
Puckett, Keith
Ramer, William B., Jr.
Reeve, Leonard
Ricco, Joseph F.
Roberts, Lonnie Fred
Rocco, Ronald Rogers, David R.
Scarabino, Patsy R.
Scheline, Ronald R.
Schildknecht, Edward A.
Schultz, William R.
Scrantom, John Gardner
Seligmann, Dr. Edward Jr.
Shaw, Harland D.
Sherman, Ronald
Siegal, Harvey
Sleeth, Jerry
Slusarczuk, George M.J.
Smith, Stanley M.
Specht, Dr. Harry O.
Stamm, Justin E.
Stanley, Marvin
Stimpfling, Dr. Jack H.
Stone, Dr. Richard L.
Stradford, Leonard
Stuck, Al
Tomlin, Glenn P.
Troeger, Martin
Turner, Bruce
Turner, Daniel L.
Valentine, Howard M.
Voorhees, Leslie J.
Weinschenk, Samuel K., Jr.
Weitzman, Stanley H.
Werner, Franz
White, Mrs. Josephine
Widener, Paul
Wilie, William L., Jr.
Wittkopf, Paul
Wolff, Dr. Peter C.

THE FIRST ARTIFICIAL BREEDING OF FISH

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, March 8, 2014)

As I have previously documented, the luxurious and extravagant habits of imperial Rome involved the maintenance - but not the breeding - of fish in both saltwater and freshwater ponds. With the overthrow of that empire, its civilization and its industry, this practice was discontinued, and the art forgotten. But it was revived in the middle ages by the religious observances of the Catholic Church, which, by determining that fish and certain favorite species of water fowl were not *fleisch*, and accordingly not forbidden food at seasons of fasting and mortification, ingeniously contrived to reconcile the indulgence of the palate with the discipline of Lent.

To every favorably situated monastic establishment was attached a fishpond, which not only supplied the tables of the professed during the prescribed fasts, but often yielded a considerable revenue from the sale of fish to worldly penitents. The success of the monks led to the extension of this branch of industry, and large ponds were constructed by laymen, so that in the sixteenth century fishponds were an appurtenance of most great estates whether lay or ecclesiastical.

The following is a summary taken from a manuscript dated 1420, found by the Baron de Montgaudry while hunting among the musty archives of the Abbey of Reome. It is extracted from de Montgaudry's report of 1854, with my translation following.

"La pisciculture n'est pas chose nouvelle. Depuis plusieurs siècles, les moines s'en occupaient et savaient peupler les étangs et les cours d'eau de leurs domaines des espèces de poissons qui pouvaient y vivre et s'y multiplier. Dans le cours du quatorzième siècle, dom Pinchon, moine de l'abbaye de Réome, écrivait sa manière de procéder.

"Il avait des boîtes longues en bois, à fond de bois, grillées aux deux extrémités en grillages d'osier, ouvertes en haut et couvertes d'un grillage d'osier. Sur le fond de bois, il formait un lit de sable fin, et, imitant la truite qui creuse un peu le sable avant d'y déposer ses œufs, il préparait une légère profondeur dans la couche de sable pour déposer les œufs qu'il avait préalablement fait féconder. Il plaçait la boite dans un lieu où l'eau était faiblement courante et attendait l'éclosion, qui, à son dire, s'opérait après vingt jours rarement, et pour tous les œufs dans le mois à peu près."

"Fish farming is not a new thing. For several centuries, the monks knew of fish species that could live and multiply in cultivated ponds and streams within their areas. In the course of the fourteenth century, Dom Pinchon, a monk of the Abbey of Réome described his technique.

"He constructed long wooden boxes, both ends covered by a wicker mesh and open at the top but covered with a similar wicker mesh. On the wood bottom he formed a bed of sand and, imitating a trout digging a little sand before depositing her eggs, he prepared a shallow hollow in the layer of sand to place the eggs that had previously been fertilized. He placed the box in a place where the water was running gently and hatching could be expected, which, according to him, rarely took place after twenty days but with all the eggs hatching in a month or so."

How the reverend father obtained his spawn is unfortunately not recorded; but obtain them he did, and no doubt received the blessing of his confreres for the welcome additions to their larder.

I have supplied the original French from de Montgaudry's report of 1854 since there has been some controversy over whether Dom Pichon artificially inseminated his eggs. The following is taken from Jules Haime's 1873 paper on the history of fish culture in Europe:

"It appears, nevertheless, that toward the end of the middle ages new methods were sought for, which might serve to increase the production of fish; a monk of the abbey of Réome, near Montbara, named Dom Pichon, conceived the idea of artificially fecundating the eggs of trout by pressing out in turn the products of a male and female of this species into water, which he afterward agitated with his finger."

Haime provides the following footnote for the above:

"M. De Montgaudry explained the hatching-box of Dom Pinchon at one of the last sessions of the *Zoological Society of Acclimation*, and was kind enough to inform us also of the manner in which the monk of Réome effected the fecundation of the eggs."

However, the following is taken from James W. Milner's paper - in the same publication - on the progress of fish culture in the United States:

"The evidences advanced to prove a knowledge of the third method referred to, before the time of Jacobi, are not, so far, sufficiently definite, and the data produced by Baron de Montgaudry to show that Dom Pinchon was the inventor of the art, in so far as it involves artificial fecundation, are very unsatisfactory.

"The description he gives of the apparatus proves Dom Pinchon's process in caring for the eggs during the period of development to have been the original of the trough method. The manner of procuring of the eggs is not referred to; he merely explains how he prepared the bed of sand upon which to deposit the eggs which he had previously made fecund.

"The Baron based his statements upon the manuscript found at Réome, without quoting from it, and leaves his readers in ignorance as to whether the mode of obtaining the eggs is described in the original.

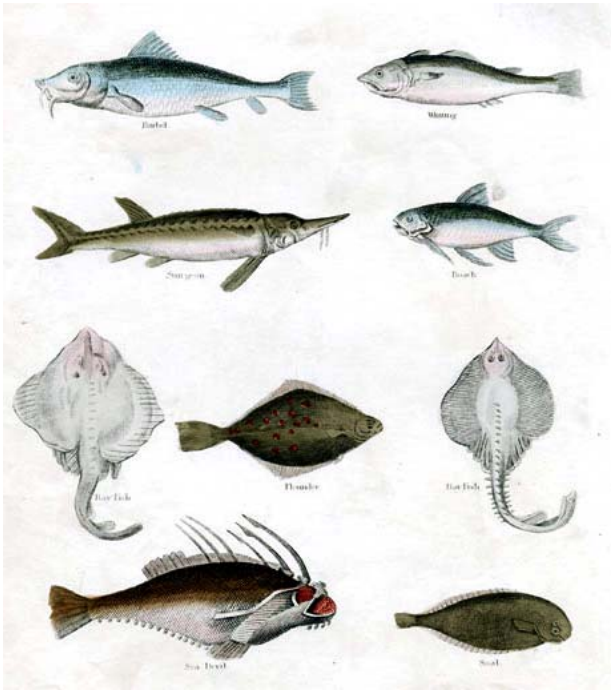
"In the absence of any publication of the manuscript the only data to support the claim are the statements made by Baron Montgaudry and the reference in a foot-note of Jules Haime's paper on pisciculture to the method employed for obtaining the eggs; this information on the subject afforded by Baron Montgaudry, and referred to in the foot-notes, was probably imparted in conversation, as there is no record of it in the papers published in the *Bulletin* or in the report of the *Procès-verbaux des séances* of the society from the time of Montgaudry's references to Dom Pinchon to the date of publication of Jules Haime's paper.

"The publication of the manuscript, if it is still in existence, would clear up the uncertainty and afford a definite record for the history of this important advance in the art of fish culture."

Although admittedly a bit cavalier about his references to Dom Pichon, Baron de Montgaudry's credentials are impeccable. He was the French Consul at Shanghai and Ning-po in 1855, and the grandnephew of Georges-Louis Leclerc, Comte de Buffon, 1707 –1788, the celebrated French naturalist, mathematician, cosmologist, and encyclopedic author. Serving as Consul, he sent back the first tofu seeds to the Society for Acclimatization in France, arriving under the name, "oil peas of China," (*Pois oléagineux de la Chine).* He was the President of the Société Centrale d'Apiculture, and Secretary and Member of the Board of Directors of the Société Zoologique d'Acclimatation. He rubbed elbows with Isidore Geoffroy-Saint-Hilaire, Baron de Rothschild and other notable French men of science of the day.

Because this information on how Pichon obtained his fertilized eggs was given to Haime orally, the piscicultural community generally recognizes Dom Pichon as the first to breed

fish but not the first to devise and use artificial insemination. Dom Pinchon is then, in all probability, the first inventor of artificial breeding. His work had, of course, had no influence on the progress of pisciculture, and is only interesting from a historical point of view. To aquarists, however, who obtain their fertilized eggs directly from their fish and breeding starts with them, the historical aspects are of somewhat greater interest.



Illustrations taken from Buffon's *Histoire naturelle, générale et particulière* (1749–1788, in 36 volumes. The bottom image shows sticklbacks spawning and nesting.

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"Fish" versus "Fishes"

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Message 8453, May 17, 2009)

The origin of the word "fish" is Old English (fisc), Common Teutonic (fisco) and pre-Teutonic (pisko), the last-named which is cognate to the Latin "piscis." Early taxonomic ichthyologists started writing in Latin and since there is a clear division in that language for one fish and more than one fish (piscis for the singular and pisces for the plural), it was only natural that they used this singular/plural to differentiate between one species and a plurality of species even when they started writing in the vernacular. (It should also be mentioned that "fishes," with an apostrophe, also serves as the plural possessive of fish; e.g., "the fishes' scales were yellow," and, of course, "fishes" is the present-progressive verb (e.g., "he fishes in the river").

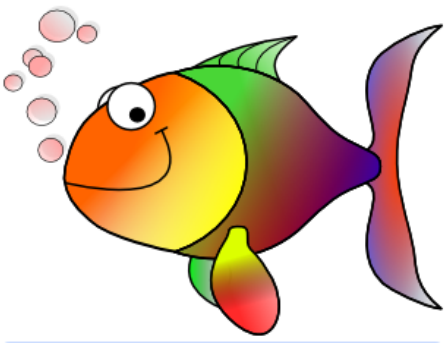
Over the years the rule in common parlance - excluding aquarists - has been to use "fish" for either a single fish or for a plurality of fish no matter whether the plurality involves more than one fish or more than one species of fish. In the early days of the aquarium hobby, however, the regular plural of fish ("fishes") was commonly used, such as "goldfishes." This, of course, has changed and that term is nowadays rarely used. Today, aquarists more often or not use the irregular plural ("fish"), e.g., "catfish" rather than "catfishes," even though reference is to more than one species. Although there is nothing to keep me from saying that I have a collection of fishes, I find it awkward and some of my friends find it a bit stuck-up for me to say anything other than that I keep a collection of fish. It often boils down to what one is comfortable in using. I would, for example, in writing about the ichthyofauna of that country, opt to use "The fishes of Guatemala" rather than "The fish of Guatemala," but my choice would be based on how it sounded, not on any grammatical "rules."

Although in biological contexts "fishes" (the "regular" plural) was used to denote more than one species, this usage is fast declining. In 2008, the Executive Secretary of the International Commission on Zoological Nomenclature, Dr. Ellinor Michel, described her background thusly: "My taxonomic specialty is primarily in malacology, but I have also worked on fish, crustaceans, sponges and bryozoans." It is interesting to note that whereas crustaceans, sponges and bryozoans are expressed here using the regular plural, Dr. Michel chose to use the irregular plural for fish (she has a long-standing interest in the role of behavior in evolution and ecology with regard to the cichlids of Lake Tanganyika). Dr. Michel is British and as an American ichthyologist friend shared with me, "Interestingly enough, I find British journal editors, in general, to be more comfortable than Americans with 'fish' as a collective plural. In fact, sometimes when I use 'fishes' as a collective plural, a British editor will try to change it to 'fish.'"

Grammar tends to lay down universal rules while usage lays down particular applications. Grammarians still disagree over whether fish as a plural is an irregular or regular form but in any case, grammarians ultimately must accede to those who speak the language. What many people tend to miss, however, is that usage is dictated by circumstance. The big struggle between grammar and usage is when a grammatically incorrect usage becomes standard or when a grammatically correct usage becomes non-standard. These are moments when most speakers use a term but most grammarians say is wrong. These instances create the great linguistic debates of history. A good example is "Woe is I" versus Woe is me." As Patricia T. O'Conner says in her book, "Woe is I," "Only a pedant would argue that Shakespeare should have written 'Woe is I' or 'Woe is unto me.'"

Following the rules of grammar strictly often makes you look pretentious. Following the rules of usage strictly often makes you look as if you're uneducated or even uncouth.* The answer is to find that middle ground, and with fish versus fishes, I find it by using my ear.

*Regarding "like" versus "as," the rule is that when the word is followed by a clause (i.e., a group of words with both a subject and a verb, as is the case above), "as" should be used; if no verb follows, use "like." However, the ground is shifting and "like" is rapidly gaining in usage on "as."



THE FOUR STAGES OF THE AQUARIUM HOBBY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 18, 2005)

When did the aquarium hobby start? Who "invented" the aquarium? What do we mean when we say the "aquarium hobby" or, for that matter, the "aquarium"? These questions have presented difficulties for hobby historians precisely because there are no universally agreed-upon definitions. Trying to pin down a concise explanation of the meaning of a word or a term sometimes is - to paraphrase a remark of my grandmother's - akin to attempting to estimate the number of angels that can dance on the head of a pin. Even if we were to agree on these definitions (and bear in mind the line from Lewis Carroll's *Through the Looking-Glass and What Alice Found There*: **"When I use a word,"** Humpty Dumpty said, in rather a scornful tone, **"it means just what I choose it to mean—neither more nor less."**) there is no guarantee that this will take us any "forwarder" on our quest to elucidate the hobby. It also should be recognized that, in defining an object, the definition then limits the object, and this may have unforeseen consequences.

One way out of this dilemma is to avoid definitions and instead describe the major stages in the development of the aquarium hobby. The first stage clearly started when people began to keep fish for their ornamental and entertainment value in ponds and in indoor containers, e.g., goldfish by the Chinese a thousand years ago, and the piscina (from *piscis,* a fish, fish-pond, pool or basin – the term later took on different meanings) of the Romans. One can argue that these ponds and indoor containers were not aquariums in the technical sense since, although the owner of any respectable Roman villa could look down upon the animals in his fishpond, they could only be viewed from above through the opacity of rippled water. The same held for the indoor containers of the time since they, too, were opaque-sided. STAGE I of the aquarium hobby, therefore, is what I term **"The Top-Down Aquarium,"** exemplified by these ancient, opaque-sided, outdoor and indoor aquariums that were viewed from above, although obviously STAGE I aquaria are still common today. I use the term "aquarium" accurately here, as originally it was nothing more than a reservoir or large vessel holding water without any specification as to the uses to which that water was applied.

STAGE II is what I term **"Through a Glass Clearly,"** i.e., any container of glass or other

THE FOUR STAGES OF THE AQUARIUM HOBBY

STAGE I:
THE TOP-DOWN AQUARIUM
(circa 4000 BC)
Opaque-sided containers.

STAGE II:
THROUGH A GLASS CLEARLY
(late 1530's)
Glass jars: fish kept for ornamental or scientific study purposes.

STAGE III:
OCEAN AND LAKE IN GLASS
(mid 1800's)
Tanks frequently with flat glass sides; aquarium books; commercial aquarium fish and equipment suppliers; object to emulate a small portion of a natural habitat.

STAGE IV:
ASSOCIATION (circa 1900)
Aquarium societies; exhibitions; competitions; aquarium magazines.

Example of a STAGE I Aquarium, i.e., a goldfish pond.

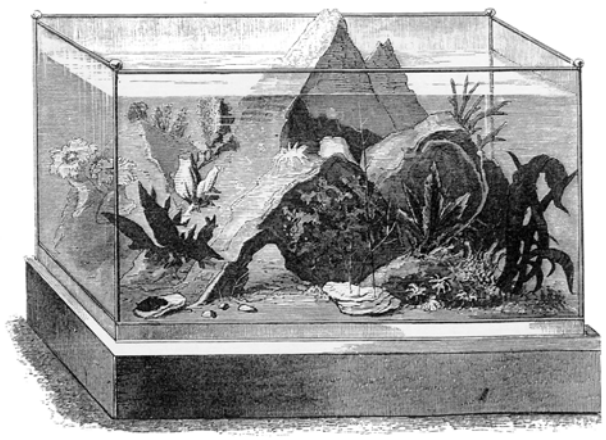
transparent medium that affords the viewing of a fish in the more direct, edge-on, eye-to-eye orientation. Since the Romans produced glass bottles and other glass containers, it might be supposed that they were used to house some of their fishes and thus were the first STAGE II aquarists. Not only is there is no evidence for this, it is highly unlikely since their fishes were rather large for such containers. The Romans, however, did maintain fish hatcheries and may have used glass jars to temporarily house the fertilized eggs of fishes destined to be introduced into waters where they were expected to reproduce and provide a source of food. Again, however, there is no evidence that they did so.

There has always been a great deal of speculation as to who was the first to keep a fish in a glass container. The Romans began to use glass for architectural purposes, with the discovery of clear glass (through the introduction of manganese oxide) in Alexandria around the First Century AD, although it was very expensive. Well-to-do Romans replaced one wall of their marble piscina with clear glass (albeit with poor optical qualities), arguably resulting in the very first aquarium in the sense that we define the term today. However, it was during the second half of the 15th Century that a material known as "Crystallo" was perfected in Venice. This was the beginning of the clear, almost transparent product we normally associate with the word "glass" today. Therefore, whether the Romans should be credited for the first glass-fronted aquarium is open to debate.

The first Stage II fish keeper of record was Jeanne Rondelet, who kept a fish alive in a glass of water for three years sometime in the late 1530's or early 1540's. In the mid to late 1700's, the keeping of fish in glass containers became fashionable in Great Britain and included such illustrious personages as Horace Walpole, the 4th Earl of Oxford.

What the aquarium craze of the mid 1850's in Britain did was to bring on STAGE III of the aquarium hobby, i.e., what I term **"The Ocean and Lake in Glass."** This stage is characterized by the following: (1) first, and most im-

The Stage II Aquarium. Cats and goldfish bowls are almost a cliché in the aquarium hobby.

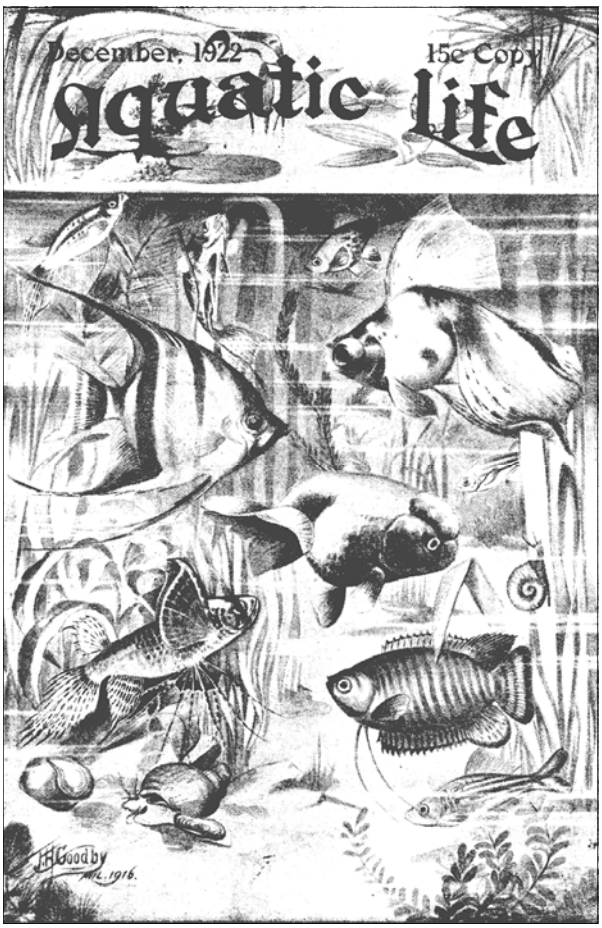


A Stage III Saltwater tank circa 1857.

portant, the interpretation of the aquarium as a mini-representation of a small portion of some natural aquatic environment - the marine aquaria of the day, for example, were frequently referred to as "parlour oceans," (2) an availability of books on the subject, and (3) the existence of commercial establishments supplying fish and equipment.

Towards the end of the 19th Century, improved printing, cheaper mails, and telephone service put people in quick touch with what was going on. It was the age of the periodical and in the aquarium hobby it started with the publication of Mulertt's THE AQUARIUM in the late 1870's and into the 1890's. Tropical fishes were being imported for the first time, starting with the Paradise Fish in 1876, and the others that followed shortly after the introduction of the Chanchito in 1895. In the 1890's, aquarium societies appeared on the scene as well as new authors such as Ernst Bade, Gregory Bateman, Charles Page, and Mark Samuel, ushering in the last stage of the aquarium hobby as we know it today, i.e., STAGE IV, **"Association,"** the notion of aquarium societies, exhibitions, and competitions, all strengthened by improved communication through the appearance for the first time of aquarium magazines, improvements in travel, and the changing nature of cities.

It should be noted that each successive Stage coexisted with previous ones and therefore one can find all four Stages today in various manifestations. Members of the Aquarium Hobby Historical Society are examples of Stage IV aquarists. Although it has been said that the aquarium hobby is the world's largest, since most present day fish keepers simply maintain their tanks for decorative purposes, a source of relaxation, a conversation piece, a learning tool, or teaching responsibility (especially for children), they more accurately may be characterized as Stage III aquarists.



AN EARLY STAGE IV AQUARIUM PUBLICATION.

The Perils of Aquarium History Research

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, September 17, 2012)

The attention of the members of the Aquarium Hobby Historical Society has been drawn to a posting that referred to a monograph that appeared on the Web site of McHenry County College, a two-year community college in Crystal Lake Illinois, written by Peter Ponzio[1] and titled, *Goldfish in America - the 1893 Columbian Exposition*.

In the monograph is a woodblock painting dated around 1700 A.D. that depicts two Japanese women examining a rectangular aquarium of spectacular size, clearly requiring relatively thick glass and exceptionally strong framing, especially considering the width of the framing. This resulted in a query asking whether the flat-sided glass tank pictured preceded anything of the sort found in Western Europe by over 100 years.

With regard to Japanese flat glass, Japan had been unable to support even a single glass-making facility until 1907, although the Meiji government (1868-1912) had tried to establish sheet glass manufacturing. The country had just emerged from 200 years of isolation, and in the last half of the 19th century Japanese businessmen scrambled

Aristocratic Lady of the Tokugawa Period by Hashimoto Shuen,[2] c. 1700 CE
Plate courtesy of *Kingyo*[3]

to compress centuries of technological progress into a few decades of growth. The glass-making field, however, remained open until Iwasaki founded Asahi Glass in 1907 with a factory in Kansai. Instead of merely importing technology from Belgium, then the world leader in flat glass production, he brought over Belgian glass blowers to get his company started properly. By 1909, these artisans had succeeded in producing Japan's first flat glass. In short, there was no Japanese flat glass in 1700.

Nonetheless, the tank pictured could have actually existed since the 1700 date is not particularly early for flat glass. Evidence has been found of glassmaking at the English settlement on Jamestown Island, Virginia and some glass windowpanes were made there after 1608. Flat glass was also, in theory, available in Japan via imports into Nagasaki and Hirado from at least 1616. However, I have gone through all of the illustrations I have come across on Japanese aquaria during the Tokugawa period and can find only two general types: globes and round or rectangular shallow bowls. An illustration (ink and color on silk) of the latter is shown below.

The Kyisai painting is interesting as it depicts an early form of “Discovery,” a method very popular in contemporary nature museums and public

Two Children Playing with Goldfish
Kawanabe Kyisai (1831–1889)4

aquaria where children have an opportunity to touch living creatures. The following are three additional paintings from the Tokugawa period.

An interesting earlier depiction is shown in the bottom image in the collection of the Boston Museum of Fine Arts where a child is playing with a shallow round container of goldfish while a couple is making love.

These shallow containers were later used in a Japanese traditional game started in the late Tokuga-

Child Playing with Goldfish
Tokugawa period, date unknown
Artist Unknown

Fond of Goldfish (Kingyo ko)
Tokugawa period, 1863
Utagawa Kunisada I (1786–1864)

Women Playing with Goldfish
Tokugawa period, about 1800
Kitagawa Utamaro I (?-1806)

Couple Making Love and Child Playing with Toy Goldfish
Tokugawa period, about 1765–70, attributed to Suzuki Harunobu (1725–1770)
or to Kitao Shigemasa (1739–1820)

wa period, around 1810, called Kingyo sukui ("Kingyo" means goldfish and "sukui" means scooping). The game involves scooping up goldfish with a special scooper (sometimes bouncy balls or toys are substituted for the goldfish). The Japanese take this game seriously and they even hold a National Competition of Goldfish Scooping.

Each person plays individually. The basic rule is that the player scoops goldfish from a pool with a paper scooper called a "poi" and puts them into a bowl with the poi. This game requires care and speed as the poi can tear easily. The game is over when the poi is completely broken or incapable of scooping properly. Even if one part of the poi is

torn, the player can continue the game with the remaining part.

At ennichi or summer festival stalls, however, the game is not a competition. Participation typically costs around 100 yen (about $1.27) and players can take the scooped goldfish home in a special bag provided by the stall keeper. The game is unlimited, so players can scoop until their pois are completely broken. If they cannot scoop any goldfish, the stall keeper may be kind enough to give them one or two free goldfish. Each stall usually has its own rules. For example, there are some stalls where players can get a stronger poi if they pay more. Other stalls give players special presents if they scoop a lot. In some variations, medakas (*Oryzias latipes*) are used that are faster and harder to catch than goldfish. Usually, for every four goldfish, there is one medaka, so in ennichi, if you catch one, it counts as four goldfish.

Returning now to the question of whether the Japanese had the sort of aquarium shown in the Hashimoto Shuen painting depicting the Tokugawa Period, circa 1700. The Tokugawa period (also known as the Edo period) is a division of the history of Japan when it was ruled by the shoguns of the Tokugawa family, running from 1603 to 1868. The period was characterized by strict social orders, isolationist foreign policies, an increase in both environmental protection and the creation and popular enjoyment of arts and culture.

Hashimoto Shuen, better known to his contemporaries as Yoshu Chikanobu (1838-1912), was a military retainer of the Sakakibara clan of the Takada domain. After the collapse of the Tokugawa Shogunate, he joined the Shogitai and fought in the Battle of Ueno (1868). Following this, he joined the Tokugawa loyalists in Hakodate, Hokkaido, where he fought in the Battle of Hakodate (1868-1869) at the Goryokaku star fort and achieved fame for his bravery.

Following the Shogitai's surrender, his military career was over and in 1875, decided to try to make a living as an artist. He travelled to Tokyo where he found work as an illustrator for a newspaper. In addition, he produced nishiki-e artworks (literally “brocade picture” and refers to Japanese multi-colored woodblock printing). Chikanobu was known as a master of bijinga, images of beautiful women, and among his other work, illustrated women's pastimes as shown in his depiction of the goldfish aquarium from the 1893 Columbian Exposition.

There was a “goldfish boom” during the Genroku period (1688-1704) and later, during the Bunka and Bunsei eras (1804-30), where artists used them as a creative motif. Since Chikanobu was not alive in 1700, it is clear that this is no more than a woodblock painting depicting the artist's idea of what an aquarium looked like in those days. The depiction of an object in a painting does not mean that the object exists or ever existed; it is just an artist's conception.

It is fitting, therefore that I end with this quotation: “In God we trust, all others bring data.”[5]

NOTES

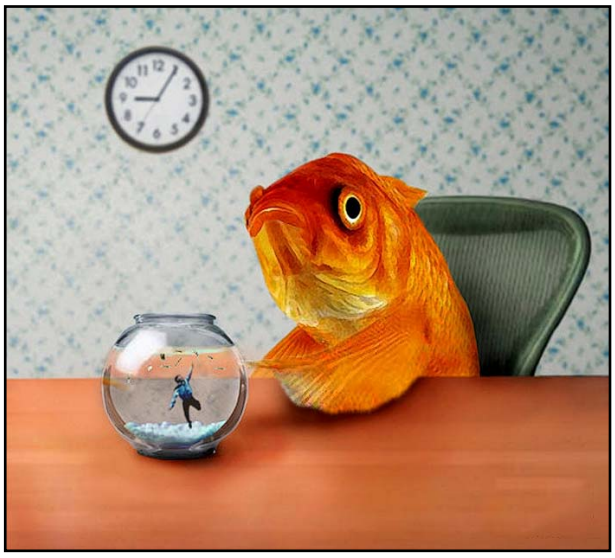
1. Peter Ponzio, a Humanities instructor at McHenry County College, is an American Goldfish Association certified goldfish judge, as well as being an Associated Koi Clubs of America certified koi judge. He has been raising and breeding goldfish for 45 years, and koi for 25 years. Ponzio has written three books on goldfish, and has written several hundred articles on goldfish and koi. He has judged over 50 goldfish and koi shows, and has given lectures on goldfish and koi throughout the U.S.

2. Also known as Hashimoto Chikanobu, Toyohara Chikanobu, Yoshu Chikanobu and
Yoshu Shuen.

3. Takaoka, Kazuya and Kuru, Sachiko; *Kingyo: The Artistry of Japanese Goldfish*. Tokyo: Kodansha International, 2003.

4. This and the images that follow (with the exception of the Artist Unknown image for which attribution is also unknown) are from the Boston Museum of Fine Arts.

5. This quote has been widely attributed on the Web to the American statistician, William Edwards Deming (1900-1993), but there is no evidence that he was its author. The quote is, in effect, anonymous.



UP AND DOWN THE BROOKS: AN ESSAY ON NATURE WRITING, 1860-1909

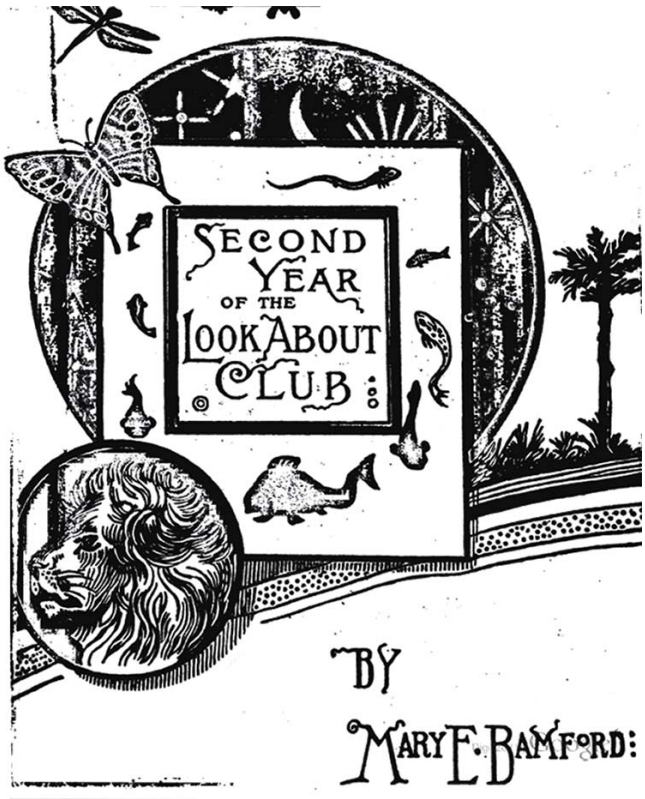
by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, March 25, 2009)

INTRODUCTION

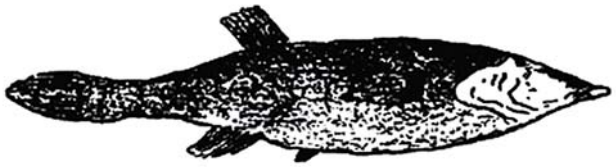
For those of you who are not familiar with the name Mary E. Bamford, she was born in 1857 (as Mary Ellen Bamford) in Healdsburg, California, the daughter of Dr. William and Cornelia Elizabeth (Rand) Bamford. Her father was a pioneer physician who traveled across the plains in the early 1850s. Her mother, a native of New Hampshire, went to California via long voyage (1854-1855) around Cape Horn.

Bamford graduated from the Oakland High School in California, and was an assistant in the Oakland Free Public Library for four years. Her father contributed to the *Western Lancet*, and her mother wrote a good deal for the *New York Independent*, *New York Observer* and other papers.



Bamford was the author of the twenty books listed in the Appendix. She also wrote a pamphlet, *Burma: The Work and the Workers*, published by the Woman's Baptist Foreign Missionary Society and did much writing for the *Youth's Companion* (Boston), Cook's publications (Chicago) and the publications of the different Baptist denominational boards. She also was secretary for North and Central California for the Woman's Baptist Foreign Missionary Society of the West, headquartered in Chicago. One of her passions, however, was for natural history, a good example being her *Second Year of the Look About Club*, published in 1889. Briefly, in this book a group of children unite to research and share stories, primarily about the birds, animals, and insects they discover near their home. An assortment of adult relatives offer guidance and participate in some activities. The following is an example taken from the book:

> "Now, it's papa's turn," said Al, and Mr. Perry called them all to come to the light and see a picture in a book he held. It was a picture of a blind fish.
>
> "Where do such fishes as that live, papa?" asked Blanche.
>
> "In Mammoth Cave," answered her father. "They are supposed to be found in all underground rivers flowing through the limestone region of the United States, and they have often been found in wells."
>
> "Are they blind all their lives?" asked Kittie.
>
> "People suppose so," said her father. "As far as people know, the baby fishes are blind as well as the bigger ones. Once in a while one is found that can see. But do you remember, Kittie, how quick to hear and



BLIND FISH

From Mary E. Bamford's, *Second Year of the Look About Club,* 1889.

touch anything some of those blind children were at the asylum?"

"Yes, indeed," said Kittie. "I couldn't have walked so fast with my eyes shut as that blind girl did."

"Well," said Mr. Perry, "that is the way with these blind fish. The sense of hearing and touch is so acute that they are very active. Mud-fishes live in the waters of Mammoth Cave, too, and these blind fish will rush after them and catch and eat them, although the mud-fishes have eyes."

"How do the blind fish catch them, then?" asked Al.

"Why, you see," said his father, "the blind fish have a very acute sense of touch, while the mud-fish is rather stupid in this respect, and so the mud-fish is always bumping against something in the dark, and that gives the blind fish a chance to catch up and capture the mud-fish."

This brings me now to another Bamford book written for children, but whose literary style was vastly different.

WRITING IN 1898 FOR "YOUNG PEOPLE"

One of the books I own and frequently re-read for my own delight is Bamford's *Up and Down the Brooks*, published in 1898 by Houghton, Mifflin as part of their Riverside Library for Young People. In a review of her book in the NEW YORK TIMES of November 9, 1898, one naturalist is quoted as: "She is so delighted herself that she makes you happy whenever she catches a pollywog. It is enough to make any one want to start out to catch one himself immediately."

Indeed, the prose is fun to read and entertaining, as the following example attests:

"Yet, when one possesses a caterpillar that desires to make a repast on spiny thistles, one is apt to have a slight bond of sympathy with that historic gentleman mentioned by Mother Goose:

'Simple Simon went to look
If plums grew on a thistle;
He pricked his fingers very much,
Which made poor Simon whistle.'"

A paragraph or so later, Bamford ups the ante on thistle poems with this classical reference:

"From this, the observant reader will perceive that I have never yet learned to grasp nettles firmly enough, a lesson inculcated in the old rhyme written by Aaron Hill in 1750 on that window in Scotland.

'Tender-handed stroke a Nettle,
And it stings you for your pains.
Grasp it like a man of mettle,
And it soft as silk remains.
Tis the same with common natures,
Use 'em kindly, they rebel;
But be rough as nutmeg-graters,
And the rogues obey you well.'"

However, I am always amazed at the abundance of classical references in the text. For example, on page 31 we read,

"Burton in his 'Anatomy of Melancholy' tells us that when Jupiter and Juno held their wedding-feast all the other divinities were invited and many noblemen besides, and among them came a Persian prince named Chrysalus, a very simple person, but gorgeously arrayed in golden attire. And the

> assembly, seeing him come with such pomp, were deceived, and rose up to give place to so noble a being. But Jupiter, seeing what a fantastic, idle fellow he was, turned him and his followers into butterflies, greatly to the astonishment of the guests, no doubt. If this be true, how comes it that Vanessa Antiopa wears black? Did Vanessa go to the wedding-feast wearing mourning?"

Re Vanessa Antiopa, Bamford is alluding to the Mourning Cloak butterfly (now known technically as *Nymphalis antiopa*), a specimen of which she came across while searching for a type of aquatic beetle that formed the subject of this chapter in the book.

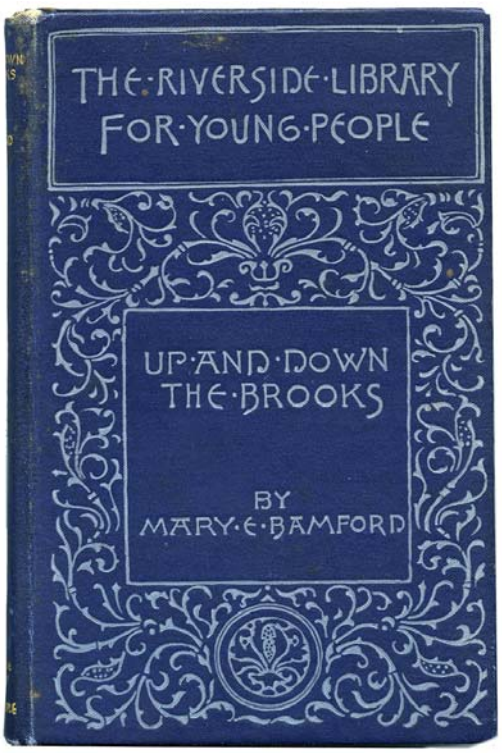
On page 94, while discussing the predatory whirligig, Bamford writes,

> "Perhaps when the child is older, and when she better understands the murderous character of many water-beetles, she will not be so ready to name herself after them. For the carnivorous water-beetles are as bloodthirsty as were the mob that Machiavelli tells us tore poor Ser Nuto to pieces. Says that chronicler: 'Ser Nuto being brought by the mob into the court, was suspended from the gallows by one foot; and those around having torn him to pieces, in little more than a moment nothing remained of him but the foot by which he had been tied.'"

And on page 125 in the course of describing the smaller aquatic life of ponds we read,

> "You sit down on a bank and think yourself alone. But there are many eyes on you. You hear a rustle, and behold a little white frog is hopping away from your feet. Aphides alight on your shoulder, and now would that a person might have as acute hearing as the mythic Heimdall had, he who lived in the fort at the end of the rainbow, and had so fine ears that he could hear 'the wool growing on the backs of sheep and the grass springing in the meadows.' For, if we had such ears we might hear many a bug and beetle and spider in this supposed-uninhabited nook saying to each other, 'Who is the giant who has come here and why has he come? This part of the world belongs to us. We are the Brookside Folk.'
>
> "And you reflect that the spiders and beetles and bugs really have more to substantiate their claims than had those Three Tailors" whom Carlyle mentions as addressing Parliament and the Universe, sublimely styling themselves, 'We, the People of England.'"

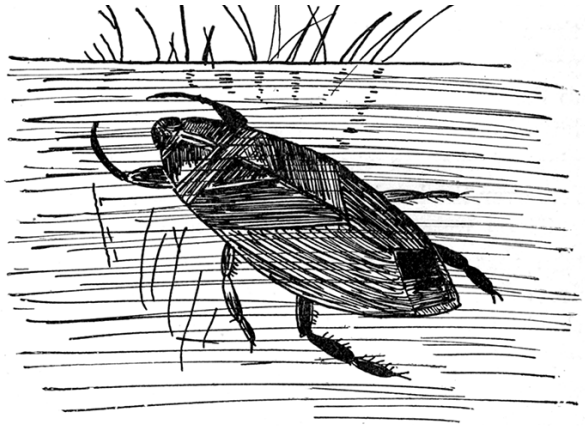
WOW! After quoting Machiavelli's 1525 *History of Florence* followed by one from Burton's 1850 *Anatomy of Melancholy*, on a single page we get references to Heimdall, a deity from Norse mythology, and Carlyle's 1875 *The Early Kings of Norway*. One might wonder how this kind of erudition was achieved in view of the fact that Bamford's formal education ended with her graduation from high school. However, in the 19th and even into the early 20th centuries, high



school was only for the children of the elite. In point of fact, in the 19th Century hardly anyone went to high school at all, let alone college. Throughout its career the Oakland High School has been an academic or cultural school; thus Bamford would have studied Latin and French, Geography (ancient, modern and physical), history (ancient, modern and United States), English (besides the usual reading, spelling, grammar and composition, it would have also included rhetoric, declamation and the history of literature), Mathematics (including arithmetic, algebra and geometry), and Natural Philosophy, the forerunner of what we would today call "science").

Be that as it may, one asks oneself the question, are these books in the Riverside Library really intended for "young people"? Bamford herself seems to have had had some misgivings about the ability of her audience to grasp the finer points of the language:

> "Still, there are drawbacks to one's felicity. I passed by a small house not long ago. A little scrap of a boy stood at the back gate, and, as I vanished down the road, these words were wafted to mine ears, 'There's the lady that catches fish.' I am consoled, however, by the appellation, 'lady.' Let all fish-women be hereafter known as 'fish-ladies.' To such a pass has come our English tongue."



Belostoma grandis.

From Mary E. Bamford's,
***Up and Down the Brooks,* 1898.**

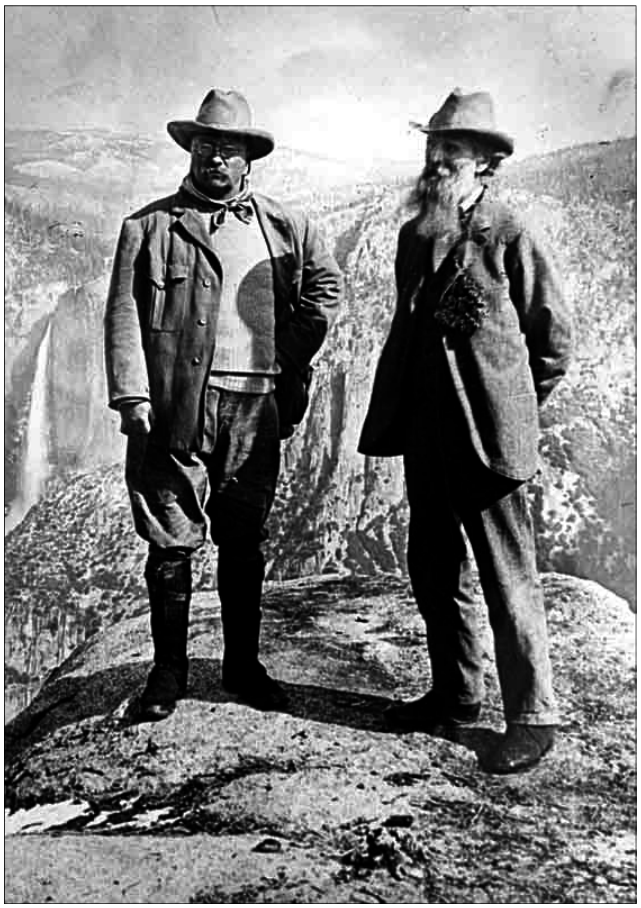
Perhaps a clue to the provenance to this kind of writing may be gleaned from this quote from the publishers:

> "The authors engaged are for the most part writers who already have won attention, but the publishers give a hospitable reception to all who may have something worth saying to the young, and the power to say it in good English and in an attractive manner. The books in this Library are intended particularly for young people, but they will not be written in what has been well called the *Childese* dialect. The publishers hope to have the active cooperation of parents, teachers, superintendents, and all who are interested in the formation of good taste in reading among young people."

In any event, I was determined to delve further into why Houghton would publish nature books for young people that included such scholarly references.

THE EMERGENCE OF AMERICAN NATURAL HISTORY WRITING, 1860-1909

John Burroughs and John Muir were the most prominent nature writers of this era. Muir led the fight to preserve wilderness with his *Century* articles about Yosemite, as well as with his founding of the Sierra Club. In the second half of the nineteenth century, however, John Burroughs was the most popular and significant nature essayist in America. During the Civil War, he was a close confidante of Walt Whitman and later one of the poet's most successful advocates. By the mid-1880s he was widely regarded as the pioneer of the recently emerged field of writing "treating nature in a half-scientific and half-poetical way." By the first decade of the new century, he had become a national celebrity—a friend of presidents and tycoons, an icon of teachers and schoolchildren, and the country's special ambassador to the natural world. Burroughs popularized the study of local nature with his many volumes of essays, and brought political and economic muscle into the conservation movement by befriending such influential figures as Theodore Roosevelt and Harvey Firestone. He represented not only the highest



LEFT: TEDDY ROOSEVELT; RIGHT: JOHN MUIR

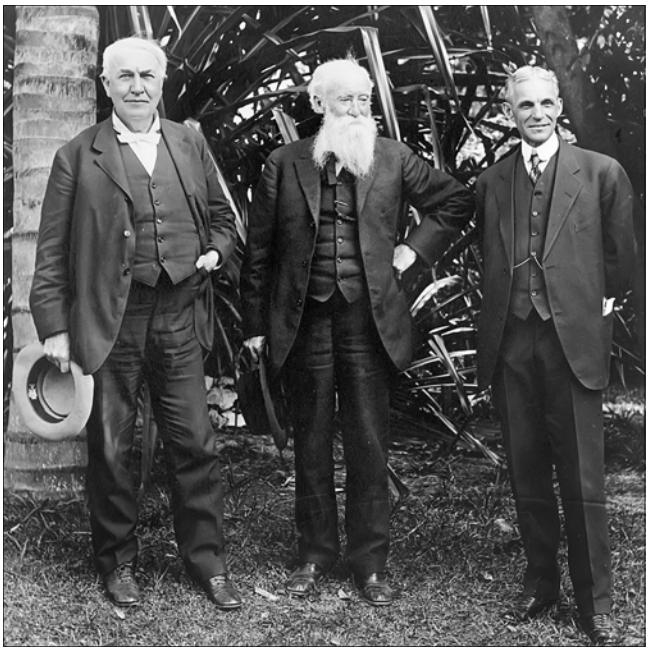
level of literary achievement, but also the simple, rural life that many middle-class Americans hoped to claim as their national heritage. Shortly after Burroughs's death in 1918 one writer offered a portrait of Burroughs as many Americans knew him in the final years of his life.

> "He smelled of wood smoke and wild berries. He was tanned with wind and sun and his hands were calloused by farm labor," writes Garland. "But when he took his pen in his fist he became the master of English which makes his pages a delight… In the door of an old barn, with a dry-goods box for a desk, he penned the most lucid, powerful, artistic prose—prose that has not been surpassed by any other nature writer in America."

Indeed, it was John Burroughs, not Henry David Thoreau, who was the instrumental figure in the genre's history before 1900. After Thoreau's death in 1862 his legacy seemed a subject hardly worth speculation. He was at the time more commonly identified as a social critic than as a natural historian, and at best he seemed a vaguely absurd devotee of Emerson and at worst, "a cold morbid misanthrope whose retreat to Walden was an attempt to disavow affiliation with humanity." Another claimed that he was merely an imitator who "treads in Emerson's tracks with legs painfully short." Only as Burroughs gained national prominence in the 1870s and 1880s did the importance of both Thoreau and nature writing become increasingly well defined.

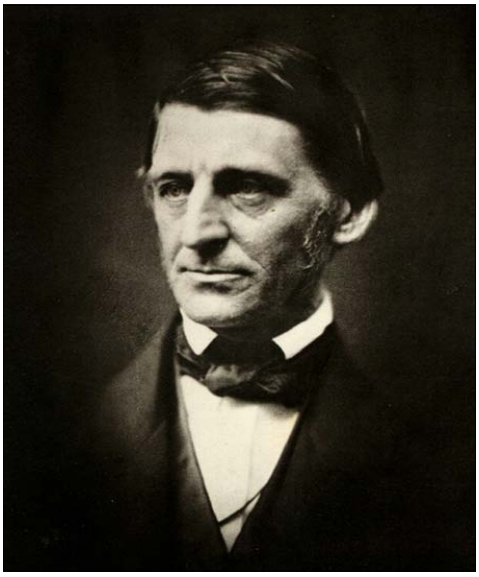
Burroughs's writings were shaped in part by Emerson early on. He first read Emerson in the spring of 1856 when he was nineteen years old and studying for a term at the Cooperstown Seminary in New York. At first he found Emerson's work difficult. Reading Emerson's *Essays* he observed was like "tasting green apples." Burroughs soon developed a taste for Emerson, however, and within the space of several months, read everything of Emerson's that he could find. The experience proved to be a watershed in his life and career. As he later noted, he read Emerson "in a sort of ecstasy. I got him in my blood, and he colored my whole intellectual outlook."

It is common wisdom that nature writing became an increasingly prominent feature in American literary



FROM LEFT TO RIGHT: THOMAS EDISON, JOHN BURROUGHS, HENRY FORD

LEFT: HENRY DAVID THOREAU



RIGHT: RALPH WALDO EMERSON

culture primarily because readers were concerned about the natural world. Overlooked, however, is that it emerged also through the efforts of several elite literary institutions whose influence strongly determined its form, its audience, and the cultural capital it represented.

Nature writing has played a more varied and significant role in American literary culture than is generally assumed. At the turn of the twentieth century, the genre participated in numerous and sometimes conflicting cultural discourses; not only the emergence of the conservation movement, but also the emergence of a decidedly middlebrow culture, the articulation of New England's regional identity, and the definition of a generally "American" identity that purported to speak for all parts of the expanding nation.

THE IMPORTANCE OF HOUGHTON, MIFFLIN AND COMPANY IN NATURE WRITING

Houghton, Mifflin and Co. packaged and promoted Burroughs's writing with great enthusiasm, and also made his work the foundation of an impressive collection of nature-related books. It is often overlooked that Houghton assembled and published nearly all of the important American writers now classified as "nature writers" before World War I. In the final decades of the nineteenth century, Houghton transformed what its editors referred to as "outdoor writing" from a miscellany of nature-related writing into a clearly defined tradition of essays centered on Burroughs and (eventually) Thoreau.

No wonder, then, that during these years the firm consistently named their "outdoor books" as one of their particular specialties. As the firm noted in its 1899 catalogue, the field of literature representing "the enthusiasm of lovers of nature" was now "largely occupied by Houghton, Mifflin and Company." Of course, the rhetoric of self-promotion should always be read with care. In this case, however, we can take the Houghton editors at their word. In the final decades of the nineteenth century—the years just before the term "nature writing" emerged and came to denote the tradition of literary essays that Burroughs had made popular—the field of environmental prose was indeed largely occupied by the Houghton firm. No other contemporary literary institution had as profound an influence on this particular field of writing.

Perhaps surprisingly, editors spoke of their natural histories intended for children in similar terms. Bamford's *Up and Down the Brooks* was commonly included in the outdoor book promotional materials of Houghton, as were several collections drawn from the work of Burroughs. Such works, according to house editors, needed to be lively, accurate, and accessible, never patronizing. Children's books failed, they often noted, when authors lacked respect for the imagination and intelligence of their young readers.

As with the work of Burroughs, editors emphasized that juvenile natural history needed above all to have elegant, graceful prose. One manuscript was dismissed by Houghton editor Horace Scudder noting that its sketches were "written with a good deal of vivacity, but in a careless style… a publisher dealing largely in such matter and not too particular about the literature might do fairly well with it." Similarly, in the *Atlantic* (owned by Houghton until 1908) Scudder questioned the underlying design of Julia McNair Wright's *Nature Readers* (a series published by D.C. Heath & Co. between 1888 and 1901) thusly:

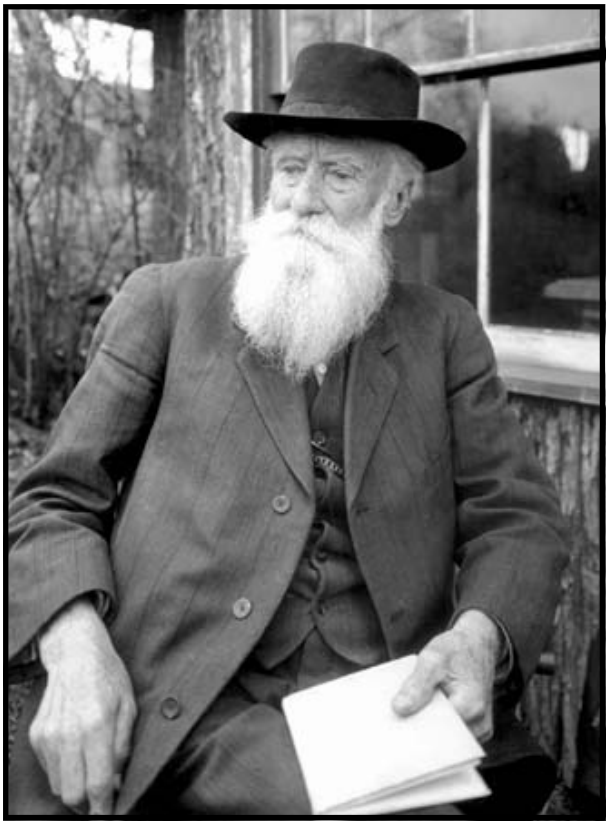
> "The plan of the books is to give beginners in reading an acquaintance with simple facts in nature. We have no criticism upon the facts in the book, but object to giving children reading matter instead of literature for reading. These books have no style whatever, and surely style is of the first importance."

When Bamford submitted her manuscript in 1888, Scudder reported that it was a "lively" work of outdoor writing for children—"accurate, readable, and… by far the best book of its kind yet produced in this country." Scudder, by the way, noted that the manuscript was only about 20,000 words long. If the book were larger, it would be "admirably adapted" to the Riverside Library for Young People (RLYP). Scudder thus recommended that Bamford triple the size of the manuscript and resubmit it, which she did.

After 1890, Houghton editors consistently considered these new criteria when reading nature manuscripts submitted for publication. Meanwhile, they began including works of outdoor writing in a number of general educational and juvenile series, making the genre an increasingly important part of the firm's more general mission to reform American schools (and schoolchildren) through literature.

According to an 1889 advertisement, the RLYP series was aimed specifically at "boys and girls who are laying the foundation of private libraries." Each title was illustrated, between 200 and 250 pages, and priced to be relatively inexpensive (seventy-five cents or about $15 in today's currency). Though the firm assured prospective buyers that "the books included in it are not ephemeral publications" and that the authors were of the highest rank, the series was something of a hodgepodge and ultimately, the Riverside Library for Young People had only limited success. While its selections of juvenile fiction and childhood memoirs such as Lucy Larcom's *A New England Girlhood, Outlined from Memory*, sold quite well, the average book sold between 100 and 200 copies per year. The collections by Burroughs fared slightly better than average, with sales between 200 and 250 per year. Still, the series is of particular importance because it helped set the standard for the books in the educational market that later formed an important part of Houghton's business.

Over the next several decades, the firm continued to advertise its connection to the nature writing tradition. Ironically, however, the years of nature writing's popular emergence also marked the rapid decline in Houghton's cultural authority. At the turn of the twentieth century the context in which Americans produced, sold, and used literary writing was wholly transformed, and in this time of flux the Houghton firm lost much of its



JOHN BURROUGHS

influence as a cultural trust. The changes in the national magazine market offer an instructive example: in the 1890s a host of new magazines emerged that were radically different from the "quality monthlies" in which Burroughs had established his career in the sixties and seventies.

The newer magazines— which included *Cosmopolitan*, *Ladies Home Journal*, *McClure's*, *Munsey's*, and *The Saturday Evening Post*—were loosely modeled on *Harper's*, the *Century*, and the *Atlantic*. However, these newer magazines conceived of themselves neither as repositories of permanent literature nor as the province of sophisticated readers. Rather, they actively sought a mass audience, to whom they delivered news, entertainment, and—of special importance—advertising. Indeed, advertising was these magazines' crucial function. *Cosmopolitan* and *Ladies Home Journal* were explicitly conceived as marketing instruments for large-scale manufacturers seeking to create and maintain a national market for their products. Within their pages, advertising shared space with articles, stories, and illustrations. And unlike, say, the *Atlantic*, these newer magazines were financed not through subscription fees but through advertising revenue.

EPILOGUE

I got my start in the aquarium hobby over 60 years ago by going up and down the brooks myself (and other bodies of water that supported fish life) when I was a teenager, collecting sticklebacks and breeding them as I did with *Cyprinodon* and *Fundulus*. This is an example, therefore, of how the aquarium hobby, spurring my interest in nature in general, has opened new vistas for me. I never would have become especially interested in Thoreau and Emerson nor would I have paid any attention to the name John Burroughs if I had not picked up a copy of Bamford's *Up and Down the Brooks*. A warning, however. If you decide to read her book and are interested in exploring her many classical references, be prepared to spend some serious reading time on the net!

ACKNOWLEDGEMENT

The historical material in this monograph was taken from Eric Christopher Lupfer's doctoral dissertation, *The Emergence of American Nature Writing, 1860-1909: John Burroughs, Henry David Thoreau, and Houghton, Mifflin and Company* (The University of Texas at Austin, May 2003).

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The Aquarium Hobby's First Historian

by Albert J. Klee, Ph.D.

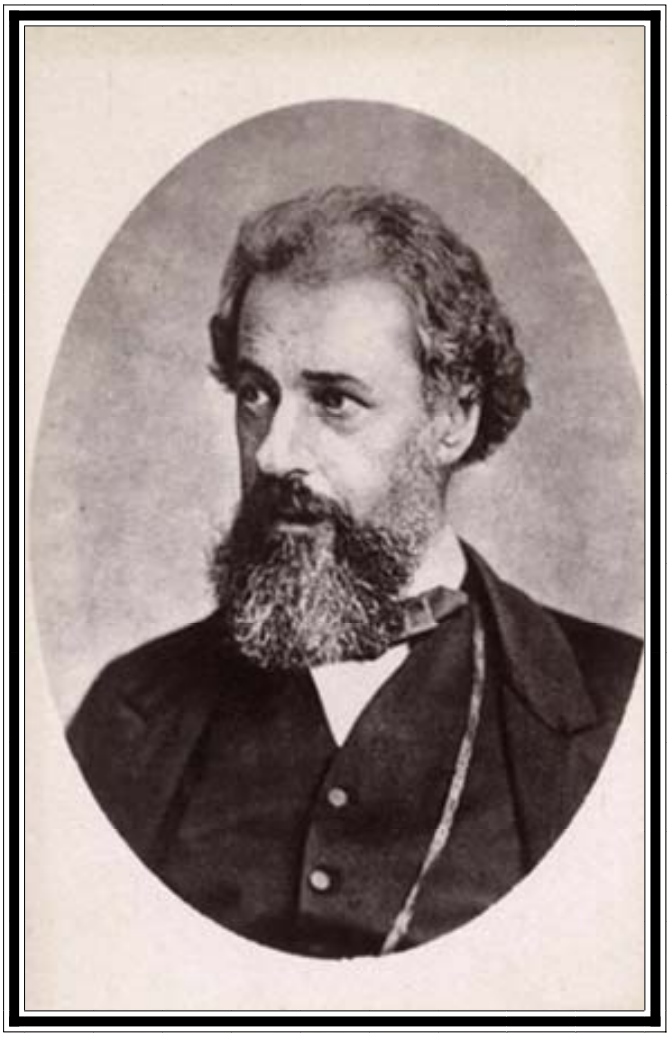
(Aquarium Hobby Historical Society, Yahoo Files, October 7, 2012)

Edward Newman (1801- 1876) was an English entomologist, botanist and writer. Both his parents were keen naturalists, and he was further encouraged to take an interest in the natural world at his boarding school in Painswick, a village in Gloucestershire. He left school at sixteen to join his father's business in Guildford, in Surrey, moving to Deptford, a district of southeast London, in 1826 to take over a rope-making business. Here he met many of the leading entomologists of the day and became a founder member of the Entomological Club. In 1832 he was elected as editor of the club's journal, The Entomological Magazine, and the following year became a fellow of the Linnaean Society and one of the founder members of the Entomological Society of London.

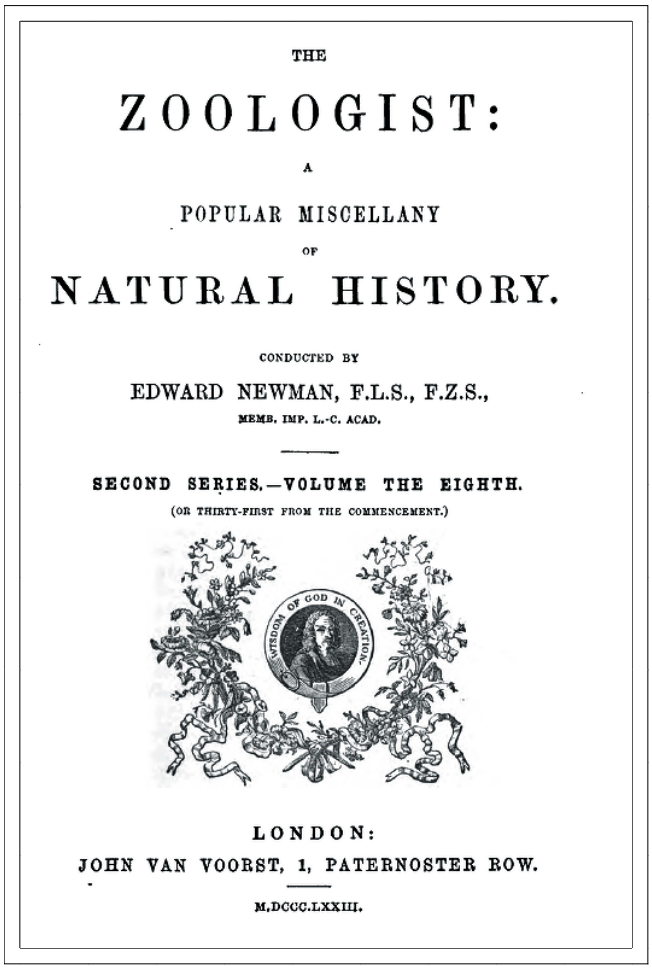
In 1840 Newman published the first edition of "A History of British Ferns and Allied Plants." He became a partner in a firm of London printers, Luxford & Co., and a printer and publisher of books on natural history and science. He later became the natural history editor of The Field, editor of The Zoologist and editor of The Entomologist. His books included "Birds-nesting" (1861), "New Edition of Montagu's Ornithological Dictionary" (1866), "Illustrated Natural History of British Moths" (1869) and "Illustrated Natural History of British Butterflies" (1871). Newman's "Attempted division of British Insects into natural orders" in the Entomological Magazine in 1834 established many new families and is therefore an important work of scientific classification.

As an evangelical Quaker, he was deeply worried by the 1859 publication of Charles Darwin's On the Origin of Species, claiming that Darwin's theories were "not compatible with our notions of creation as delivered from the hands of a Creator."

Interestingly, Newman viewed the skeletons of Pterosaurs not as reptiles but as marsupial bats. This was based on earlier suggestions that some pterosaur fossils showed tufts of hair, which suggested they could not be typical cold blooded reptiles. As a result he published a reconstruction of pterosaurs as hairy animals in a 1843 edition of The Zoologist. This is, as far as is known, the first reconstruction of pterosaurs as hairy warm blooded creatures, which modern research suggests was actually the case. However, they are now thought to be highly evolved and warm blooded reptiles and not marsupial



EDWARD NEWMAN (1801-1876



THE

ZOOLOGIST:

A

POPULAR MISCELLANY

OF

NATURAL HISTORY.

CONDUCTED BY

EDWARD NEWMAN, F.L.S., F.Z.S.,

MEMB. IMP. L.-C. ACAD.

SECOND SERIES.—VOLUME THE EIGHTH.

(OR THIRTY-FIRST FROM THE COMMENCEMENT.)

LONDON:

JOHN VAN VOORST, 1, PATERNOSTER ROW.

M,DCCC.LXXIII.

bats. He argued, in this rather amusing article, that it was rather unlikely that his ideas were correct, since authorities like Georges Cuvier and William Buckland thought pterosaurs were reptiles, but, even so, it was still possible that the experts were wrong and he got it right!

In 1873, Newman embarked on a series of articles in The Zoologist that marked the first cohesive history of the aquarium hobby as it was known at the times. Although the books on the aquarium hobby published up to that time mentioned important developments in the history of the aquarium hobby, they were presented merely as facts without any attempt at analysis. The following is Newman's introduction to his theme:

"The Aquarium is an Institution, a great Institution, and in its present form a novel institution; but I venture to believe a lasting Institution: it has passed through two eras, and has entered on a third; the first, which endured for a decade, say from 1830 to 1840, was very humble, very instructive - almost wholly utilitarian; the second, which endured for two decades, say from 1840 to 1860, was literary, poetic and fashionable; and the third, upon which we have boldly and vigorously entered, may be styled commercial and ambitious: the first was the humble handmaid of Science; the second the servant of fashion; and the third the child of speculation. I need scarcely say the first decade had my entire and zealous sympathy; the second my amused attention; and the third my boundless admiration of the results obtained, without exciting much interest in its progress as a commercial venture."

Newman's history of the hobby primarily covers a period of about 30 years and this is quite detailed and contains information not previously found in aquarium histories, including my own since space would not accommodate such a level of detail. Newman deserves a place of honor with the other greats of his day, such as Warington, Ward, Gosse, Bowerbank and William Alford Lloyd. Indeed, his history contains a great deal of biographical information on the last-named not previously published. His section on aquarium aeration was extremely helpful to me personally when I wrote my monograph, "The Early History of Aquarium Aeration," and his discussions on the controversies of the day place the history of the aquarium hobby in greater perspective than was understood previously.

The following is his complete history, taken from "The Zoologist: A Popular Miscellany of Natural History," edited by Edward Newman, Second Series, Volume 8 (or thirty-First from the Commencement), John Van Voorst, 1, Paternoster Row, 1873. The text I have in hand is in PDF format and was digitized but not optical character recognized (OCR). *The Zoologist* numbered the pages consecutively so the text starts at page 3341, making it difficult to get to the three widely separated parts of his history or to do a search looking for a word or a name, so I took it upon myself to do the OCR.

All of the spelling and grammar of the day has been preserved in the process, often bringing smiles to my face when reading it. In order to make the reading easier I have, however, italicized scientific names when possible and broken up extremely lengthy paragraphs. In early times, long paragraphs were not unusual and Newman's history is a bit excessive on this point when he quotes these earlier authors. Where we would nowadays use periods to end a sentence, such authors often used colons. At one point I was trying to break up a paragraph of some fifty lines but was having trouble finding the end of a sentence. I finally tried using the search function in my editor to find a period and it did discover one, on line forty!

Short references such as "Zool. 796" refer to pages in *The Zoologist*. Except for the layout of the tanks in the Crystal Palace Aquarium, there are no illustrations in Newman's history. To break up the monotony of text only I have supplied illustrations typical of the period in question.

Newman starts with Era I, which he calls "Utilitarian:

ERA I. UTILITARIAN.

The birth of the aquarium is of such remote antiquity that we fail to ascertain the date with any certainty. The point at which, any vessel containing water and fishes becomes an aquarium is equally open to discussion. There is abundant reason to suppose that the Chinese and the Japanese had their fresh-water aquariums thousands of years before the Christian era; the Romans certainly had theirs; but in neither of these instances is there any evidence of their being considered, as now, a noteworthy institution; by the Romans they were established for economic purposes and nothing more. I do not know whether such vessels are again mentioned until 1665, when Mr. Pepys in his Diary, under date 28 May, 1665, as cited by Mr. Lloyd, observes, "Thence to see my Lady Pen, where my wife and I were shown a fine rarity; of fishes kept in a glass of water, that will live for ever—and finely marked they are, being foreign."

I consider this brief passage of infinite interest; were I in a severely critical mood I might object to the expression "live for ever," because I doubt whether any created being enjoys perpetuity of existence; but waiving this objection, I think the passage establishes the fact that fishes were kept in confinement at Lady Pen's in 1665; and that Mr. Pepys was informed that they had this extraordinary vitality. It is rather a notable fact that we know of no instances of fishes dying or being deteriorated by age: we never hear complaints of a sole, or a turbot, or a salmon, being old and hence objectionable: this can scarcely be asserted of our taurine or anserine, or even gallinaceous, food."

[I note with some amusement of Newman's reference here to "…taurine or anserine, or even gallinaceous, food," by which he meant beef, geese and chickens. Newman not only had an impressive command of the English language (and a good sense of humor), but by extension his readers also. AJK]

Coming down to later times, we find that in 1743 our countryman Baker distinctly represented specimens of *Hydra viridis* kept in water in an upright glass vessel.

"It appears from the works of Esper (the reference here is to Eugenius Johann Christoph Esper 1742–1810, a German entomologist), published continuously from 1771 to 1784, that that distinguished entomologist constantly kept aquatic insects in water: he has given us most interesting particulars concerning them, and seems to have been delighted in observing their longevity in confinement; he particularly mentions a male individual of *Dytiscus marginalis*, a carnivorous water beetle, that lived three years and six months in his aquarium; and James Francis Stephens many years subsequently, commenting on this seemingly extraordinary fact, attributes this prolonged life to enforced celibacy. Esper has left no record, so far as I am aware, of the plan or principle of his aquarium, and I believe only this single record of his success.

"Simultaneously with Esper, Gilbert White seems to have utilized the aquarium for observation: the first edition of his 'Natural History of Selborne,' printed in 1789, but written in 1781, has the following passage:—

"When I happen to visit a family where gold and silver fishes are kept in a glass bowl, I am always pleased with the occurrence, because it offers me an opportunity of observing the actions and propensities of those beings with whose lives we can be little acquainted in their natural State. Not long since I spent a fortnight at the house of a friend, where there was such a vivary, to which I paid no small attention, taking every care to remark what passed within its narrow limits." This great naturalist, for great he really was in his singular acuteness of observation and scrupulous truthfulness of narration, thus utilized an aquarium, although calling it by another name: his observations on the manner of death in fishes, on the structure of their eyes, and on their mode of progression, the pectorals being employed for gentle motion, and the caudal for "shooting along with inconceivable rapidity," show to what good purpose he devoted these opportunities of observing.

"I have met with no evidence of experiments or arrangements of the same kind until, in 1830, my esteemed and respected friend James Scott Bowerbank, then residing at No. 19, Critchell-place, New North-road, continuously and successfully utilized the aquarium in his researches into the "Circulation of the Blood in Insects." Of all investigators 1 ever knew, Dr. Bowerbank was the most enthusiastic, the most persevering, the most successful, and the most willing to impart his discoveries to others. I have always considered my introduction to Dr. Bowerbank one of the most fortunate events of my life, and the hours that I have spent under his tuition as the most delightful and most worthy of remembrance. Let us see what Dr. Bowerbank did with his aquarium. Cuvier's 'Règne Animal' was published in 1824, and contains the following paragraph translated from the French:

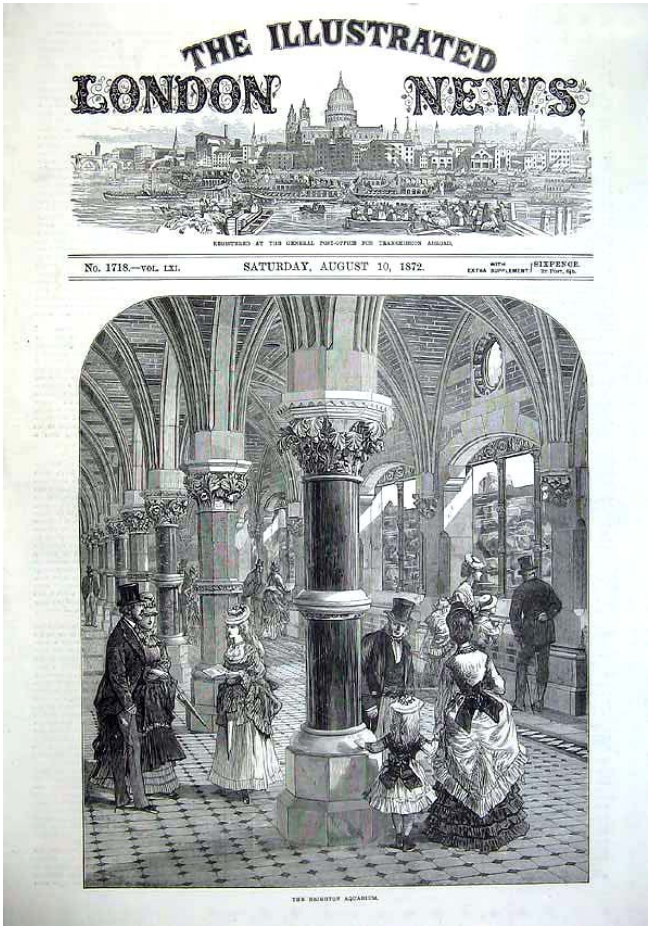
"In animals that have no circulation, in insects particularly, the parts are all bathed in the nutritive fluid; each of these parts draws from it what it requires, and if the production of a liquid be necessary, proper vessels floating in the fluid take up by their pores the constituent elements of that fluid."

No sooner had I read this than I expressed my dissent from such a doctrine; I felt certain that insects possessed a circulation. Whether influenced by a desire to bring Cuvier's dictum to the *experimentum crucis*, or from a simple and characteristic thirst for truth, Mr. Bowerbank went into the question heart and soul. Throughout the years 1831 and 1832 he worked hard at the important question whether or no insects possess a circulation: to this end he sallied forth on larva-hunting expeditions with the late Mr. Tully, the celebrated optician, with one of whose excellent instruments his microscopic researches were conducted.

'He [Mr. Tully] told me,' says Mr. Bowerbank, 'all about these larvae, and where to obtain them, and that they must be kept in the water to which they were accustomed; so we always adhered to that plan, for we found that if we brought them home in a very little water, and added a considerable quantity from the house-cistern, the water thus added generally killed nearly all of them; so I employed a man to take an earthen jar that would hold at least a gallon of the very water in which the larvae were found; this I poured into the glass prepared for it, putting in a little Conferva and a few water-snails, *Limnea peregra*, and the smaller species of *Planorbis*, in the water, and floating a little duck-weed on the surface: then the glass was placed in the sun, so as to assimilate the condition of the little captives as nearly as possible to what it had been when in the ponds on Hampstead Heath in which they had been hatched, and in which tile were found. Treated thus they continued alive and well, without change of water, and thus I was enabled to continue the observations for nearly two years."

Although in this passage the words "aquarium," "balance of life," and "compensating principle" do not occur, it is very evident that Mr. Bowerbank was aware of the use of vegetation in maintaining life-supporting properties in stagnant water, and the necessity also of imitating the natural conditions of the animals he desired to keep therein. To this hour none of us have advanced further with fresh water, and success only results from keeping these objects steadily in view. Mr. Bowerbank's paper was finished on the 1st of October, 1832, and was published at p. 239 of the *Entomological Magazine* for April, 1833. I need scarcely say that it placed the author at once at the head of all observers in this branch of Entomological Science. I regard it as the best, if not the first instance of thoroughly utilizing the compensation principle of the fresh-water aquarium: plants to evolve oxygen, animals to consume it.

In the same year Professor Daubeny read, at the Cambridge meeting of the British Association for the Advancement of Science, a paper communicating the result of researches he was then making on the subject of confining animals and plants together in water, in the course of which he established beyond dispute that it was the illuminating and not the heating powers of the sun's rays which caused the evolution of oxygen from plants. He then went on to say that the plants not only evolved oxygen but assimilated carbon from the poisonous carbonic-acid gas which results from the respiration of animals, decomposing it and rendering it harmless. Final-


THE ILLUSTRATED LONDON NEWS

No. 1718.—VOL. LXI. SATURDAY, AUGUST 10, 1872. SIXPENCE.

The Brighton Aquarium

ly, he asserted boldly 'that the influence of the vegetable might serve as a complete compensation for that of the animal kingdom.'

Thus he seems by inductive reasoning and possibly by seeing the successful results in many parlours in London, to have perceived as clearly, as he expressed happily, the theory and practice of the aquarium; but it must be recorded that while everyone else was succeeding to admiration, Dr. Daubeny utterly failed in reducing his theory to practice, and his establishment for exhibiting the compensatory process was totally unsuccessful.

Imitation is the inevitable tribute, the sweet-smelling incense, offered on the altar of obvious success. I will not presume to express a doubt of the originality of many of those who set up aquariums between 1830 and 1840, but I think that most of us were incited to the act by Mr. Bowerbank's successful example; Goring and Pritchard admit the fact; they even quote Mr. Bowerbank as the authority for their doings. I was a similar imitator of my friend: after seeing his captives, and watching the unspeakable grace and beauty of their movements, I caught at once at this new field of observation. In January, 1832, I commenced operations with a water-net made of cheese-cloth: the Woolwich Marshes and Wandsworth Common were the scenes of my exploits, and a large white basin my first aquarium: some of the results were published at p. 315 of the first volume of the *Entomological Magazine* in 1833, simultaneously with Mr. Bowerbank's.

I made my appearance as an aquarian, as I may truly say, hanging on by the skirts of my leader's coat. I soon became absorbed in the denizens of the white basin, and they were as speedily transferred to a more convenient receptacle, an upright glass jar, where they lived in health for a very considerable time, but the only observation published in 1833 was that "the carnivorous water-beetles, *Dytiscus, Colymbetes, Acilius, Hydroporus*, &c., in swimming moved their hind legs simultaneously, striking out with great vigour in the same way as a frog; whereas the herbivorous water-beetles, *Hydrous, Hydrophilus*, &c., moved their hind legs alternately, thus making weaker strokes and progressing in the water much more slowly." Professor Westwood, at pp. 97 and 123 of the first volume of his 'Modern Classification,' did me the honour to copy, endorse and adopt my observations. I might here introduce a multitude of jottings on the manners and customs of water-beetles in confinement, but I forbear.

In the years 1836, 1837 and 1838 my friend Mr. Edwards, a most accurate and painstaking observer, then residing at 17, High-street, Shoreditch, by means of his aquarium, made himself thoroughly acquainted with one of the most deeply interesting and unexpected facts ever discovered in the entire range of Natural History—I allude to the nidification of sticklebacks. It was not until fourteen years afterwards

that Mr. Warington, going over the same ground, observed the same facts, and recorded in the 'Zoologist' the wonderful results. In the course of his communication Mr. Warington incidentally observes, "Mr. Edwards, of Shoreditch, whose London garden-pond has afforded much interesting matter to many microscopists, informs me, in a note dated August 27,1852, that it is fourteen years since he first noticed the fact of the stickleback building a nest, guarding and defending the young ones." Mr. Gratton, Mr. Bowerbank, and I, as well as microscopists out of number, were in the habit of visiting Mr. Edwards, and took great interest in his aquarian researches.

I should, however, here record that Mr. Edwards's first aquarium was, as Mr. Warington has described it, a "London garden-pond"; in fact, it was a stuccoed basin through which a small stream of New River water was constantly flowing. This plan, perfectly successful as regards the health and vigour of his captives, was soon supplemented by the glass jar, so much more convenient for patient, continuous and accurate investigation. Mr. Edwards was a watchmaker, and his sticklebacks were kept in a delightful little parlour behind the shop. It was not until some years later that Mr. Gratton set up a similar stickleback observatory at 87, Shoreditch; and the late respected Matthew Marshall another, at his official residence in the Bank of England, so that I enjoyed abundant opportunities of watching the proceedings of these "wonderful fishes."

I mention Mr. Edwards as the first scientific man who observed the nesting of sticklebacks. I say "scientific," because I am aware that from time immemorial the boys hunting "stitlers," and bringing them home in a quadrate pickle-bottle suspended from a stick, were perfectly cognizant of a fact which seemed to have been unknown to naturalists: from them I had learned, long, long before, that there were "cock stitlers" and "hen stitlers," and that the former were also called "redbreasts," and were famous for their fighting propensities: often as I watched the exhibition of these propensities in the aquariums of Mr. Edwards, Mr. Gratton and Mr. Marshall, and often as my fingers itched to write an account of them, I always forbore, for the discovery was the property of these gentlemen, and not mine; and to them, and not to me, of right belonged the honour and glory that must result from making the revelation. Alas! these excellent men have passed away, have left no record of their doings except in the memories of their survivors.

Our stickleback doings at that early period not only engrossed the attention of the little company of aquarians who met at Mr. Bowerbank's hospitable mansion on a Monday evening, but attracted the notice of an outside public, to which they were the never-failing source of pleasantry: very refreshing was that incessant fusillade of small jokes to those who fired them, and very harmless to those who received them. Even the "inimitable" author of the 'Pickwick

Papers,' whom nothing amusing, or ludicrous, or note-worthy, or instructive, ever escaped, took the tide of this little mania on the flood, and rendered Hampstead Heath and its ponds and its sticklebacks immortal in his pages.

Mr. Pickwick is described as the author of a paper entitled "Speculations on the Source of Hampstead Ponds, with some Observations on the Theory of Tittlebats," and the Club of which he was the enlightened President sent forth that eminent man to make further researches. The author adds, "There sat the man who had traced to their source the mighty ponds of Hampstead, and agitated the world with his Theory of Tittlebats, as calm and unmoved as the deep waters of the one on a frosty day or a solitary specimen of the other in the inmost recesses of an earthen jar." This shows that the new fancy had taken so deep a hold on the public mind that it was worthy of good-humoured banter by a man who never fought with shadows.

It was not until the year 1842 that the nest-building talents of the stickleback were fully revealed to the world, and then it was another species of stickleback, *Gasterosteus spinachia*, through another medium of observation (the open sea), and another hand (that of R. Q. Couch) that held the pen (Zool. 796). Mr. Couch, like his predecessors, has passed away, but unlike them has left a trace of his handywork which will endure as long as Ichthyology is a science.

Again, Mr. Kinahan, addressing the Dublin Natural History Society, years afterwards, observes of *Gasterosteus leiurus*, "Concerning the manner in which this little fish preserves its spawn not the slightest notice, if I may judge from the silence of our latest authorities, has been taken by any naturalist." Alas! that it should have been so; yet numbers of us, I can positively assert, were as intimately acquainted with the facts which Mr. Kinahan recorded (Zool. 3526) as he could possibly have been.

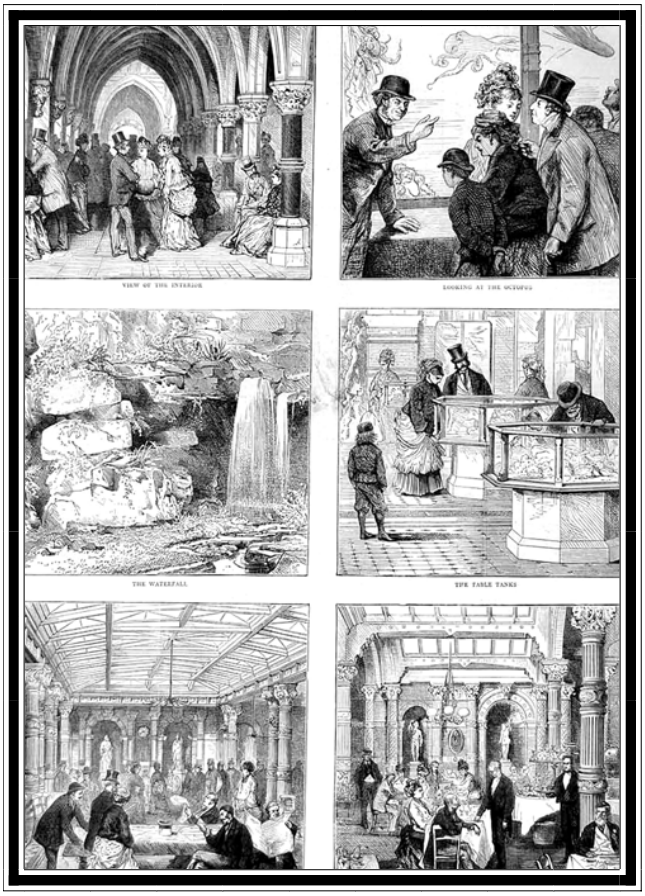
In 1851 Mr. Warington repeated these observations, and thus accomplished a task which Mr. Edwards was fully competent to have undertaken and completed twenty years previously. All honour to them both: these gentlemen, like Mr. Coach and Mr. Kinahan, and subsequently M. Conte of Paris, have given us abundant evidence that they observed accurately the facts which they have recorded so graphically. I trust that no confusion of dates will arise from my coupling the observations of 1838 with the records of 1851. It is really difficult to do otherwise, for a succession of observations were being carried on during the whole of the intervening period, although no contemporary record appears to have been made.

No one who has not witnessed, I may say who has not gloated over, the procreative and educational proceedings of the sticklebacks, can form any conception of their absorbing interest: no one who has not seen the "redbreast" in all his glory and pride of place, can possibly picture to himself the exceeding beauty of this little fish: it only endures while the cares of paternity are upon him: then, and then only, I might address to him the lines of Lord Byron's dedication of Childe Harold to Ianthe:

"Shall I vainly seek
To paint those charms which varied as they beamed?
To such as see thee not my words were weak,
To those who gaze on thee what language could they speak?
Oh, let that eye which, wild as the gazelle's,
Now brightly bold, now beautifully shy,
Wins as it wanders, dazzles where it dwells."

It may be a strange conceit to transfer this picture to a fish, and to a male rather than a female, but it is appropriate; the female is a nonentity, a being without attraction; a provision for the continuance of her kind, and nothing more; she fulfils her destination without love, without sentiment, without sensation, a perfect apathet: but with the male it is not so; his eye is more resplendent than the throat of a humming bird, and like that beautiful object varies with every change of position; it is now a burning sapphire, now a living emerald; his breast and belly are brilliant crimson thrown up by contrast with the delicate translucent green of his back; his entire body seems diaphanous, his eye alone retaining its solidity; the rest is glowing, aye, melting, with internal incandescence. Strange, but sad, this male Ianthe is possessed by a demon! Can he be jealous of his inornate mate? Jealous of the advent of other Ianthes? Yes, but he is only jealous of their meddling with his nursery: the loves of the fishes are wonderful, and man's sagacity cannot understand them.

But I am putting the cart before the horse: I have prepared a receptacle for this Ianthe, a lozenge-glass eight inches in diameter and twelve inches in height; two inches of loam cover the bottom, and perhaps an inch of very clean and very fine gravel covers the loam; a plant of *Valisneria spiralis* is rooted in the loam, and sends up its sword-like leaves and its corkscrew-like petioles to the surface of the water, each producing a single flower destined to float in company with innumerous green circular disks of duck-weed, and a dozen leaves of frog's-bit, each doing its best to take firm hold of the water with its roots; those of the duck-weed are simple threads; those of the frog's-bit generally tend downwards in an oblique direction, and are thickly fringed throughout with lateral fibres, making them look like minute bottle-brushes of rather unusual proportions; imagine small water-beetles treading the water in an orderly and business-like manner, and now and then rising to the surface like pigmy water-balloons, each with a bubble of air annexed to his posterior extremity.



The Brighton Aquarium

He is the manufacturer of his own gas: imagine half-a-dozen other water-beetles crawling deliberately, belly upwards, among the duck-weed, and add a few smaller living creatures floating, or walking, or darting in the water just as fancy or instinct guides them, and you will have a tolerably correct notion of the sort of aquarium in general use amongst as Bowerbankians, and into the depths of which we gazed with boundless and unwearyingly satisfaction. Next witness the arrival of a quadrate pickle-bottle, with a wet string twisted three or four times round its neck and once or twice across its wide mouth, this transverse portion of string serving as a handle by which to carry it: the boy who brings this recommends the contents as being "prime stitlers, all cocks." We take his word, and carefully pouring off the superfluous water, empty the living contents of the pickle-bottle into our aquarium.

Success is neither certain nor immediate: my feelings at Deptford, where all my manual acquaintance with the aquarium was gained, have many times been cut to the quick by finding the sticklebacks chevying one another for days and nights round and round the lozenge-glass, until they died apparently from sheer exhaustion; at first the amount of vital energy was excessive, far too great, but it was the old story, the sword wore out the scabbard; more frequently complete success was the result.

We will suppose a dozen of these little fishes turned into the upright aquarium I have described; an hour will scarcely elapse before one of the fiery redbreasts asserts himself master, selects a part of the establishment "for building purposes" and drives off all intruders: if a second redbreast should call his supremacy in question and contest the point, he must be removed at the risk of disarranging the establishment, but this disarrangement is of less importance than it appears: after stirring up the contents of the glass in a most violent manner in your determination to eject an objectionable tenant of any kind, they will settle down in half an hour and arrange themselves as prettily and as naturally as before you converted their dwelling-place into a miniature Maelstrom.

Leaving one redbreast master of the situation, he immediately commences building operations, but at first these operations do not seem to be conducted on any definite plan; and you begin to think the work is aimless and objectless: half a dozen nests will be begun and deserted; the structure is then pulled to pieces and the materials are carried elsewhere: what are these materials? little gravel-stones, roots of water-plants, hair-like Confervae spontaneously generated out of nothing, decaying leaves of *Valisneria*, and all manner of fragments, which we should characterize as rubbish: by-and-bye an event occurs, unseen and unnoticed, which concentrates all the attentions of the redbreast to one spot: this event is the deposition of spawn by a gravid female; I could never witness the operation, but have no doubt whatever that this event is the governing cause of future proceedings: a foundation, a circular wall or rim, is then constructed around the precious deposit, and this is increased, and improved, and consolidated, in the most wonderful manner, the builder being incessant in his labours; sometimes he will bite off a root of the duck-weed or frog's-bit, and will set it floating in the water.

He will then contemplate this fragment, remaining stationary at a little distance, and will hover like a kestrel over a mouse, supported by the incessant fan-like motion of his pectoral fins: should the fragment bear this rigid inspection he proceeds to utilize it; sometimes, however, the fragment does not meet with his entire approval, and then it is at once abandoned. Mr. Kinahan has observed that after a fragment has been thus abandoned by one fish no other will use it; they take hold of it, examine its capabilities, and invariably reject it; thus proving that these little creatures have some instinctive knowledge of its adaptability or otherwise to the purpose required ; the occupations of searching, finding, testing, examining, selecting and rejecting materials seems incessant; sometimes, however, it will be interrupted by the appearance of an intruder, who is immediately made an object of attack, seized, bitten, and compelled to retreat: the victor will chase him round the glass for a

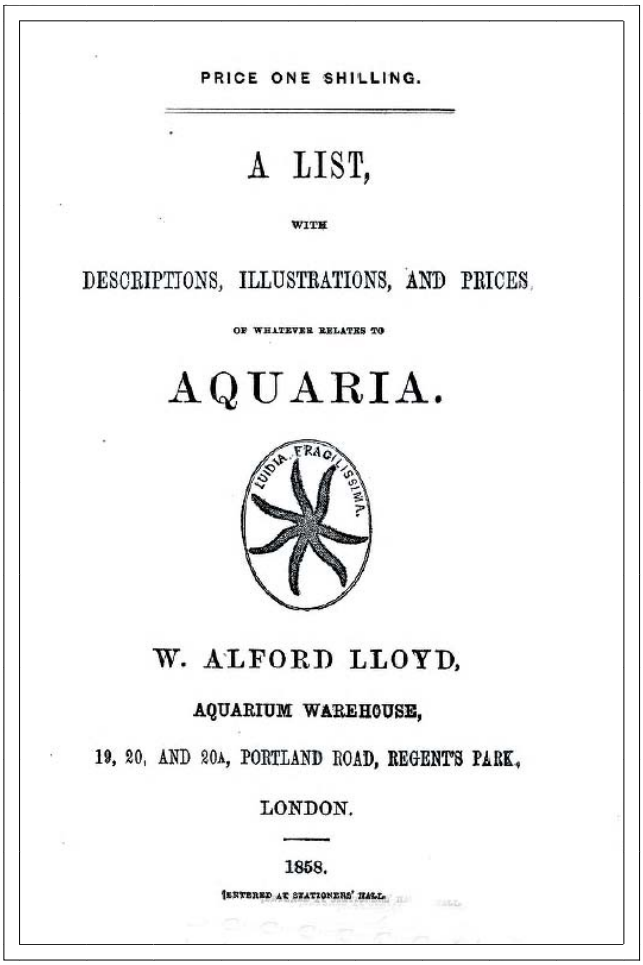
few seconds, and then return and survey his building; he is ever suspicious that it may have suffered injury during ever so short an absence, and will hang in water, like a Syrphus in air, with his head pointed towards his nest, until he is assured that his nursery is intact.

This Syrphus-like suspension is well worth studying; the little fellow, although perfectly still at intervals, will often, with a kind of start, change his position, and take up a new one on the other side of the glass, but still with his nose pointing towards the object of attraction, "true as the needle to the pole," and there he will hang hovering, and winnowing the water with his fins, just as he had hung hovering before. After awhile, assured that his building is intact, he will resume his architectural labours. How often have I seen him, like a tailor- bird, carry some little plant-fibre, or perhaps a fragment of thread which I had dropped into the water for his especial use and benefit, and watched him pass the end through and through the walls of the nest, until it was adjusted to his mind; how often have

I seen him stop when his body was half-way through the nest, his head projecting on one side, and his tail on the other; how often have I wondered by what seemingly miraculous power he passed through the nest he had taken so much pains to construct—yes! pass through it in any direction, as though, like Pepper's ghost, the nest itself were an "airy nothing" which offered no resistance to his compact body, thews and sinews, muscles and spines. From time to time would he come forth, his eyes flashing fire, his breast glowing with rosy red, and if no disturbing element was near would contemplate his work with unmixed satisfaction; then he would go to work again.

The question when or how the eggs are deposited, whether before or after the building of the nest, is by no means finally ascertained. Something like a love chase occasionally takes place, proving that fishes are not altogether insensible to the tender passion, but such scenes are rarely witnessed, and only revealed to those who have an unlimited allotment of time and patience: I have seen a male seize a female by the small of the back, by which I mean that slender part of the body which succeeds the last dorsal fin and precedes the caudal fin; and sometimes also by the sharp spike or spine which we call the ventral fin, and having thus seized her he seems disposed to say by force, not by words, "come into my bower;" but these scenes are not understood: as I have already said, we know next to nothing of the loves of the fishes, and only imagine them by the results. As to the period required by the eggs in coming to maturity, we have evidence of a rather partial kind: "Mr. Gratton had a fine brood hatched in fourteen or fifteen days, the nest having been formed immediately after the introduction of the fish." This is the only record I possess.

These little fishes are wondrous creatures when they first assume the parental figure; they look



PRICE ONE SHILLING.

A LIST,

WITH

DESCRIPTIONS, ILLUSTRATIONS, AND PRICES,

OF WHATEVER RELATES TO

AQUARIA.

LUDIA FRAGILISSIMA.

W. ALFORD LLOYD,

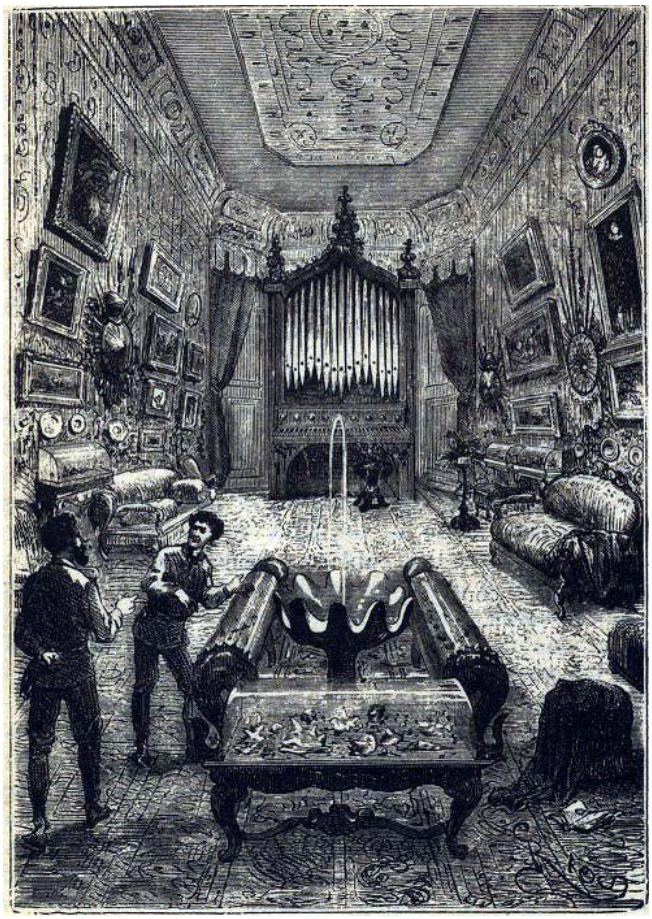
AQUARIUM WAREHOUSE,

19, 20, AND 20A, PORTLAND ROAD, REGENT'S PARK,

LONDON.

1858.

[ENTERED AT STATIONERS' HALL.



The salon of Captain Nemo's Nautilis with its fountain aquarium.

like spicules of silver or bright motes in sunshine, as they float in your aquarium: no one seeing them for the first time, and without the aid of a magnifier, could imagine them to be fishes: then as to number; we are accustomed to count the spawn of fishes by thousands and bund reds of thousands, but 1 think this is not the case with sticklebacks; I have taken some pains to ascertain, and have concluded that the average number of a brood does not exceed twenty: I have never counted more than fourteen. But I admit they may be more numerous: I have caught hundreds of these atomic fishes in my water-net, but then I know not how many broods composed the school.

One word more: in 1843 Mr. Frederick Holme, then at Oxford, published (Zool. 200) his account of keeping water-beetles in confinement: no description of the prison-house is attempted, but Mr. Holme speaks of it as a "glass": he says of his prisoners, "They speedily become familiarized to a certain extent, and will follow the finger round the glass in expectation of food." He continued his observations during summer and winter for a long period.

"When I kept a pair together," thus he continues, "I always found the male died first, and that his dead body bad generally been mutilated and pretty nearly devoured by his widow. The females were at all times much more voracious than the males. 1 generally fed them with raw beef, of which they sucked the juices, but in summer I sometimes supplied them with small aquatic insects, which they seized with their fore feet and tore to pieces with their mandibles, rejecting the elytra and other hard parts."

It will be seen from several expressions in his brief account that Mr. Holme's observations were continuous, extending over summer and winters; we also learn with pleasure that the widows of water-beetles are not utterly inconsolable. I wish here to invite attention to the fact that up to this period (1844), although the aquarium was thoroughly utilized, more so indeed than ever since, its name had not been mentioned.

ERA II. LITERARY, POETIC AND FASHIONABLE.

In this second era or campaign, as I may call it, Mr. (now become Dr.) Bowerbank resigned the command, which, like Alexander's, was divided amongst four of his generals, Warington, Gosse, Mitchell and Rymer Jones.

Mr. Robert Warington, of Apothecaries' Hall, not only devoted every spare moment of his life to experimenting on different forms of vessel, different arrangements of light, and different combinations of inhabitants, in order to ascertain the fittest, but he introduced a new element, substituting salt water for fresh, marine animals for fresh-water animals, sea-weeds for *Valisneria.* I was a constant visitor at Apothecaries' Hall, and

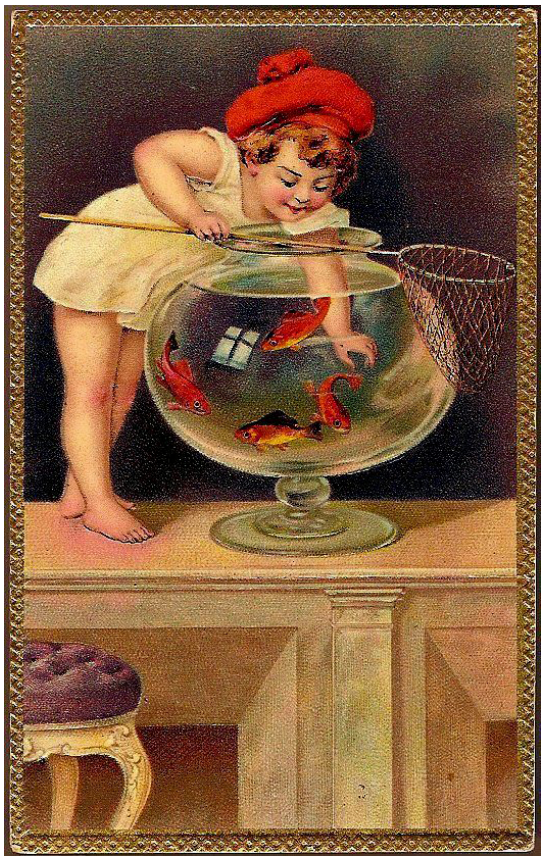
found Mr. Warington ever ready to exhibit and explain his experimental proceedings, for it must be admitted they were experimental; for unlike Mr. Bowerbank, who seems to have attained success at a single bound, Mr. Warington had to think out his plans, and as his was altogether new ground, or rather new water, he was subject to repeated failures and disappointments, but eventually he triumphed over them all.

At our delightful reunions at Mr. Bowerbank's, first at Critchell-place and afterwards at Highbury, the lamented David William Mitchell, then the energetic Secretary of the Zoological Society, who was ever on the alert for something to "draw," was a frequent visitor; the sticklebacks arrested and riveted his attention, and he was not long in taking a lesson from Mr. Bowerbank's book: every one urged it; and Mr. Mitchell listened with marked attention, and conceived the project of an aquarium in the Regent's Park. With Mr. Mitchell there was seldom much time lost between the conception and the execution of a plan. In this instance these followed each other with unparalleled rapidity; he commenced building forthwith, ordered his tanks, and stocked them with their appropriate inhabitants, availing himself of every observation previously made either by Mr. Bowerbank or Mr. Warington.

On Saturday, May 21st, 1853, as reported in the 'Athenaeum' of May 28th, there was opened at the Zoological Gardens in Regent's Park a building or room for the express purpose of exhibiting living marine animals. This building, I believe, received at the hands of the Council the title of "Marine Vivarium," but this inflated appellation soon became toned down by the visitors to the more modest and less assuming one of "Fish House," which it has borne from that time to the present. I extract from the 'Athenaeum' of Saturday, May 28, 1853, the following details, which will be interesting as a contemporaneous record of a notable event, and as inaugurating the second era in aquarian history. Moreover, it has the advantage of incorporating an account of the prior but more humble efforts, in the same direction, of Sir John Dalyell and Mr. Warington, and this saves me the otherwise necessary labour of describing the very important result of the indefatigable exertions of these distinguished aquarians.

"Fresh-water fish were tried first in these gardens. Perch, pike, roach, dace, eels, sticklebacks and minnows were all to be watched, and their domestic secrets and most retired proceedings to be brought to light. The grand experiment, however, of making a little ocean, a miniature sea, in which we might look on the habits of the creatures of the great deep had yet to be made. Sir John Dalyell, it was well known, had kept a sea anemone alive for twenty-eight years, and numerous other marine creatures for less periods; but then throughout these twenty-eight years every morning he had had sea-water brought to his house. It seemed almost impossible to bring up sufficient quantities for such a purpose into our inland towns. Gradually it became known that by aërating the salt water by means of filtering or agitation it became fitted for the support of animal life. Here then a chance of success to an object long desired seemed to present itself, and the enterprising Secretary of the Zoological Society determined to make a trial on a small scale. He began with sea anemones and some of the more hardy shell-fish, and succeeded most satisfactorily.

"While, however, this experiment was in progress a fact of much greater importance became known. It had been observed by vegetable physi-



ologists that plants purify a small quantity of water just as they purify the air,—that is, by taking up carbonic acid and giving out oxygen,—and here was the explanation of the fact of animals living for any length of time in a limited quantity of water, provided there were plants enough to take the carbonic acid which the animals threw off, and supply the oxygen which they needed. The question naturally arose, Why should not sea-weeds do the same for sea-water as fresh-water plants do for fresh water? Various dredgers and sea-shore naturalists had successfully had recourse to this plan; but we believe the merit of first having perfectly succeeded with an arrangement of the kind in London is due to Mr. Warington.

By arranging sea-plants and animals in a limited quantity of sea-water, he maintained the balance of animal and vegetable life that for several months they required neither fresh water nor any mechanical aëration. It is the adoption of this plan on a large scale that constitutes the novelty of the Vivarium now opened to the public in the Zoological Gardens. At the present moment there are in the glass house six large tanks of glass containing marine invertebrate animals and fish.

"These tanks have been arranged in something like zoological order. The first contains a variety of crustaceans, crabs, lobsters and shrimps. Here may be seen in living activity species of these creatures only to be caught by the dredge, and which have been only occasionally seen when cast up on our coasts or pinned down in our museums; several of the spider crabs—which are inhabitants of the deep sea—will attract more attention among these specimens. In the second tank is a collection of Echinodermata. A third tank contains a collection of sea anemones or animal flowers. The more common forms of these lowest members of the great family of polypes are scarcely unknown to the least curious visitors of oar sea-coasts, but it has fallen to the lot of few to see them to such advantage as they now may here.

"In variety of colour they almost vie with a bed of tulips, and they will enable the observer to understand something of the beauty which arrests the attention of the traveler in the South Seas, where these creatures and their allied forms abound. The naturalist will also find in this tank some of the less common of the species of the family Actiniadae which are found on the British coasts. In a fourth tank is a collection of the British Mollusca. Those who gather shells by the sea-shore will recognize many of their old acquaintances in this department, but no longer as uninhabited dwellings. Each contains its proper tenant. Several species of ascidian Mollusca are found here, whose rough membranaceous and ungainly exterior would hardly lead to the conclusion that they are allied to shell-fish at all, did not their interior inhabitant reveal the fact. In another tank a highly interesting group of Mollusca, the nudibranchiate, are to be seen.

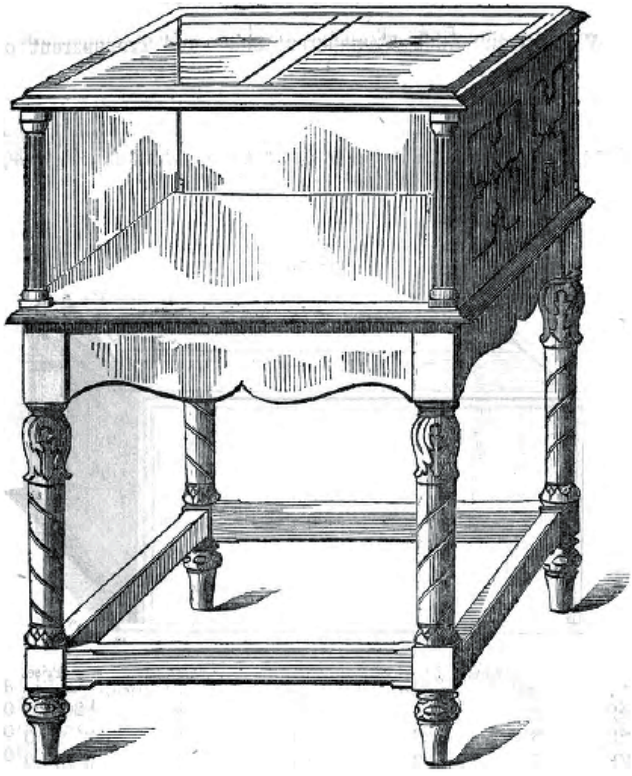
"These have no shells, and are remarkable for their delicate colouring, and for the curious forms assumed by their gills or breathing organs, which being placed outside of their bodies have got for them the name of naked-gilled. The species of this family belong to the genera *Doris* and *Eolis*. In the fourth tank are also contained some species of barnacles and sea-acorns (Cirripedia), which, with their hard molluscous-like shells, were once included under the Mollusca, but are now known to have an internal structure which allies them with the articulated tribes of animals: in this tank are some small species of sea-fish, including the blenny, the fifteen-spined stickleback, the wrasse and the father-lasher (*Cottus bubalis*). The Annelides are represented in several of the tanks by species of Aphrodite and the beautiful Sabellae.

"Many of the leaf-like and vegetable-looking objects at the bottom of the tanks are popularly called sea-weeds, and demand a microscope to make out clearly their animal nature. Nevertheless a sharp eye will detect a downiness on the surface of their bodies, which is the tentacle of the minute creatures that inhabit every portion of their structure, and are the representatives in our seas of those mighty workers, the coral animals of the southern ocean. The present collection is, we believe, only an earnest of future development. Some marine creatures, such as the jelly fishes, are not at present represented, but before the summer is over a collection of these fragile forms will undoubtedly find a place in the Marine Vivarium of the Society."

The aquarium immediately became a fashion, a rage, an infatuation, which, now that we are sobered down and are able to regard a stickleback with equanimity and a sea anemone without any sensible increase in the rapidity of pulsation, it seems difficult to realise. The press lent its powerful aid to this result. A judicious publisher is not he who invents, but he who avails himself of an invention: a man who embarks his capital in a 'Principia' or a 'Paradise Lost' will be esteemed a man of discernment by future generations, but will not be remunerated by the present. The successful journalist follows, while he is supposed to lead, public opinion; he deludes even himself with this gratifying but shallow fallacy.

It was not until the parlour-pond had thoroughly established itself as a fashion that the press detected in it a source of profit. Book-makers and book-publishers then saw their opportunity, and were not slow to embrace it: the press teemed with aquariums. My friend Mr. Van Voorst took the lead in this movement, and amid the surging wave of aquarian literature, original and imitative; his volumes are still the best and most likely to endure. I will give the titles and dates of those aquarian volumes which appear to possess inherent excellence, interspersing those of a few tracts which, although of minor importance, assisted greatly in fanning into flame the fire that had already been kindled.

1850. "On the Adjustment of the Relation between the Animal and Vegetable Kingdoms, by which the Vital Functions of both are Permanently Maintained." By Robert Warington.



An aquarium and stand in Lloyd's Catalogue.

('*Zoologist*' for 1850, p. 2868.)

1852. "Observations on the Natural History of the Water Snail and Fish kept in a confined and limited portion of Water." By Robert Warington. ('*Zoologist*' for 1852, p. 3638.)

1853. "On Preserving the Balance between the Animal and Vegetable Organisms in Sea Water." By Robert Warington. Read at the Hull Meeting of the British Association. (Printed in the 'Annals and Magazine of Natural History' for November, 1853, and at p. 4118 of the '*Zoologist*' for 1858.)

1853. "Aqua-vivarium." An article by Dr. Edwin Lankester. (Printed in the Natural History Division of the '*English Encyclopedia*')

1853. "A Naturalist's Rambles on the Devonshire Coast." By Philip Henry Gosse. 452 pp. letter-press and 28 plates, most of them coloured.

1853. "The Aquarium; an Unveiling of the Wonders of the Deep Sea." By Philip Henry Gosse. 278 pp. letter-press, 6 coloured plates, and 6 engravings on wood.

1856. "Tenby; a Sea-side Holiday." By Philip Henry Gosse. 400 pp. letter-press and 23 plates, most of them coloured.

1858. "The Aquarian Naturalist; a Manual for the Sea-side." By Thomas Rymer Jones. 524 pp. letter-press and 8 coloured plates.

1860. "Actinologia Britannica; a History of the British Sea Anemones and Corals." By Philip Henry Gosse. 362 pp. letter-press and 11 plates, 10 of them coloured.

These delightful works abounded with lucid descriptions, pleasing pictures, poetic quotations, and graphic accounts of the doings of aquatic animals as first seen by the assistance of the aquarium: nothing can exceed the beauty of some of the word-painting by Philip Henry Gosse; and as for Thomas Rymer Jones, he is overflowing with poetry: no less than one hundred and sixty-two quotations, or as I may call them "snatches of song," are scattered through his "pleasant pages." He seems to have been so led away by his subject that he could not resist the impulse to break forth into melody.

A complete change had now taken place in the element as well as in the style of treating of it, the water employed for the experiments during the first era being almost invariably fresh, during the second period almost entirely salt: the object during the first era was almost entirely confined to the habits of the living tenants of the aquarium; during the second period, the fashion, admeasurements, size, materials, structure and ornamentation entered largely into aquarian literature; indeed these matters, utterly ignored by Bowerbank and his followers, became of paramount importance. Mr. Gosse says:—

"The tank is 2 feet long, 1-1/2 foot wide, 1-1/2 foot deep; the sides and the ends of 3/16th plate-glass; the bottom of slate, the corners of beech wood, turned into pillars, each surmounted by a knob, and united by a frame top going all round. The glass is set in grooves in the slate and wood, and fastened with white-lead putty."—'Aquarium,' p. 101.

Mr. Warington, after experimenting unsuccessfully for some years, gave instruction for the making of a small tank as a more permanent reservoir, with certain improved modifications as regards form and the admission of light. He writes thus:—

"From the experience I had obtained in my experiments with the fresh-water tank, I was induced to modify slightly the construction of the vessel; thus at the back or part towards the light the framing was filled with slate, in the same way as the ends and bottom; for I had found that the glass originally employed very soon became covered with a confervoid growth which had an unpleasing appearance to the eye, and in consequence of which I have been obliged to paint the glass on the exterior to prevent the growth from increasing to too great an extent. It was almost an unnatural mode of illumination, as all the light should pass through the surface of the water.

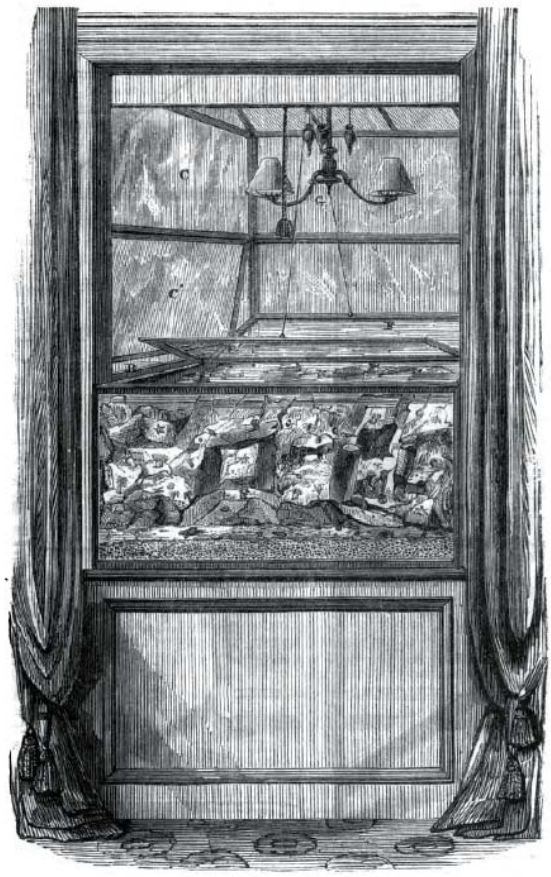
The front towards the room and the observer was constructed of plate-glass, the whole being set in a stout frame-work of zinc and cemented with what is known under the name of Scott's cement, and which I have found to answer for the purpose most admirably. Within the tank were arranged several large pieces of rockwork thrown into an arched form, and other fragments were cemented against the slate at the back and ends, and at parts along the water-line, so that the creatures could hide themselves at pleasure; a short beach of pebbles was also constructed in order that shallow water could be resorted to if desired; the whole tank was covered with a light glass shade to keep out the dust and retard evaporation." —'*Zoologist*' 4119.

Professor Rymer Jones, modestly referring to Mr. Warington and Mr. Gosse as his authorities, recapitulates Mr. Warington's instruction, and points out its advantages:—

"First, that it allows of a most extended view of the whole interior of the aquarium.
"Secondly, that it enables the occupants to resort to any depth they may desire, or even to ascend the sloping back and emerge from the water.
"Thirdly, it admits of a much larger surface being exposed to the action of light; and
"Fourthly, the sloping top allows the water which condenses on the glass to trickle off and return to the aquarium without first resting on the zinc or iron frame-work. It need hardly be suggested that the sloping back is to be covered with light rockwork extending to a short distance above the water line."— '*The Aquarian Naturalist*,' p. 6.

Each of these various instructions, insisting on the exclusive use of putty, white lead, red lead, Scott's cement, &c., were severally regarded as embodying the perfection of human wisdom until the next adviser suggested an improvement; but notwithstanding this wide divergence on minor points, it is an important fact that all aquarian authorities seem to have deliberately considered and tested, and then uniformly rejected and condemned, all attempts at aëration or circulation.

Dr. Lankester avers that circulation is only needed as "precautionary" until the vegetation is quite established. Mr. Warington says, "With the sea-water obtained in January, 1852, I have been working without cessation up to the present time, agitating and aërating when it became foul during unsuccessful experiments on the sea-



The interior of a window sill aquarium.

weeds, but since then it has rarely been disturbed," and then he emphatically adds, and I think it desirable to express his decision by italics:—*"It must be decidedly understood that no agitation or so-called aëration is required when the balance of animal and vegetable life is properly established."* This sentiment, perhaps somewhat less decidedly expressed, runs through all the aquarian books of this era: I wish, indeed, to show beyond the possibility of doubt, that the system of aëration and circulation belong to the third era, but it were of no avail to supplement the fiat of the leader with the milder enunciations of the followers; it is like adding wine and water to wine.

It must not, however, be supposed for a single instant that the aquarian literature of the era is restricted to dry and useless advices or mistaken prohibitions: such a conclusion would be decidedly erroneous, utterly opposed to fact, and Mr. Gosse's work especially abounds in truthful descriptions of aquatic life which might fairly challenge a comparison with anything that has ever been written on the "manners and customs" of the World of Animals. I will make but one extract in proof of this, a long one indeed, but I cannot divide it without destroying its value, and as for making an abstract or abridgment, it is quite out of the question. The author's ideas might possibly be conveyed in an abstract, but the life, the soul of the passage would be wanting if I robbed it of the author's phraseology.

"The Sepiola **[Note: This is a genus of bobtail squid]**. —My notions of the Cephalopoda, derived from figures of the various species in books, were anything but agreeable. I thought of them as hideous, repulsive, fierce, atrocious creatures, hated and feared whenever seen. But an acquaintance with the pretty *Sepiola vulgaris* has not a little modified these ideas; and its beauty, sprightliness, and curious habits have made it quite a favorite pet among the denizens of my Aquarium. I take it in considerable numbers in this Bay, by means of the keer-drag already described, which rakes the bottom. It is a little creature, rarely exceeding an inch in length; though the extensibility of the arms somewhat varies its dimensions.

When we turn out two or three from the net into a pail of sea water, they are at first restless and active. They shoot hither and thither, as if by a direct effort of will, but in reality by the impulse of rapid and forcible jets of water directed towards various points from the mouth of the flexible funnel situated beneath the body. After a few moments they suspend themselves in midwater, hovering for many seconds in the same spot, scarcely moving a hair's breadth either way, but waving their large circular swimming-fins rapidly and regularly up and down, just like the wings of an insect.

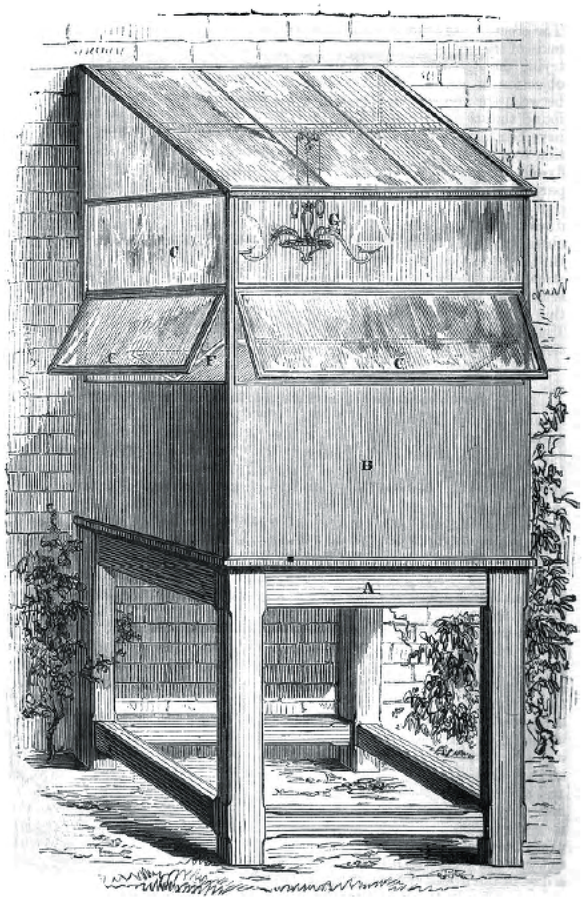
"Indeed, the resemblance of the little Cephalopod, in these circumstances, to a brown moth hovering over a flower, is most close and striking, and cannot fail to suggest an interesting comparison. The body is held in a horizontal

position, the large protuberant eyes gazing on either side; and the arms, grouped together into a thick bundle, hang freely downwards. If you essay to count these organs you find only eight; and even if you are aware that one of the characters of the genus is to have ten, of which two are much longer than the rest, you may search for these latter a long time in vain.

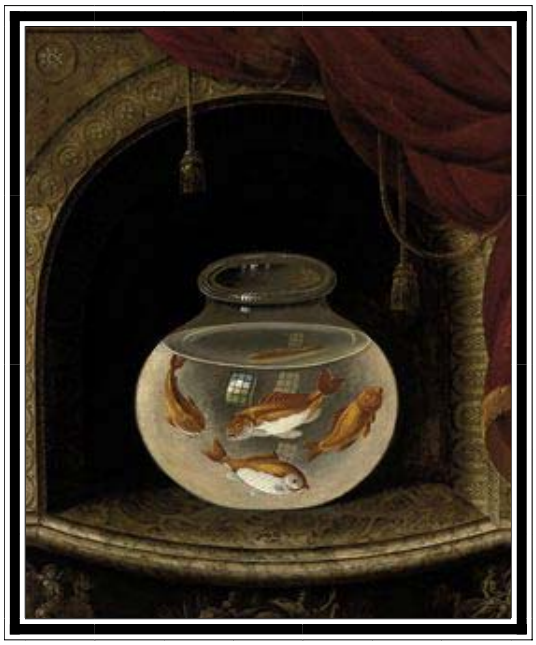
Of course I mean during the life and the health of the animal, when its impatience of being handled presents obstacles to a very accurate investigation; you may then turn it over and over with a stick, and look at the bundle of arms from above and below in turn, now grouped together, and now thrown all abroad in anger at being teased; still you can make out but eight. It was not until after many trials that I at length caught a peep at the missing organs—the pair of long arms—and discovered that it is the animal's habit to carry them closely coiled up into little balls, and packed down upon the mouth at the bottom of the oral cavity. If we manage to insert the point of a pin in the coil, and stretch out the spiral filament, the little creature impatiently snatches it away and in a twinkling rolls it up again.

"A zealous votary of the circular system would seize on this analogy with the spirally folded tongue of a moth, and triumphantly adduce it as additional proof that the Cephalopoda represent, in the Mollusca circle, the Lepidoptera among insects. While thus hovering motionless in the water, the Sepiola presents a fair opportunity for observing its curious transitions of colour, which are great and sudden. We can scarcely assign any hue proper to it. Now it is nearly white or pellucid, with a faint band of brown specks along the back, through which the internal viscera glisten like silver. In an instant the specks become spots, that come and go, and change their dimensions and their forms, and appear and disappear momentarily. The whole body,—arms, fins, and all,—the parts which before appeared free, display the spots which, when looked at attentively, are seen to play about in the most singular manner, having the appearance of a coloured fluid, injected with constantly varying force into cavities in the substance of the skin, of ever-changing dimensions.

"Now the spots become rings, like the markings of a panther's skin; and as the little creature moves slightly, either side beneath the fin is seen to glow with metallic lustre, like that of gold leaf seen through horn. Again the rings unite and coalesce, and form a beautiful netted pattern of brown, which colour increasing leaves the interspaces a series of white spots on the rich dark ground. These and other phases are every instant interchanging and passing suddenly and momentarily into each other with the utmost irregularity. But here is a change! One is hovering in quiescence, his colour pale, almost white; one of his fellows shoots along just over him; with the quickness of thought, the alarmed creature turns from white to a uniform deep brown, the



The exterior of the window sill aquarium.



rich full colour suffusing the skin in a second, like a blush on a young maidens face. The hue is very beautiful; it is the fine, deep, sienna-tint of tortoise-shell; a substance which, indeed, the mingling clouds of brown and pellucid horn closely resemble in the intermediate phases of colour.

“Hitherto we have seen the Sepiola only in the pail of water into which it was turned out of the net. After a little while it drops upon the bottom, and crouching up remains motionless; if you rouse it, it will again swim for a few minutes, but presently seeks some corner, into which it thrusts its rear, and huddles up as before. This is all that you will see of its habits under such circumstances; for in all probability the morning will reveal your protégé a lump of white jelly, dead and stiff, with uncoiled arms, on the naked floor of his prison. But introduce him while in health into an Aquarium, where living sea-plants are perpetually revivifying the water, and where the bottom, varied with sand, gravel, and pieces of rock, imitates the natural floor of the sea, and you will soon see other particulars in the economy of our little friend, which will, I doubt not, charm you as much as they have pleased me.

“The Sepiola is a burrower; and very cleverly and ingeniously does it perform a task which we might at first suppose a somewhat awkward one— the insertion of its round corpulent body into the sand or gravel. Watch it as it approaches the bottom, after a season of hovering play such as I have described. It drops down to within an inch of the sand, then hangs suspended, as if surveying the ground for a suitable bed. Presently it selects a spot; the first indication of its choice being that a hollow about the size of a silver fourpence is forcibly blown out of the sand immediately beneath the group of pendant arms. Into the cavity so made the little animal drops; at that instant the sand is blown out on all sides from beneath the body backward, and the abdomen is thrust down ward before second series the cloud of sand which has been blown up settles, but which presently falls around and upon the body.

“Another forcible puff in front, one on each side, and another behind, follow in quick succession, the fine sand displaced at each blast settling round the animal, as it thrusts itself into the hollow thus more and more deepened. I was not at first quite sure by what agency these blowing, so admirably effective and suited to the purpose, were performed. The jet in front I readily attributed to the action of the fleshy funnel projecting from beneath the mantle on the breast; but 1 did not see how this could blow a stream directly backwards. I therefore put one of my pets into a vessel with glass sides, which was furnished with the requisite sand and water.

“I at once saw that the funnel was indeed the organ employed, and the only one, in every case; and perceived its beautiful adaptation for the work it had to do, in its extreme flexibility. This organ is very protrusile, and being perfectly flexible, its orifice can be, and is, at will pointed in any direction, so as to blow the jet of water forward, backward, or to either side at pleasure. It frequently occurs, of course, that small stones are mingled with the sand, or the animal may find it convenient to burrow in the loose gravel. In either case the arms come to the aid of the funnel, the sucking disks with which they are

furnished being made to adhere to the stones, which are dragged out and thrown aside.

"You may suppose this to be a clumsy expedient, but you would think differently if you saw it; the rapidity with which the arms are thrust under, and drawn out, bearing pieces of stone of comparatively large size, and the graceful ease with which they are then thrown forward, discharging and dropping the burden, impress the mind with admiration of the beautiful fitness of the organization for the requirement. This use of the funnel, and of the sucking arms, so different from their normal purposes, affords additional examples of that Divine economy in creation, which, when a new formation is ordained, does not always form new and special organs for the necessity, but adapts some already employed in other service for the new work; while still both the one and the other function are fulfilled with such perfection as shows that every emergency was foreseen and provided for in the mighty plan, and that it was not for want of resources that distinct actions are performed by the same instrumentality.

"We admire the skill of the artisan who can effect different operations with the same tool, especially when we see that each kind of work is of faultless excellence. The ordinary employment of the sucking arms is no doubt the same as in other Cephalopoda, the capture and retention of prey. Of this I saw an instance in the case of one of my Sepiolae which had seized a shrimp (Crangon trispinotus), a sand-burrower like itself, and was, when I saw it, holding it firmly against the horny jaws, which were devouring it. The discharge of ink through the funnel I have also witnessed, though this is far from being a frequent action with this species.
"One of them that had been for a day or two in an Aquarium, and was evidently at home there, I put into another vessel. No other animal was present, but the strangeness of the new abode evidently frightened it; it darted about in manifest alarm and excitement, and presently shot forth from its funnel a cloud of inky fluid to a distance of several inches; another and another discharge succeeded in rapid sequence, and it was not for some time that the animal recovered its equanimity. It did not appear to me that this fluid could be of much service to the little creature in the way of concealment; for although the matter was tolerably copious, and densely black, it did not diffuse itself in the water, but remained in masses, and when moved with a stick was drawn into slimy strings."

Here ends the second era in the history of the aquarium, and although we are indebted so greatly to the leaders of this period for their patient research and indomitable perseverance, it cannot truthfully be denied that a large share of these qualities was wasted on useless instructions about selecting and cultivating sea-weeds; in cruel and mistaken advice to keep the captives without food; and in denouncing the very principle, that of aëration and circulation, by which alone the aquarium can become permanent.

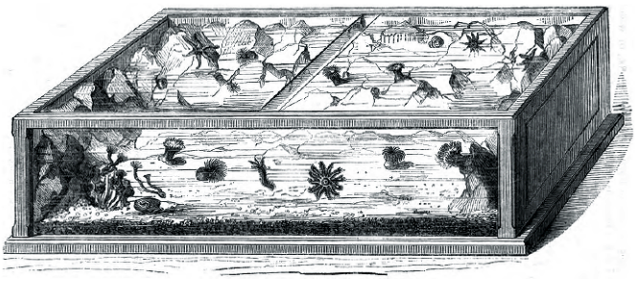
ERA III. COMMERCIAL AND AMBITIOUS.

From the preceding pages it must, I think, be evident that nearly all the conclusions at which we arrived during the First and Second Eras require careful reconsideration. I cannot say that what has been termed the balance of nature—so much water, so much air, so many animals, so many plants—is altogether a mistake; but I do without hesitation say that we made too much a rule-of-three sum of the affair, and that the formula we were in the habit of laying down was framed under the idea that by the aid of experience we could define what laws ought to govern Nature, rather than leave Nature entirely unfettered, and humbly ask her to show us how she governs herself; for, as a sea-cave in full flower with anemones is far more beautiful than anything we can achieve by our own management, so are the concomitant conditions which have produced that result infinitely more subtle than any arrangements we have in our power to devise.

As for sea-weeds in a state of nature, I deny none of the properties which have been attributed to them, but I maintain that in our clumsy attempts to introduce sea-weeds into our fictitious seas, we frustrate rather than promote the object we have in view; and it is not a little curious that when Nature was actually sowing broadcast her Algae and Confervae in our aquariums we deliberately laid our unwise heads together for the express purpose of defeating her beneficent intentions.

We wrote instructions how to get rid of the green growth that was such a nuisance in our otherwise successful aquariums: it is as though a man writing on breeding poultry were to recommend the destruction of all the chickens. Nature should be her own marine gardener. There should be a bottom and sides to an aquarium—this seems an absolute necessity, whether that aquarium be an ocean or a tank; and Nature, unassisted and uninvited, will clothe the bottom and sides with a drapery of vegetation wherever the light can penetrate. The seeds of sea-weeds are ever floating in the water, and ever ready to find anchorage where they meet with a stable surface. So universal is this sporadical growth of aquatic vegetation, that I believe it impossible for a stone to be immersed in water under the influence of light, without attracting the seeds of aquatic plants, and these will assuredly vegetate on its surface; and it is also a most indubitable fact—a fact that loses none of its importance by frequent repetition—that this humble vegetation emits, in a powerful light, a series of ascending bubbles of oxygen.

But there is another necessity, a necessity which aquarians of the first and second eras, as we have seen, not merely refused to acknowledge, but took the utmost pains to condemn. I think it probable that every naturalist who trusts himself on the ocean, even for a dozen hours, and from



A marine aquarium pictured in Lloyd's Catalogue.

the deck of a steamer snuffs the invigorating breeze as it passes over the agitated surface of the water, will after a while admit that some other principle is at work beside the maintenance of an exact balance between the breathings of sea-weeds and the breathings of sea anemones or fishes; and will perhaps also admit that motion is such a principle.

It has been asserted by voyagers over and over again that the sea itself becomes foul during a long calm, and that its life-supporting powers seem absolutely to have departed; fishes and pelagic crabs die by myriads and float on the surface, and, together with dead sea-birds and detached sea-weeds, constitute a putrid, fetid, fever-generating scum, more dreadful, more fatal to man, than when the great deep is in its wildest and stormiest moods. The introduction of sea-bang, sea-lettuce, sea-endive, sea-whistle, sloke, dulse or carrigeen will not remedy this. Whatever quantity of these life-restoratives be cast upon the waters, they will do harm rather than good; they will float on the surface, decay, and add to the seething and putrefying mass.

A more powerful agent is required, and Nature kindly supplies it. A breeze springs up; a change comes o'er the spirit of the scene; motion sets in, and all is restored. We read that in a space of time incredibly short, the water resumes its life-sustaining power, and every trace of impurity has vanished as by a miracle. These narratives must, I think, convincingly establish to those who read them, the fact that there is no necessity for changing the water. When the life-sustaining power of the sea has been exhausted, Nature herself restores it, and the restoring element is motion. She has no power to change the water; the same sea must be used again and again; the same water must be encompassed by the same land. However clearly the theory of change in relative position may have been established—however manifest it may be that the ocean now rolls over what was once dry land, and that what is now dry land was once covered by the sea—still there is nothing new, nothing added, nothing subtracted; the same materials remain, fluid and solid, and will remain for ever. Motion continually exposes a fresh surface to the atmosphere, and this contact of air and water, called aëration, is in continual operation.

"The great want felt," says Mr. Lloyd," was constant motion like that of Nature, by which the water may be continually turned over and over, presenting successive and multitudinous surfaces to the surrounding atmosphere, and may by contact with it incessantly absorb large quantities of oxygen necessary for the sufficiently rapid decomposition of organic matter given off by the animals."—'Handbook,' p. 18.

Twenty years before this the absolute necessity for motion and aëration was, I believe, first pointed out by Mr. E. W. H. Holdsworth, in his 'Handbook to the Fish House in the Gardens of the Zoological Society of London.' This excellent little pamphlet is not only useful as a companion to the aquarium, but is a philosophical exponent of the only principles and arrangements on which marine aquariums can be established so as to become permanently successful. Mr. Holdsworth has shown himself perfectly acquainted with his subject, and thoroughly competent to explain it to others. The 'Handbook' is now so exceedingly rare that I need make no apology for the rather long quotation given below.

"The main difficulties at present met with in the satisfactory maintenance of the aquarium are unquestionably due to our ordinary inability to imitate that most important condition of the

sea—its continual motion. The advantages derived from that movement are incalculably great to its inhabitants; so much so as to mask, in a great measure, the principle of compensation on which plants and animals are largely dependent for the supply of the gases necessary for their respiration. In a small tank the presence of decaying animal or vegetable matter, even in inconsiderable quantities, is often sufficient to destroy the purity of the water, and so to cause the death of the animals in it; for the poisonous gas, carburetted hydrogen, arising from putrefaction, is there confined within a small space, and the stagnant condition of the water prevents its rapid combination with the oxygen, which, uniting with the hydrogen, produces water, and with the carbon results in carbonic acid.

"But, in the sea, any dead matter not consumed by crabs or other scavengers is distributed in every direction as fast as it becomes decomposed and assumes the gaseous form, and a supply of pure water immediately takes its place, so that the plants and animals in the neighbourhood are not exposed to any hurtful influence arising from it, as is the case when the decaying matter gives off its deleterious gases in the motionless water of the aquarium. In large establishments this movement of the water may be produced without much difficulty by the aid of gutta-percha pipes and a small reservoir or supply tank from which the water may flow into the aquarium and the waste be pumped back to continue the circulation; for it is not necessary that the water should be renewed. *Any loss that may take place by evaporation should be made good by the addition of pure fresh water; but the great bulk of the sea-water will last for years if it is kept well aërated; indeed, there is no reason for its ever being unfit for use.*

"The salts held in solution retain their properties for an indefinite time, as far as is known; and as the pure water is all that is lost by evaporation, that alone requires replenishing in order to preserve the proper specific gravity or density of the whole. In small tanks the water may be temporarily agitated by the use of a convenient kind of force-pump, adopted by Mr. W. A. Lloyd; but unless there is a special supply tank placed on a higher level than the aquarium, so as to ensure a continuous stream, the movement of the water cannot be easily maintained. Prawns and fishes are also useful, to a certain extent, in causing a motion of the water, but they have too little power to produce anything like the continued washing of the sea which the Actiniae are accustomed to; for it will be remembered that these animals, being attached, are exposed to the recoil of the water from the resistance of the rock as well as to the influence of the tidal current; and this double motion of the water produces the wash which gives such a life- like appearance to everything growing within its reach. Animals subjected to this peculiar movement of the sea display vigour almost unknown in the usually quiet waters of the aquarium.

"The Actiniae attach themselves firmly in sheltered crevices and expand their flower-like disks to the ever-changing water around them, every wave brings a fresh supply of food within their reach, and their bodies are kept clean by the motion of the water. Fishes, and other swimming animals, also seem to enjoy the continual strug-

gle necessary to prevent their being carried away by the stream, and thus all their vital powers being called into action, everything presents the appearance of health and animation. Such are the results we must endeavour to produce in the aquarium, and we can only do so effectually by imitating, as far as possible, the means employed by Nature. In cases where it is inconvenient or difficult to establish a constant change of water, as in small tanks, great advantage may be derived by occasionally drawing off the water, and in this manner placing the animals in the condition to which they are accustomed when the tide is out. Of course this treatment is only applicable to those animals and plants naturally living between tide-marks; for, except in the case of some of the blennies, and a few other small fishes, this exposure to the atmosphere is unsuited to the habits of free-swimming animals.

"The appearance of the Actiniae, and other soft-bodied creatures, when left thus exposed, is often so unlike their condition, when immersed, as to give rise to the suspicion of their being in an unnatural state; but experience tells us that these animals thrive best when subjected to this periodical exposure, and they show renewed vigour on the subsequent rising of tube artificial tide. A great advantage is also gained by returning the water in a small stream to its place in the tank; by this means the whole of it undergoes purification in its passage through the air, and becomes better fitted to support life. We need only take a glance at the rocks at low water to satisfy ourselves that periodical exposure to the atmosphere is almost one of the necessary conditions of life with many species of marine animals.

"Some of the sea anemones are found so high up in the range of tide that they must necessarily be out of the water for at least six hours of the twelve occupied by its ebb and flow; and if we go lower down and look under the large boulders, and into the dark crevices of the rocks, we shall find a multitude of creatures, and many of them of the most delicate structure, which, for an hour or two in every tide, are quite out of reach of the water. Marine animals can bear this exposure better than the inhabitants of fresh water; the salts held in solution in sea-water retain a moist atmosphere around the bodies of the various animals which have been bathed with it, and evaporation consequently does not take place very rapidly, so that we need not fear imitating Nature even in what, at first sight, appears to be a hazardous proceeding."— 'Handbook to the Fish House,' p. 10.

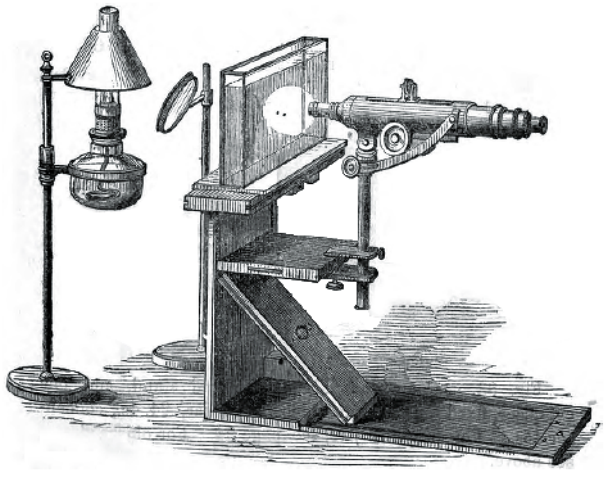
Here we have the principle of the salt-water aquarium clearly explained; and I have, as in one or two previous instances, italicised a passage to which I wish particularly to invite attention. Nothing can be more truthful than the entire extract, and it is difficult to conceive anything more neatly expressed than the sentence I have printed in italics; Mr. Holdsworth's method of returning the water into the aquarium is perhaps somewhat superseded by the more energetic operation of the steam-engine, but the idea is the same, and is perfectly in accordance with present practice.

I believe it was during the year following the successful opening at Regent's Park, that the late Dr. Robert Ball introduced a novel mode of aëration at Dublin: this is spoken of as "a method of keeping the sea-water in occasional motion by passing bubbles of air through it from a pair of bellows worked by visitors." I cannot find at this moment any categorical description of the experiment, or any statement of its success or otherwise; but it is due to the memory of this enthusiastic and kind-hearted naturalist, with whom I had the honour to be personally acquainted, to preserve the record of an ingenious invention.

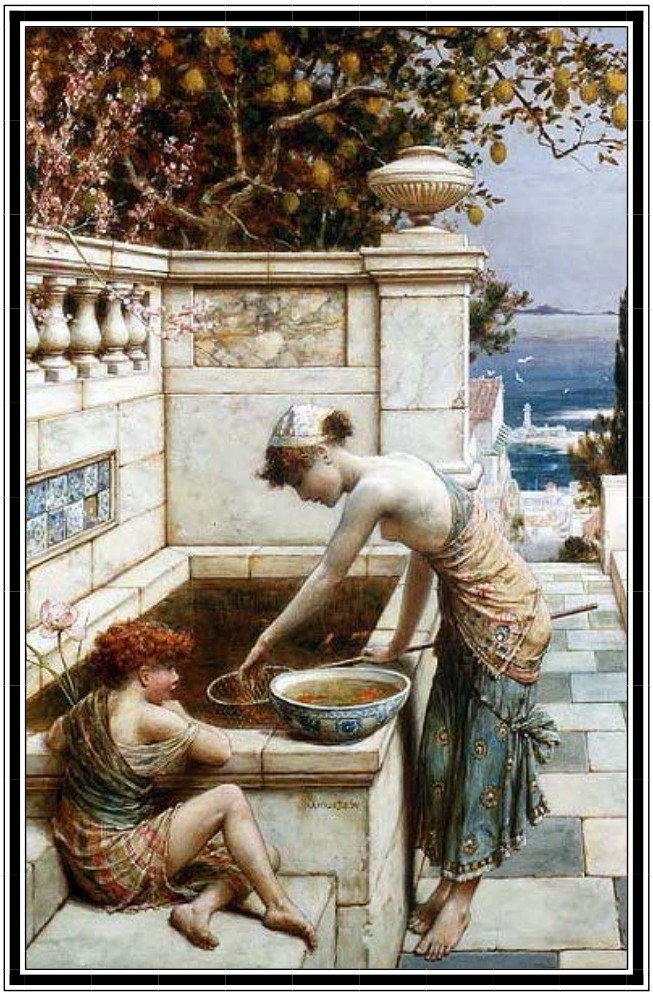
Again, two years subsequently, in 1856, the Baron Cloquet, whose ingenuity is well known to all the savans who took part in establishing the Jardin d'Acclimatation at Paris, revived the use of bellows for the purpose of aëration. His instrument had a gutta-percha pipe fitted to its nozzle, and at the extremity of this a leaden tube, which extended to the bottom of the aquarium; the aperture of the tube was covered with wire-gauze, which pulverized in the most complete manner the air forced through it by the bellows; the emission of the air at the bottom of the aquarium would doubtless partially effect the desired object, but not so thoroughly as Mr. Lloyd's; for on his plan, presently to be described, the air comes in contact with the water, both in its rapid descent and its deliberate ascent, whereas in the baron's method it could only do this in its ascent.

Still subsequently, M. Milne-Edwards the younger, son of the great naturalist of that name, invented an apparatus for aërating an aquarium, the peculiar advantage of which was said to be that it required neither manual labour nor any attention; it is described as working "automatically," thus reminding one of that grand desideratum in mechanics, perpetual motion: its figure was that of our old hour-glass, consisting of two chambers connected by what may be called a narrow waist. The upper chamber was full of water, the lower full of air; the water descended by its own gravity from the upper chamber into the lower, expelling the air and driving it into the water of the aquarium, which thus became saturated with air: the operation of emptying the upper chamber took a long time on account of its large size and the smallness of the waist; but when once this was accomplished the entire apparatus swung and reversed itself, in which operation it closed one valve and opened another, and the chamber which now contained water being uppermost, the same result took place as before: without seeing the machine I am unable to understand this, so I feel my inability to explain it to others: we all know that under any circumstances the heavy or water-filled chamber would, like a modest gentleman, evince an invincible repugnance to take the uppermost place.

In 1859 Mr. George Hurwood, of Ipswich, contrived an arrangement whereby the pressure of a stream of fresh water, such as exists in the pipes of water-works in towns, or such as can be got from a high cistern already existing in a dwelling-house, may be employed to compress air, which compressed air in turn forces a current of sea-water into an aquarium. This arrangement was adopted by Mr. Lloyd in the Jardin d'Acclimatation, and was eminently successful: it has continued in operation for thirteen years.



A microscope for viewing small marine creatures in a large glass cell (Lloyd's Catalogue).



The necessity of aëration and motion having been generally admitted, after their introduction in the Zoological Gardens in Regent's Park, other aquariums, more or less fully adopting the principle, were established in the Surrey Zoological Gardens in London, in the Zoological Gardens in Dublin, in Belfast, Galway, Edinburgh, Scarborough, Weymouth, Vienna, and the Crystal Palace; the last named, under the management of Mr. Bartlett, the present invaluable Superintendent of the Zoological Gardens: this was remarkable for the ugliness of its exterior and the extreme beauty and temporary success of its internal arrangement. Others were established in America, and those at Boston and New York became somewhat celebrated—a result, at the latter city, probably due in great measure to the matchless advertising talent of Mr. Barnum. Mr. Lloyd, however, tells us that all these exhibited two faults: the stock of animals was invariably excessive in number, and the animals themselves excessive in size, faults which carried their own punishment, for from this very excess the creatures dwindled and died.

William Alford Lloyd, the projector of the Crystal Palace Aquarium, and now the Superintendent, and the author of the 'Official Handbook,' was born on the 8th of August, 1828, at No. 6, Bush-lane, Cannon-street, in the City of London, the site now occupied by the premises of Messrs. Barron, Squire and Co., wholesale druggists. He was a weak and sickly child, and at five years of age was sent into Wales for the invigoration of his body and improvement of his mind: he was put to a hedge-school at Llwynlleia, in Merionethshire: the spot thus honoured is equidistant from three villages rejoicing in names which I am totally unable to pronounce, and therefore gladly take refuge in letter-press: these villages are Bettwsygwerfilgoch, Cerrigydruidion and Llanfihangel—names a familiarity with which, Mr. Lloyd tells us, in his pleasant autobiography, largely assisted his speedy acquisition of the German language in after years. Would that they had the same effect on me! Mr. Lloyd's "school days" might possibly have furnished matter for a narrative as interesting as those of Tom Brown, but he has only given us a very small installment of such a narrative, and I believe even that would have been withheld had it not been for the accidental finding a crab, a circumstance that incidentally leads us to an introduction to his school and schoolmaster in the year 1833.

"I smuggled the crab into the school-room," says Mr. Lloyd, "in order to get the schoolmaster, Humphrey, the learned man of the place, to tell me all about it. He was a little thin old man, with a yellow, shrunken face, yellow teeth, and yellow finger-nails, was dressed in a black velvet coat, waistcoat, and knee-breeches, with black stockings and huge shoes. He knew no English; and at intervals throughout the day smoked very coarse tobacco from a short black pipe in the school-room, which was also the dissenting chapel of the place. There were no writing-desks

or tables of any kind, but the scholars knelt on the rubble-floor, and used as desks the deal forms on which the congregation sat on Sundays. Humphrey's scholastic fees were all paid in kind: some of the lads brought com, or oatmeal, or flour, or wool, or bacon, and I remember once trying to carry on my head my payment, a big square lump of coal; but it was too heavy, and another boy kindly let me carry his payment of a lump of butter, and he, being stronger, conveyed my coal. Cheese was a luxury known only to the rich: money was seldom seen in the form of coin, and farthings never. I did not take my crab to school as a matter of payment, nor yet for play or idle curiosity, but truly to learn something about it from the only person whom I thought could give me help, and his reply was, 'Ah, William Bach! only learned men in London can give information on such things,' and he smoked his pipe vigorously, and gave me permission to put the crab away during school-time in the chapel pulpit, to be out of the reach of the boys."

In 1837 Mr. Lloyd returned to London, and visited the Zoological Gardens, which proved a constant source of amusement and interest to him whenever he obtained a holiday: this continued for many years, during which his reading and learning, equally sources of instruction and amusement, seemed incessant and most miscellaneous.

In 1838 he obtained the exalted post of errand boy at Messrs. Pontifex and Wood, engineers, of Shoe-lane, and stayed in this place for three years. Unlike any other errand boys whom I have known, his constant study was to acquire a knowledge of the various mechanical contrivances and combinations which he saw around him. We next find him apprenticed to Messrs. Remnant and Edmonds, the bookbinders, in Lovell's-court: but he was far less assiduous in gaining a knowledge of that branch of trade. He was out of his time in 1847, and then, and before, seems to have found opportunity for a most extensive and varied course of reading, and just such reading—deeply instructive reading—as a lad usually pronounces to be "slow" and "dry"; however, he now had reading to his heart's content. The first book he ever bought with his own money was, in 1840, Craik's 'Pursuit of Knowledge under Difficulties.' "No written or spoken words," says Mr. Lloyd, 'can express the avid-

ity with which I read Craik's book over and over again, or can tell the encouragement I gained from it." At the same time he met with a memoir of John Hunter, and was absorbed in admiration of the great anatomist.

"By my reading I was constantly, as it were, brought into contact with him, and learned how he kept at Brompton many living animals in a small menagerie, observing their habits and forms when alive, and dissecting their bodies when dead, and doing so amidst many difficulties. Reaumur and Hüber were two other naturalists of whom I read with mentally wondering eyes." But at this time Mr. Lloyd got involved in figures, and the works of Thomas Simpson and James Ferguson, mathematicians, engrossed a principal share of his time, and, stranger still, Augustus de Morgan's 'Elements of Arithmetic'; thus his attention was diverted for a time from facts to figures; from truths to the expression of truths.

In 1851 he obtained a place in Old-street, at Mr. W. Browns second-hand book shop, and here, of course, he had an opportunity of indulging his taste for books, and of making his store of knowledge still more extensive: from the 'Penny Magazine,' that great source of miscellaneous knowledge, he learned a little of everything.

The 18th of November, 1852, was a public holiday, the funeral of the Duke of Wellington: this memorable day Mr. Lloyd spent in the Zoological Gardens, and here he met with an incident that gave an aquarian tendency to the whole course of his future life.

"On arriving there, near the side entrance, was a building I had never seen before, and which had risen since my last visit—a conservatory-looking glass erection of not large dimensions, standing on a low wall. The door was fastened, and I could see no one inside, and on my asking of a passing attendant what the place was for, he said it was a 'Fish House,' though Borne people called it an 'Aquarium' and that it was destined to contain fish and other such things, even sea-fishes and lobsters, and that it was intended to be opened in the following spring. He added his disbelief in its success and an expression of his sense of the impropriety of its introduction into a zoological garden.

"I went back to the 'fish house,' and passed round to its rear, and there to my great astonishment, I saw through the glass side of the tank containing perfectly clear water, and wonder of wonders, a living pike! I wish I could write what I then felt; I wish I could now feel as I then felt, but such freshness of wonder comes to one not more than half-a-dozen times in a life. I could not get away from the place—it was at the extreme north-east corner of the building, and the tank has been for years converted into a marine one—but I went to it again, and remained there till it began to grow dusk, and it was time to get home. During the last eighteen years in London and Hamburg I have never been without a pet jack in an aquarium."

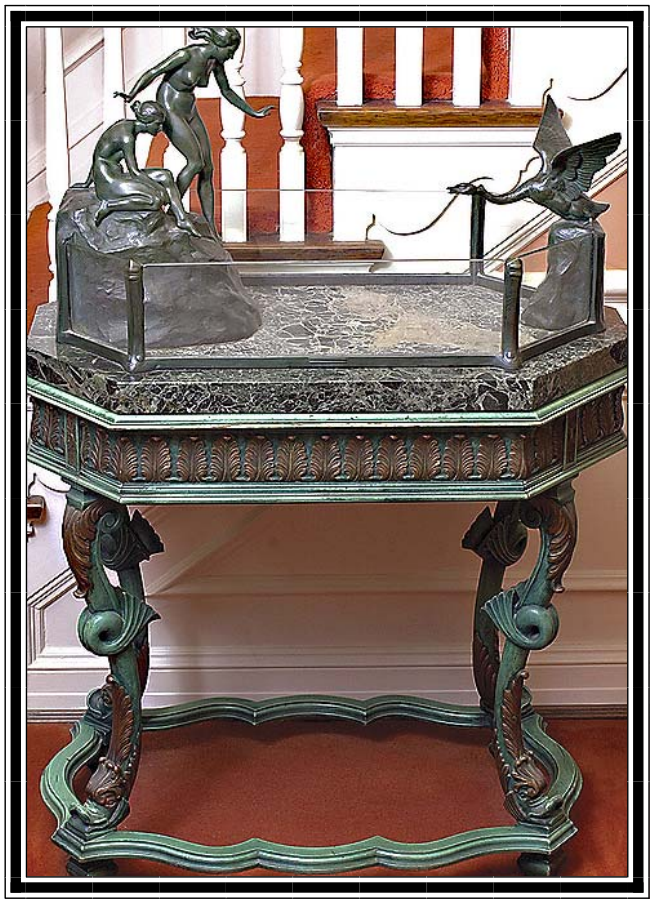
This seems to have been Mr. Lloyd's first introduction to fresh-water captives. I will now intro-

duce both him and my readers to the denizens of the sea: he says that although now (1873) in the Crystal Palace, with all possible means and appliances at his command, he can look back on a time, twenty years ago, when his pence and halfpence had to be laid out with rigid economy, and I am thus introduced to one of the most interesting passages in his life—the search for sea anemones in the streets of London! He had already set up small aquariums in wide-mouthed glass bottles filled with artificial sea-water, but these miniature establishments were without living inhabitants: his *modus operandi* for supplying this want is thus described:—

"I used to sally forth at dead of night, where heaps of oyster-shells were thrown by day from street oyster-stalls, in Smithfield and St. John's-street, and bring them home. The oysters devoured in such poor neighbourhoods are not the genteel little smooth 'natives' eaten at luncheon-bars, but big, rough commoners with bold foliations on the upper shell, and deeply ribbed on the lower one; and in and below these hiding-places I could find many little sea anemones of several species, some hopelessly smashed, but others quite perfect, having been protected by the strong projections of the oyster-shell and unharmed by rain or other fresh water. The species I found thus were *Actinoloba Dianthus, Sagartia viduata, S. Troglodytes, B. Bellis, S. elegans*, and, but very seldom, *Actinia Mesembiyanthemum*.

"All these I used to pick off the shells with never-wearying patience and care, and drop them into the fictitious sea-water and transfer them to my bottle, to which they adhered and made themselves happy. I used to feed them with little morsels of oyster-flesh which I found adhering to the inside of the shells, and when the water would become offensive from the effects of the food, because the quantity of fluid was too small to hold enough oxygen in solution to decompose the dead animal matter fast enough, I poured the water from the little bottles into a great earthenware foot-pan covered with a sheet of glass to keep out dust, and standing in a dark corner of the room. The foot-pan was so very large in comparison with my small bottles that the emptying of them periodically into the pan did not interfere with the water in the latter, so that from it I immediately refilled the bottles, one at a time on successive days. The water in the foot-pan on the floor thus effectually counteracted all tendency at going wrong in the bottles on the window-sill above."

Two years after this, namely, in 1854, Mr. Lloyd sent me two short papers for the '*Zoologist*,' which show that his love for sea things continued in all its force. These exhibit beyond all question the deep, and I may almost say, the devout attention, with which he studied Nature at this period: his "Note on the Habits of *Limnea stagnalis*" (Zool. 4248) is a master-piece of descriptive writing. Of course I was anxious to know such a man, and in March, 1855, I found him located at 164, St. John-street-road, in Company with poverty and sea anemones, sacrificing



all worldly considerations to a love of Science. Other papers soon followed, entitled severally "Occurrence of *Edwardsia vestita* in Britain" (Zool. 5180) and "Note on a Sea Cucumber in Confinement" (Zool. 5181).

These exhibit in an especial degree three great qualifications of a naturalist—1st, the knowledge which leads to the instant selection of what is peculiarly worthy of observation; 2ndly, the faculty of observing systematically, or in the words of De la Beche, the knowledge "how to observe"; and 3rdly, the power of defining the observations: these qualities Mr. Lloyd possessed and possesses in an eminent degree. I have never forgotten, and hope never to forget, that first visit to the great aquarian and the appearance of his little aquariums; glass bottles or cylindrical vessels, some on the table, some on the window-sill, some in the dark, some in the light,—all contributing to his already large stock of knowledge, all revealing secrets previously hidden.

In 1856 he removed to Portland-road, and embarked in business; as a matter of course, the aquarium business,—and almost also as a matter of course, unsuccessfully; he was not cut out for business on his own account; he had no skill in buying and selling; but his reputation as an aquarian was established, and in 1859 he was summoned to Paris, and undertook the management of the aquarium in the Jardin d'Acclimatation.

In 1862 I find Mr. Lloyd again in London, exhibiting an aquarium, worked by compressed air, at the International of 1862, and accompanying the exhibition by the publication of a very clear and compendious account of the principle and construction of aquariums in general and of the Exhibition aquarium in particular.
While thus occupied he was visited by Dr. H. A. Meyer, who was desirous of establishing an aquarium at Hamburg, and this finally led to an arrangement with Baron Merck for Mr. Lloyd's removal to that city and the construction of an aquarium in the Zoological Gardens there, under his sole superintendence: this was opened in the spring of 1864, and soon became eminently popular as well as successful in a pecuniary point of view; the names of the late Dr. Meyer, Professor Mobius, Chief-Justice Schwartz, and the late Baron Ernst von Merck must always be associated with that of Mr. Lloyd in this admirably managed establishment. The sea-water is circulated partly by a water-pressure engine set

in motion by the town water-works, which drive a pair of water-pumps (instead of compressing air as was done in Paris), and partly by a steam engine which drives two other pumps.

"The great pecuniary success of the Hamburg Aquarium caused other aquariums to be erected in various parts of the Continent, namely, in Hanover and at Boulogne-sur-Mer, in 1866; in the Boulevard Montmartre in Paris, in 1867; in the Reserved Park of the Paris International Exhibition, in the same year, in two places; twice at Havre in 1867 and 1869; in the Zoological Gardens at Brussels, in 1868; in the Flora Gardens at Boulogne, in 1869; and in Berlin, in 1869."—' Official Handbook; p. 20.

I do not mention these dozen aquariums as under Mr. Lloyd's superintendence, but as called into existence by his successful management at Hamburg and elsewhere. In 1870 he returned to London, at the summons of the "Crystal Palace Aquarium Company," and there he is located at present, and I trust bids fair to become a fixture. And here it is indispensable that I mention that since the Crystal Palace Aquarium was opened two others (at Copenhagen and Brighton) have been completed; five more (at Vienna, Manchester, Southport, San Francisco and Naples) have been commenced; and still three others (at Frankfort, Birkenhead and Rothesay) are partially erected.

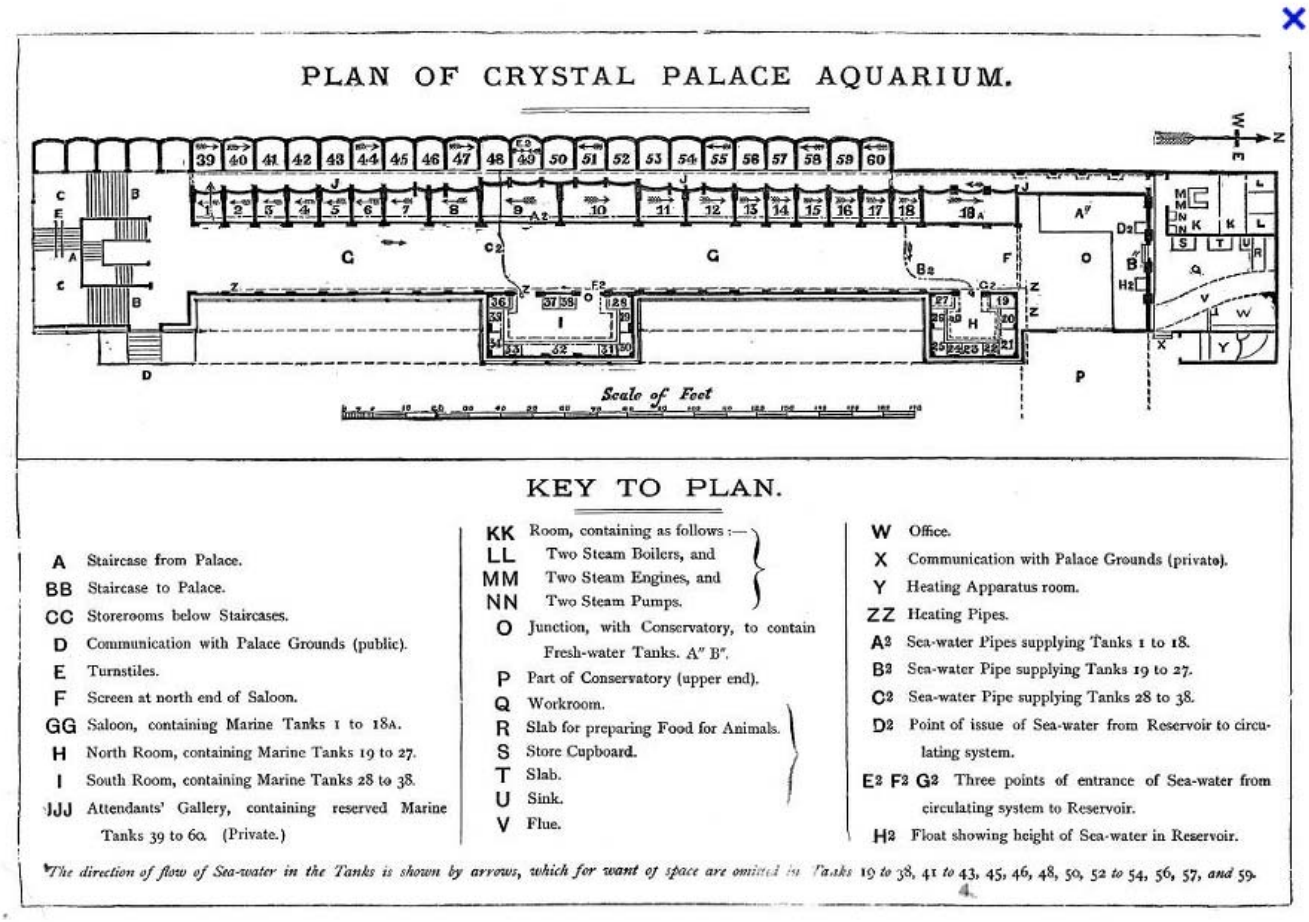
We will now enter the Crystal Palace Aquarium, Guide-book in hand, or rather 'Zoologist' in hand, for I am indebted to the courtesy of the Crystal Palace Company for the use of their stereotype plan of the aquarium, which explains the details. I fear I have been a long time in reaching this point, but I hope I have spent that time pleasantly and advantageously; and thus between fear and hope, the two great ingredients of human life, I also enter a restricted passage, which is not without its dangers:

"Contra, jussa monent Heleni, Scyllam atque
Charybdim ♣
Intra utramque viam, leti disorimine parvo,
Ni teneant cursus."
Aentid, book iii. line 684.

The prosy style is my Scylla, the florid my Charybdis; I will try to steer between them.

The plan of the aquarium is shown by the plate: in round numbers, it is 400 feet long and 70 feet broad. It is only one story high, and this ground-plan exhibits everything that requires explanation, except a reservoir, which is under ground, and contains 100,000 gallons of sea-water, kept in the dark. On the subject of keeping a very large proportion of the water in the dark a great deal has been said by Mr. E. Edwards, formerly of Menai and now of Chester, Mr. Warington, of London, and Mr. Lloyd. Various contrivances have been tried for keeping a portion of the water of aquariums thus in the dark, on the plea that but little light can penetrate the ocean, a fact strongly supported by the fact that the deep-sea animals are frequently without eyes, or at least without eyes that we are accustomed to consider as such, thus showing that vision is neither required nor possessed at great depths below the surface: on this subject I cannot forbear to quote Mr. Warington.

"When the rays of light strike the glassy surface of the water, the greater part of them are reflected, and those which penetrate are refracted and twisted in various directions by currents of



the water; and when the depths are considerable it would be few rays that would penetrate to the bottom; but let the surface become ruffled by the passing wind, and it is little light that can be transmitted; and when the same disturbing cause lashes into waves and foam, not a ray can pass, and all below must be dark as night"—Zool. 6702.

The great bulk of water in the ocean being then in its "dark unfathomed caves," the plan of keeping it dark in an aquarium is obviously little more than a direct obedience to the teachings of Nature, and there is little necessity for explaining the principles which require, or the circumstances which accompany, profound darkness. Sea-water constantly exposed to light is apt to become opaque and of a greenish brown colour—a very serious evil in a public aquarium. The darkened tank extends under the floor of the aquarium from end to end (i.e. beneath G, G, F, &. C, in the plan) and also under the compartments marked 9 and 10. It is no part of Mr. Lloyd's design to change or renew this vast bulk of water, but it will become necessary to add from time to time a portion of distilled fresh water to compensate for the waste which must inevitably result from evaporation, leakage of pipes, or breakage of glass, this last being a calamity to which all such establishments are unfortunately subject.

Keeping the plan still in hand, the compartments or pigeon-holes, representing tanks, are numbered 39 to 60, 1 to 18 a, 38 to 28, and 27 to 19, are also filled with water, and contain altogether no less than 20,000 gallons, in which the living objects of the aquarium constantly reside, and all of which are lighted from above, nineteen of them having in addition one side (that fronting the area, G G) of plate-glass, by which means additional light can penetrate the water and illu-

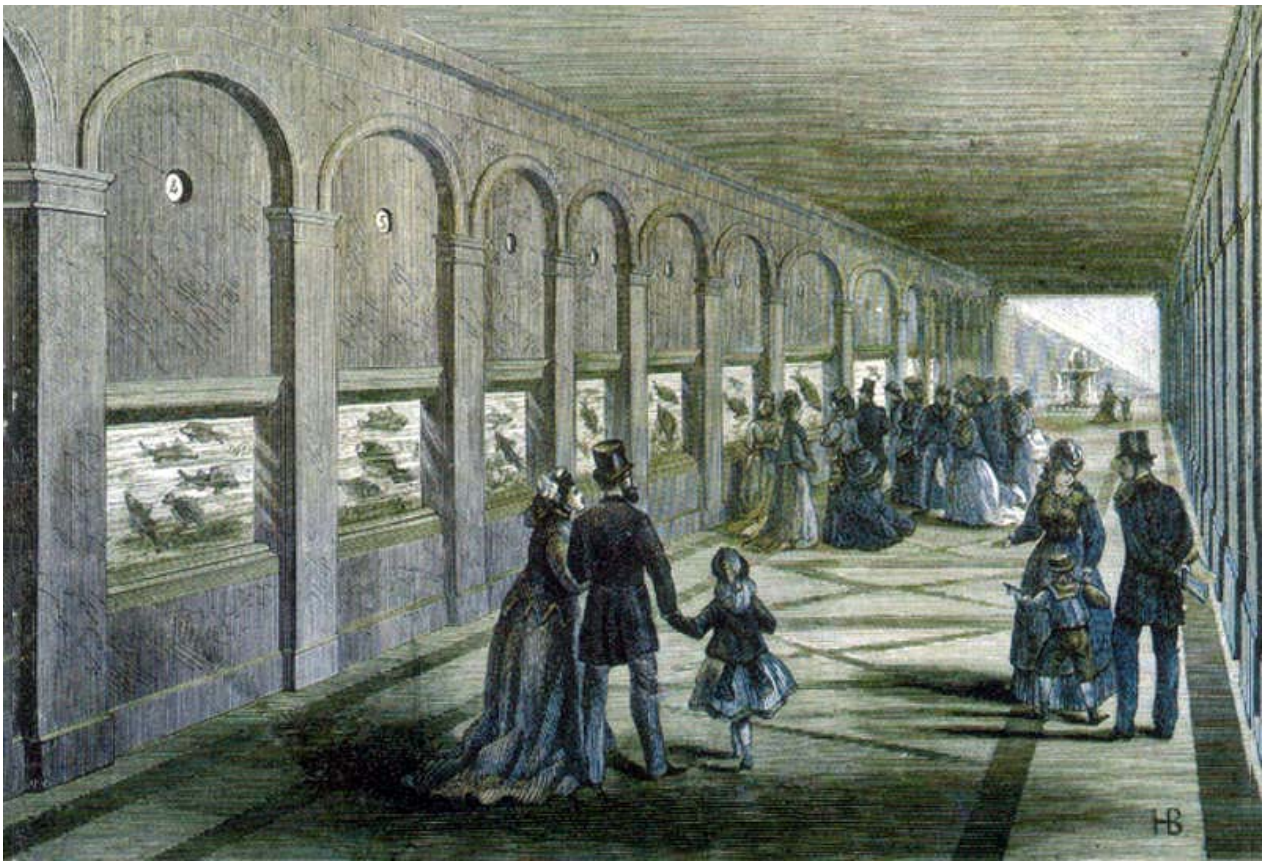
minate the objects living therein. Thus the entire quantity of water is 120,000 gallons, of which five-sixths is in the dark and one-sixth in the light. This large quantity of water is kept in constant circulation; a steam engine of three-horse power (M) and one of Forbes' patent vulcanite pumps (N) work day and night to raise water from the dark reservoir (G G F) and discharge it into the light reservoirs 9 and 10, at the rate of from 5000 to 7000 gallons per hour.

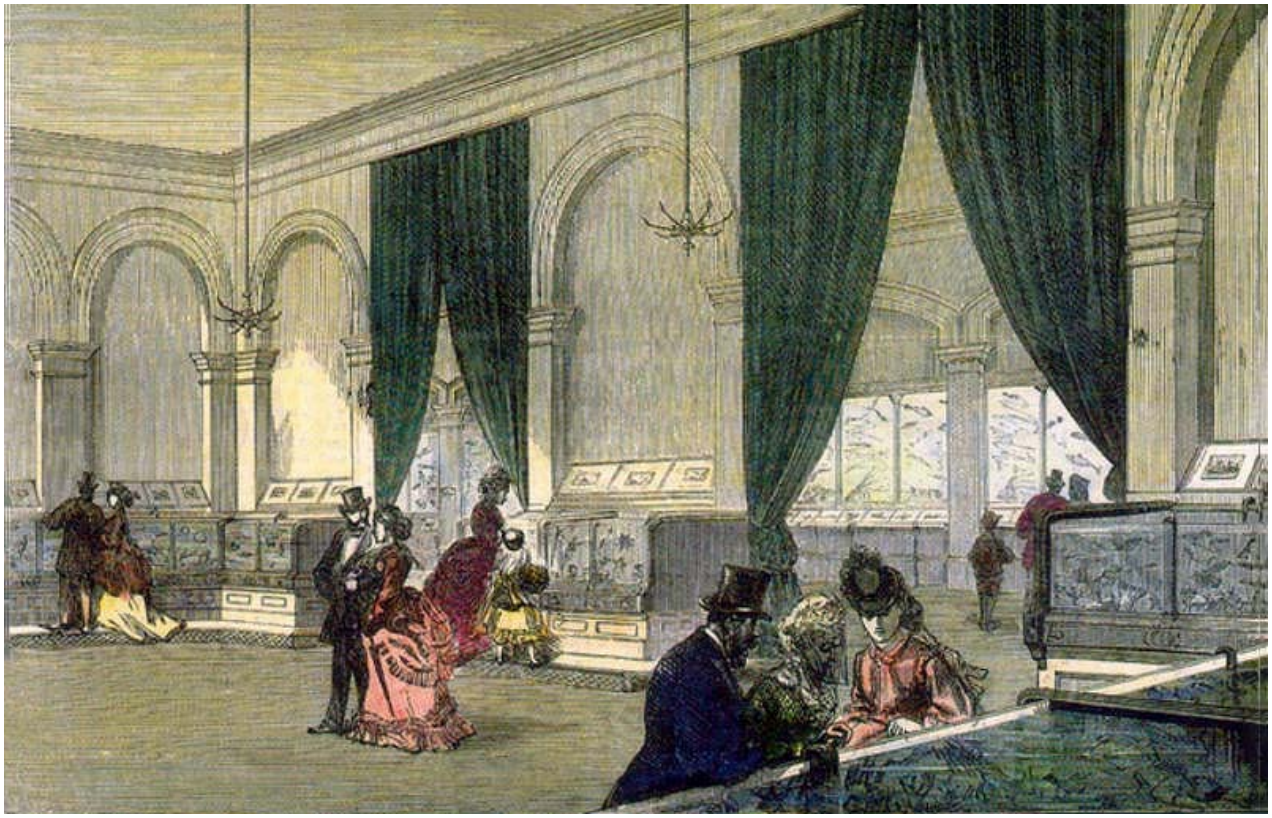
This engine and pump are necessarily in duplicate, because if either should break down through any unforeseen casualty, the motion of the water would be arrested and the lives of the prisoners jeopardized; indeed, so dependent are these on this sea-like movement of the water, that the stoppage of a pump for a single hour has produced visible effects on their health and spirits. These pumps and engines necessitate the employment of three engine-men, and these relieve each other every eight hours, so that one is always on duty. The exigencies of the animals also necessitate the employment of three other attendants, and I can bear my willing testimony to the great intelligence and unvarying civility of those now employed.

The pumped-up water flows, as I have said, into tanks 9 and 10, half into each; the stream pumped into tank 10 passes to the right, — an aperture having been purposely left in each party wall, as these divisions might be called, — into No. 11, thence into No. 12, and so on until it reaches No. 18 A; here it passes beneath the corridor or pathway (J J J), called the "Attendant's Gallery" in the "Key to Plan," and flows into tank 60; thence it turns to the left, through an earthenware pipe, into tank 59, and so on through tanks 58, 57, 56, 55, 54, 53, 52, 51 and 50, into tank 49, where it falls through a cylinder into the dark tank below. A second stream, also pumped up from below, falls into tank 9, and thence passes to the left into tank 8, and thence into tanks 7, 6, 5, 4, 3, 2 and l, whence it crosses under the corridor (J) into tank 39, and then turning to the right through tanks 40,41,42, 43, 44, 45, 46, 47 and 48, finally plunges into the cylinder in tank 49, and there, uniting with the stream I have traced from the right band, returns to the great abyss below, thence again to be pumped up, when its turn shall arrive, into tanks 9 and 10, and pursue the same course as before. The arrows in the plan show the direction which the stream is continually taking. The animals in the tanks numbered 1 to 18 A are intended to be viewed laterally from the saloon (G G F). I have already explained that the sides of these tanks facing the saloon are of plate-glass, and therefore the animals can be seen as perfectly as if you were in the sea in a transparent diving-bell: the other row of tanks 39 to 60, is intended for reserves, not open to public inspection: this reserve is very necessary, as casualties by death must of necessity occur now and then: all these forty tanks are on the left or west side of the saloon which is entirely devoted to the public.

On the east of the saloon are two apartments (H and I) containing respectively nine and eleven tanks; the whole of these tanks, numbered 19 to 38 inclusive, are very shallow, open at the top, and of a convenient height for viewing the animals vertically, or dorsally, for that is a better term, since we look down on their backs. The water is here circulated much in the manner I have described in those on the west side of the saloon, but the stream is smaller and less rapid: it passes under the floor of the saloon in both instances, into apartment H by means of an invisible pipe B 2, and into apartment I by means of an invisible pipe C 2. The flow of the water after being pumped into tanks 9 and 10 is caused simply by gravitation, there being a fall of from three to six inches from tank to tank; thus in tanks 9 and 10 the water stands at a height of six feet, while in tanks 1 and 18 A it is only three feet.

Yet this constant flow Mr. Lloyd considers still insufficient for the supply of oxygen to all the inmates; he has therefore arranged a number of small pipes, one for each tank, with a nipple nearly touching the surface of the water, and through each of these water is forced in a small but powerful stream: in its short passage be-





Scenes from The Crystal Palace Aquarium.

tween the nipple and the surface of the water each of these streams entangles and incorporates a great quantity of air, so tab myriads of bubbles of air are driven with great force, but in a state of subdivision so fine as to resemble steam or falling sand, almost or quite to the bottom of each tank, whence they return and reascend to the surface with a gentle and deliberate movement strangely contrasting with the violence of the descent. This forcing in of the air corresponds as nearly as possible with what takes place in the ocean when lashed into foam by the violence of the winds; the waves tumbling tumultuously one over another entangle and carry with them by their proverbial violence a vast quantity of air, which, after being dashed downwards, again rises to the surface, having discharged its office of communicating purity to the water and life-supporting breath to its inhabitants.

It appears from a paragraph at page 9 of Mr. Lloyd's 'Handbook,' that he places more reliance on the effects of vegetation than his admirable arrangements for aëration and circulation, just described and explained, would have led us to suppose; nevertheless "if all the necessary vegetation of the Crystal Palace Aquarium could be gathered together, it would, when deprived of water, probably not weigh one ounce": these are Mr. Lloyd's own words; but the passage to which I desire to invite attention is the following:—

"Towards the close of the [last] Century, namely in 1790, the late Sir John Graham Dalyell began to keep living marine animals for observation, in his house in Edinburgh; and continued this practice till his death, about 1850; but he changed the sea-water two or three times a week, though some of the animals lived for eight or ten years; and one sea anemone (*Actinia Mesembryanthiemum*), taken by him from the sea in August, 1828, is still alive and well. But Sir John knew nothing of employing plants to evolve oxygen, and therefore to preserve a balance of life with unchanged water, though Dr. Joseph Priestley (1733—1804), the discoverer of oxygen gas, and the first observer of the fact that that gas is emitted by plants under the influence of light, and therefore the earliest enunciator of the main principle on which the maintenance of aquariums depends, had published this discovery and observations. Ingenhousz also had shown that plants evolved this gas. Therefore if Dalyell knew this, he did not apply the principle."—'Handbook,' p. 9.

However, I have a widely different object in introducing this notice of Sir John's aquariums and their success. Mr. Lloyd, who never leaves a stone unturned if there be a chance of finding a particle of information beneath it, obtained access to Sir John's quartos ("Rare and Remarkable Animals of Scotland," By Sir John Graham Dalyell, Bart. 2 vols. 4to, 1847-48, and "The Powers of the Creator displayed in the Creation," Same author, 3 vols. 4to, 1851-58.), with a view of ascertaining his practice, his experience, and his views, at a period when this now engrossing subject was almost totally ignored; but in doing so he found explanations that required explaining. Miss Dalyell, a sister of the Baronet, was then still living in Edinburgh, and, although at the advanced age of nearly a hundred years, was in full possession of her faculties and her memory: he therefore conceived the idea of framing a series of questions on those points which appeared obscure, and of respectfully soliciting information. It was indeed a bold step, but a successful one.

To these questions Miss Dalyell most obligingly sent the following categorical replies, which cannot fail to be read with the deepest interest. My sincere thanks are due to Mr. Lloyd for having, unsolicited and unreservedly, placed these letters in my hands for the express purpose of illustrating this notice of his 'Handbook.' Miss Dalyell's replies evince a wonderful retention of faculties to extreme old age, but also prove what an observant and intelligent interest she must have taken, during very many years, in her brother's scientific pursuits.

LETTER I.
Miss E. Dalyell to Mr. W. A. Lloyd.
8, St. Colme Street, 2 January, 1800.

Sir,—In answer to your enquiries regarding the way Sir John Graham Dalyell kept his marine animals, I will certainly give you all the information I possibly can, by in the first place telling you the vessels containing them were all made of the very finest, clearest glass, wide at the top, just the same width as at the bottom: they were invariably round, and all sizes, some short, some long, some wider, some not so wide.

I cannot remember ever seeing more than one fine specimen in one glass; no marine plant whatever was in the water where the animals dwelt. Sir John fed them himself; what he gave them I do not exactly know, but raw mussel I know was one thing: he kept many of his subjects eight and ten years alive. He was most particular in giving them sea-water always out of the sea, when it was flowing: he changed the water every morning, often twice a day, if he perceived the smallest fragment amongst it, wiping and washing the glasses very clean. He got sea-water always twice a week, and sometimes three times; it was carried in an earthenware jar holding about three or four gallons of water: a person was specially employed for the purpose.

Sir John's subjects were always kept on a shelf under the window of his study; it was situated in the north out-look; whether they were put there for any purpose I don't know, but I think it was just to put them anywhere out of the way; sometimes he had a fire in his study and sometimes none. He understood nothing of Marine Botany; his chief aim was water fresh from the sea, when it was flowing and full of animalculae, and particularly clean vessels. If I can give you any more information upon the subject I will be happy to do it.

I remain your obedient Servant.
E. DALYELL.

LETTER H.
Miss E. Dalyell to Mr. W. A. Lloyd.
8, St Colme Street, 4 February, 1860.

Sir,—Your letter of the l8th of January reached me, but it being a difficult task for me to perform furnishing you with dates, I am sorry to say I am unable to perform it further than to mention, the first aquatic subject I found was dated in the year 1790, and as a curiosity I desired it to be engraved upon one of the copper-plates. It is the river worm which forms into a little fly. As you have the work, you will observe a little fly and beside it a black little worm; the worm ought to have been of the most brilliant scarlet colour. I know as to the Hydra tuba, Sir John was busily engaged about experimenting upon it in the years 1800 and 1808. This is all the information I can give you. I know very well once every subject was dated, but where these dates are now I cannot tell.

I am, Sir,
Your obedient Servant.
E. Dalyell.

Here then I conclude my observations on aquariums and arrangements for their maintenance. I have in reserve sundry notes as to their inhabitants, which are perhaps rather more in my way. I confess to feeling a greater interest in living beings than in the mechanical arrangements for their benefit. Still I shall do my best to explain should explanation be required at my hands, and shall only be too happy to receive questions that I can answer.

I should also like to add that although I have mentioned only one 'Handbook,' it is because I knew of only one when I commenced this notice. Since then I have received a second, the 'Official Guide Book to the Brighton Aquarium,' by W. Saville Kent, F.L.S., F.Z.S. It is a pleasant and readable account of that magnificent building, and I hope to return to it again and again. In the mean time I would impress on the compilers of these books the value of simplicity. They themselves luxuriate, aye revel, in technicalities and what is called the language of Science; but they must not on this account hope to inspire the general public with the same refined taste. Visitors to these aquariums are for the most part, like myself, "out for a holiday." On such occasions we do not absolutely abjure the idea of receiving instruction from books, but neither are we disposed to expend much labour in the pursuit of knowledge.

EDWARD NEWMAN.

Aquarists of The New York Aquarium, 1896-1941

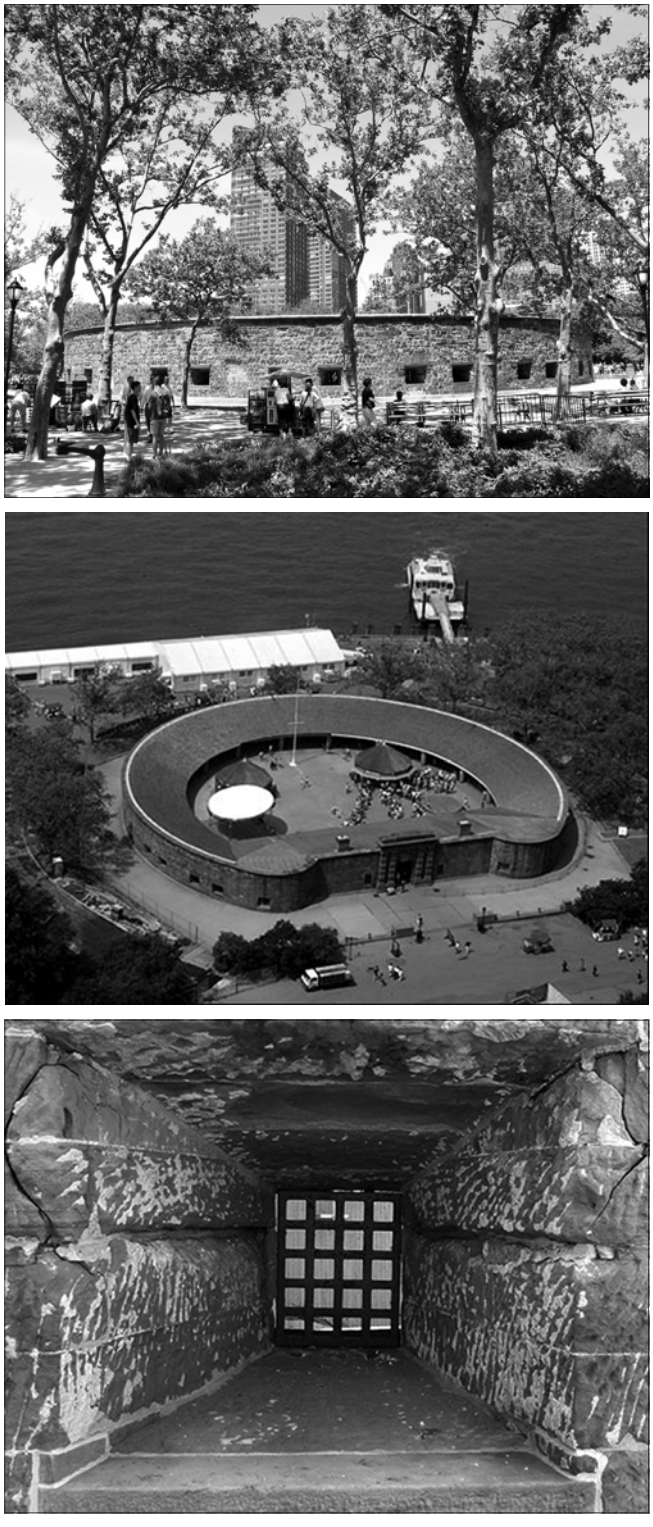
By Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society, August 24, 2008)

INTRODUCTION

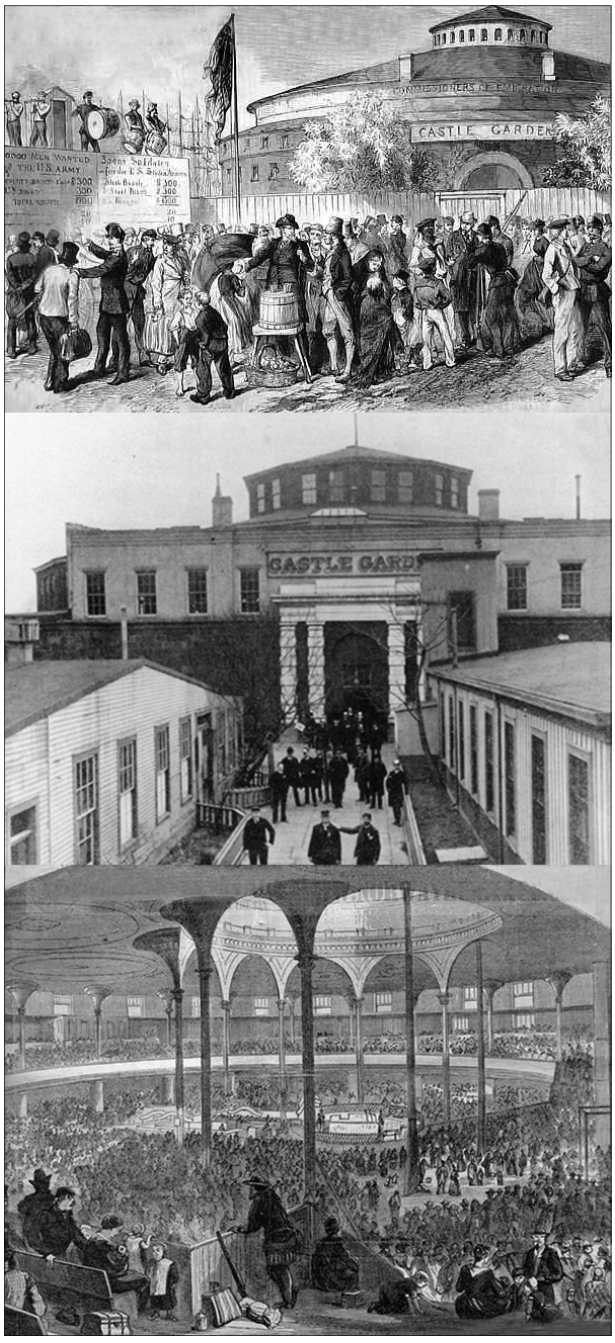
Meaningful aquarium hobby history is not so much a matter of dates and priorities as it is of people - who they were and what they did - and in this monograph I have tried to help the reader to understand a bit of the past, uncover the previously unknown, identify the relationships that the past has to the present, provide a historical perspective, and to record and evaluate the accomplishments of individuals and institutions. This, of course, is a formidable task, but I hope I have, even if only in some small way, achieved some of these goals.

The cutoff date chosen in the title is 1941, the year the Aquarium temporarily closed until it could move into its present quarters, but this is not necessarily the stopping point for the discussion of the individual aquarists selected. As I have indicated, most of them went on to further enhance their eminence within the aquarium fraternity. Since these aquarists worked for whomever was the Director of the Aquarium at the time, I have spent some time discussing most of these administrators even though one of them (Charles H. Townsend) was not an aquarist in the hobby sense. He was, however, important in the historical developments during this time period.

The relationship between the history of public aquariums and the aquarium hobby is not always clear. Both deal with fishes, but the comparison usually stops there since only a small part of the aggregate of fishes kept is identical and the equipment, although more or less based on the same principles, is hardly the same. However, there is one aspect of the public aquarium that is of historical interest in this regard, viz., aquarists who have in their younger, formative days worked in public aquaria and whose names are either well-known or whose work has meaningful significance to the aquarium hobby. This, then, is the substance of this monograph on the aquarists of the New York Aquarium.



Castle Clinton after its restoration in 1975.

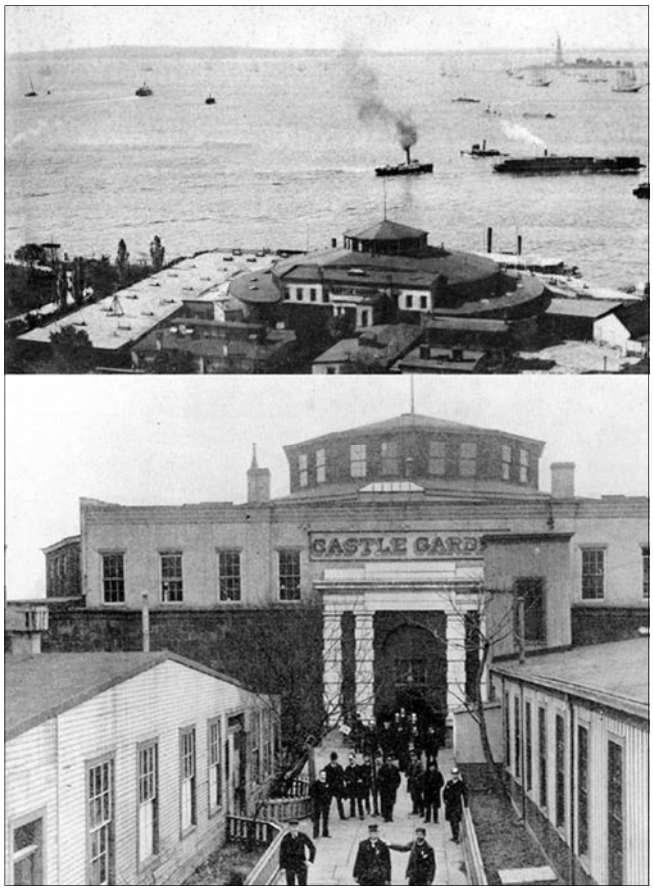


Castle Garden, site, exterior, and interior.

PRELUDE TO THE AQUARIUM

With war looming in the 1790s, Congress authorized an ambitious harbor defense construction program to protect the Atlantic seaports. As a consequence, more than a dozen forts were built to defend New York Harbor at the time of the War of 1812. The West (sometimes known as the Southwest) Battery was constructed on the rocks off the tip of Manhattan Island between 1808 and 1811. It was intended to complement the three-tiered East Battery (still existing and now known as Castle Williams) on Governors Island.

The fort was a single-tiered, open-casemated masonry structure (a casemate is the chamber behind the openings where the 30 guns were placed) of Newark sandstone, nearly circular in plan with a diameter of 205 feet and walls fifteen feet deep. It was originally designed to be built quite close to the land in only 15 or 20 feet of water, but city regulations required that it be placed 200 feet from shore where the water was 35 feet deep. An artificial island was made just to support it, a remarkable engineering feat for its time. Because subsequent



Castle Garden as an immigrant landing depot. Numerous auxiliary buildings were constructed around the site to facilitate the handling of the immigrants.

land filling expanded Battery Park, today it is located on Manhattan Island.

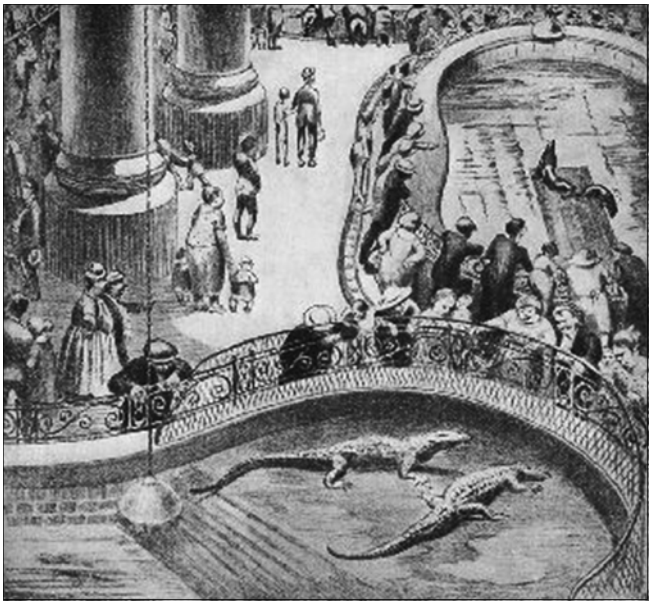
Although fully armed, these forts never had occasion to fire upon an enemy. In 1815 the fort was renamed Castle Clinton in honor of DeWitt Clinton, Mayor and later Governor of New York. The army vacated the fort in 1821 and the structure was deeded to New York City in 1823. In the summer of 1824, a new restaurant and entertainment center opened at the site. In the 19th century, such places were called "gardens" (Madison Square Garden, for example, still exists) and the Castle, which could accommodate up to 6,000 persons and even 10,000 in a pinch, became known as "Castle Garden."

It served in turn as a promenade, beer garden/ restaurant, exhibition hall, opera house, and theater. Designed as an open-air structure it was eventually roofed over in the 1840's to accommodate these uses and served as such until 1854. Important events included the triumphal return of the Marquis de Lafayette to America in 1824 and the debut of opera diva Jenny Lind in 1850, brought to America by P. T. Barnum. Many new inventions were demonstrated there to amazed audiences, including the telegraph, Colt revolving rifles, steam powdered fire engines, and underwater electronic explosives.

On August 3, 1855 Castle Garden, now leased to New York State, opened as an immigrant landing depot, the nation's first such entity. In 1890, the Federal Government took over control of immigration processing, subsequently opening the larger and more isolated Ellis Island facility for that purpose in 1892. Most of the immigration records burned in a pier fire during the transition to Ellis Island, but it is generally accepted that over 8 million immigrants (and perhaps as many as 12 million) were processed through Castle Garden.

THE ESTABLISHMENT OF THE NEW YORK AQUARIUM

Renovation of this ancient structure started in 1893 and continued to 1895, reopening as the New York City Aquarium on December 10, 1896. As I have described in my book, *The Toy Fish, A History of the*



Exterior and interior images of the Aquarium at the turn of the Century. At this time the exterior had not been altered from its Castle Garden days.

In its earliest days the Aquarium collected local fishes by seining the lakes in the Bronx Zoo.

Aquarium Hobby in America – The First One-Hundred Years (Finley Aquatic Books, 2003), Hugo Mulertt played a significant role in its establishment. Partly through Mulertt's influence, its first director was the respected ichthyologist, Dr. Tarleton Hoffman Bean, who oversaw its reorganization and rebuilding after a disastrous start. Under Boss Tweed's rule at Tammany Hall, the Aquarium was devoted less to the exhibition of fish than to the exhibition of the incompetents who were supposed to care for them. For many years workmen tinkered about the place, erecting tanks for fish, only to see the tanks burst when the water was let in. The public could not be admitted to the building and the place was a monument of useless expense. To add insult to injury, the floor pools and exhibition tanks had been lined with white tile and the general impression was that of a dim and dingy bathroom.

In February of 1894 there had been a complaint about the tiling of the Aquarium floor. The contractor maintained that the work was done according to specifications and if it was not satisfactory the specifications were to blame. In any case, the work had to be done over again. In April, Harvey T. Woodman, who was in charge of getting the Aquarium ready for its opening, presented a rosy picture before the Park Commissioners. He reported that the aeration system "was the most perfect in the world," and believed that he could keep in the aquarium species of the herring family, which had heretofore proved almost impossible before. Woodman estimated that the opening would be about July 4th. This was not to be, however. In August it was found that the tanks were leaking. The Edgewood Company, who had constructed the tanks, accused Woodman of using inferior aquarium cement. Park Commissioner Bell took the part of the Company and told Woodman that, if he had tested the tanks several weeks ago the trouble could have been averted.

Fortunately, a reform Mayor, William L. Strong, was elected in 1895 and placed the Aquarium under the control of a director who knew what keeping fishes was all about, i.e., Tarleton H. Bean (more about Bean can be found in my book, *The History of Ichthyology*, Finley Aquatic Books, 2004). The Aquarium finally opened on December 10, 1896 under Bean's Directorship. At the time the Aquarium had 78 species of fishes but in 1897 Bean made a detailed report of the fishes received at the Aquarium between 1895 and 1897. During this time there had been a total of 165 fishes of which 125 were marine species, the rest being freshwater forms. The marine species were supplied mainly by John B. DeNyse, a veteran fisherman, and his sons.

In 1896 the beauty of the big marine aquariums was greatly increased by the crystal clearness of the water. How this came about was due to a natural system of filtration, the water passing into a well in the cellar of the aquarium. The discovery of this perennial supply of water was made quite by accident. When Bean learned that there was a standing pool of water in one of the cellars of the building on the inshore side, he examined the pool with a hope he did not dare to express for fear it might be unfounded. One of the city engine companies came to his assistance with the intent to pump the cellar dry. Two 2-1/2 pipes were put down, and for twenty-five minutes a five-inch stream of water was pumped from the cellar without decreasing it. "We can't get the water out for you,

Interior of the Aquarium, 1904.

Dr. Bean," said the man in charge. "Well, I should be sorry if you could," said Bean, divulging his hope at last. The water filtered in through about 200 feet of gravel and rock fill under the building and had the same saline qualities of the water outside in the bay but was much purer. Bean had a seventeen-foot well sunk, doubling the quantity of water needed for the tanks. One great advantage in the well water was that it was some 20° warmer than the water of the bay. By this means the fifteen sharks which had been taken into the aquarium were able to be kept alive during the winter, something that had not been possible before.

THE FIRST TANK MEN

Bean hired two excellent men as Assistant Superintendents to care for the exhibits, Washington I. DeNyse (one of John DeNyse's sons) for the marine aquaria and Leonard B. Spencer for the freshwater aquaria. Stories about these two men and happenings at the Aquarium frequently appeared in the local newspapers. Indeed, Spencer acquired a reputation of being a "fish doctor," and the Aquarium was touted as having "The Only Fish Hospital in the World." He conceived the idea of doctoring fish and performing surgical operations on them as well. The following is a quote from the NEW YORK TIMES of August 21, 1904:

"New York has the only fish hospital in the world. It has its surgeons and its physicians, its wards and its operating tables. All diseases that the members of the finny tribe are heirs to are scientifically and successfully treated, and thorough investigation and research are made into some of the unknown diseases with which the piscatorial family is afflicted. This remarkable hospital is located just back of the big glass tanks arranged in a circular form in the Aquarium at the Battery. It was started as an experiment some time ago, but has developed into a regular institution that is one of the most important adjuncts of the Aquarium. In fact, it has much to do with the success of this admirable exhibition of fish that has been collected from all parts of the glebe. On entering the big building one is at once impressed with the activity and healthfulness of the fish that seem intent on

This is the original wooden framework of the Aquarium building. The timbers were later concealed by a ceiling and plaster-encases columns.

Leonard B. Spencer

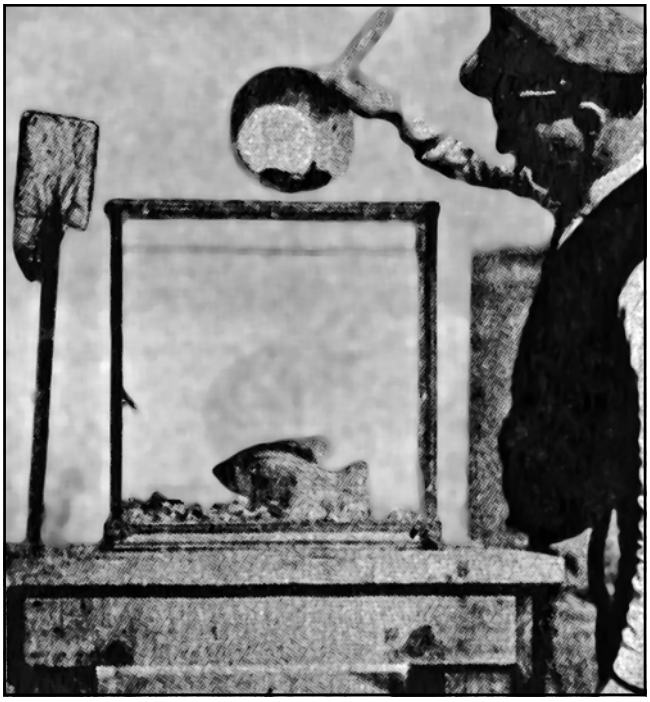
displaying their charms and accomplishments. This is all the more noteworthy from the fact that fish taken away from their native streams, lakes and ocean are inclined to become ill and consequently sluggish. But not so with the inhabitants of the Aquarium. Their physical condition is carefully looked after, and the slightest indisposition is promptly attended to."

Spencer was also a pioneer in the photography of fishes predating even William T. Innes and Charles M. Breder, Jr. who followed Robert W. Shufeldt's early successes in this area. The following is taken from a 1903 newspaper story about how fishes were photographed in the Aquarium:

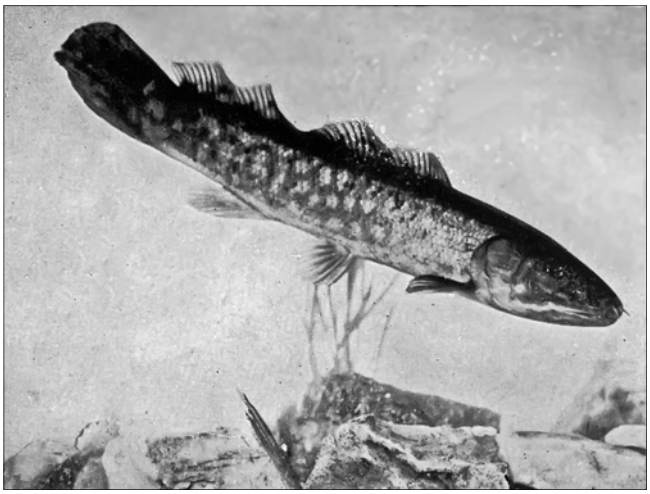
"But it is not always the amateurs who are fooled. Quite recently a reporter on one of the illustrated dailies came here, accompanied by a staff photographer, and asked permission to make some pictures to illustrate a story. Of course, permission was granted, and, although warned as to the fruitlessness of his undertaking, the photographer proceeded with his work and departed confident that he had several good views, but I was by no means surprised when shortly afterward a messenger from the paper dashed in and inquired if I could not loan it some photographs.

"Now, when we wish photographs, we remove the fish from the exhibition tanks to an aquarium specially constructed for photographing purposes (Note: Spencer indicated here with a motion a group of long and extremely narrow aquariums resting on a table in the laboratory), and even under such conditions the results are often disappointing, success only being assured under the strongest light, and when the object is completely at rest.

"One of our greatest difficulties heretofore has been our inability to photograph the living fish in their natural surroundings, for just so sure as we introduce sea-weed, foliage, rocks, or shells into the photographing tank, behind



The narrow, portable aquarium used in 1903 to photograph fishes at the New York Aquarium. Its size was 18 x 18 x 3 inches.



One of Spencer's pictures - the Bowfin, Amia calva.

these objects the fish would anchor, and they acted generally as if they knew exactly what was taking place or had personal objections to sitting for their portraits. To overcome this contrariness on the part of the fish, I am having built an aquarium fitted with an inner glass slide, in the rear of which can be placed the 'properties' characteristic of the subject. Thus equipped, we will be better prepared to carry on the educational work which is now being done in our laboratory."

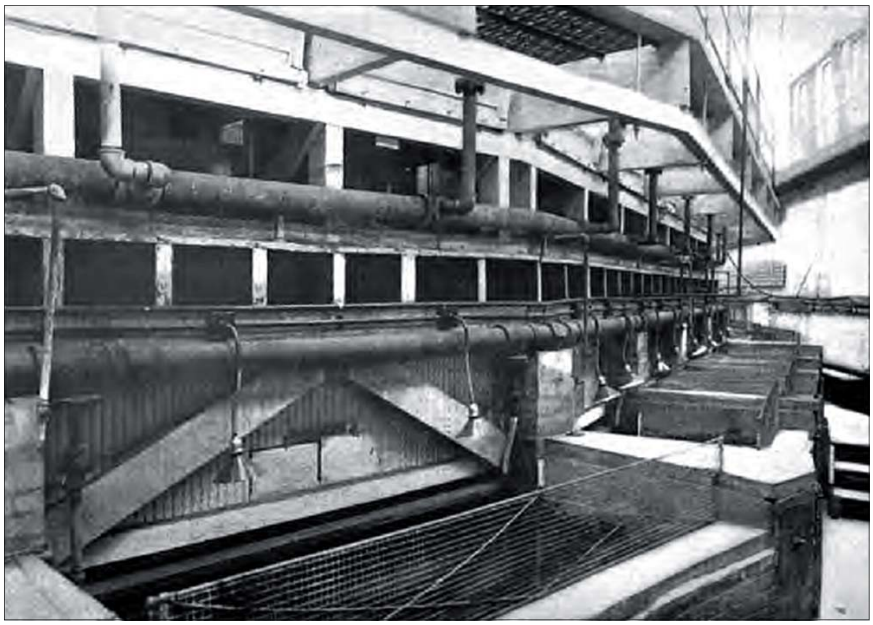
In an article that appeared in the NEW YORK TIMES for August 12, 1910 under the title "Raiders of the Aquarium, Wharf Rats Are Depopulating Tanks," Spencer discussed an odd problem that had developed in the Aquarium. The "Night Raiders" in the story alluded to a previous one that reported on some townsmen who, during the night, had cut down various advertising signs in Palisade, New Jersey:

"'I was just reading about the Night Raiders,' said Leonard Spencer, in charge of the salt water fish at the Aquarium, laying aside his paper. 'We have night raiders right here in the Aquarium, and much trouble they have caused us. The raiders in this case are hardened specimens of the wharf rat. They are fond of a fish diet, and they know how to catch fish.'

"Mr. Spencer led the way behind the scenes where one could look down into the exhibition tanks.

"'Do you see that goldfish tank?' he continued. 'Well, we had to put that wire screen over the top to protect the fish from the rats. In times past we used to lose three or four fish in a night. In the morning the attendants would find on the broad stone ledge about the tank evidence of the night visitors and parts of fish.

"'The rats catch the small fish, which swim near the surface. We keep on hand a tank full of killies, which we use to feed the large fish. They are great favorites with the rats, and the only way we can keep them from being killed each night in large numbers is to put the outlet pipe half way down in the tank, so that the water will not rise near the top.



A view of the Service Gallery of the old Aquarium, 1904.

One of the exhibition tanks, 1919.

> "'I have never seen a rat fishing, but from the evidence they have left behind and from what I know of the rat I know how it is done. They lie down on the ledge surrounding a tank and wait for a victim to float near: then out goes a paw, and quick as a wink the fish is gaffed. Once in a while the rat catches a tartar, and it is the rat, and not the fish, that is caught.'
>
> "Mr. Spencer gave a demonstration of his meaning. Approaching a tank in which were a number of vicious-looking sturgeon, he put one finger down to within an inch of the water. One of the fish watched the finger for a second, and then like a flash he sprang at it. Mr. Spencer jerked his hand up, but only just in time. Being a student of nature, Mr. Spencer argues from this fact that rats reason and that they have learned by experience where the tanks of easy victims stand."

Bean served at the Aquarium with notable distinction from 1895-1898, when political changes led to his resignation. Unfortunately, all the good work he did at the Aquarium was promptly undone in the days of the Van Wyck regime. Robert Van Wyck was the first mayor of Greater New York following the consolidation of the five boroughs in 1898. He became involved in probably more scandals than any mayor in the city's history, having been selected by the leaders of Tammany Hall as a man who would do little to interfere with their running of the city. In 1898 Van Wyck gave Bean's job to "Captain Jim" Jones, a politician whose interest in fish was mainly confined to shore dinners. Fortunately, both DeNyse and Spencer stayed on in their jobs.

CHARLES HASKINS TOWNSEND

In 1901 anti-Tammany forces elected a reformer, Republican Seth Low, to become mayor and in 1902 the New York Zoological Society took over the administration of the facility at the city's request, electing Charles Haskins Townsend as its Director.

Townsend was born at Parnassus, Pennsylvania, September 29, 1859. His parents had intended to prepare him for the ministry, but at an early age he became interested in natural history. At the age of twenty he joined Ward's Natural History Establishment in Rochester New York where he met William T. Hornaday who was later (in 1896) to become the first Director of the New York Zoological Garden (i.e., the Bronx Zoo). Three years later Townsend spent some time at the Academy of Natural Sciences in Philadelphia. In 1883, he first met Professor Spencer Fullerton Baird who offered him a position in the U.S. Fish Commission, and within a month shipped him off to the salmon hatchery on the McCloud River in northern California where he began the career in fishery work that was destined to occupy his attention for the remaining sixty years of his life.

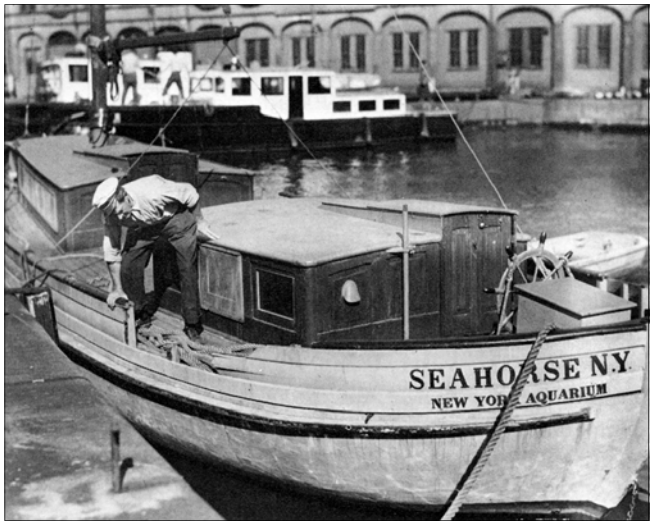
In 1885, he was detailed to the Revenue Cutter *Corwin* on a voyage to Kotzebue Sound, Alaska, and the following year he made a cruise on the Fish Commission Steamer *Albatross* to the Bahamas. In 1887, he collected on the Segovia River in Honduras, and in the autumn of that year accompanied the *Albatross* through the Straits of Magellan to the Pacific where it stopped for 11 days at the Galapagos Islands.

Charles Haskins Townsend (1859-1944)

While he was serving as Naturalist on the *Albatross* during the decade from 1886 to 1896, most of his time was spent in the North Pacific, surveying the fishery grounds along the northwest coast and in the Bering Sea and mapping the fur-seal rookeries on the Pribilof Islands. He also took part in the Bering Sea patrol, charted part of the Aleutian region, and sounded the route for the Hawaiian cable. He was a member of the Fur Seal Commission in 1896-1897 and, after serving five years as Chief of the Division of Fisheries of the Fish Commission, was detailed as Fishery Expert in 1902 to the Russo-American Arbitration Commission at The Hague. (As we shall see, the fur seal commission and the Hague arbitration assignments came back to haunt him some years later.) 1902 also was the same year he was appointed Director of the New York Aquarium. In the years that followed the collections increased considerably and the Aquarium attracted hundreds of thousands of visitors each year. In 1909, Washington and Jefferson College in Washington, Pennsylvania awarded him an honorary Ph.D.

When Townsend took over, the physical plant of the Aquarium was in dire straights. At the time of new-moon tides, the sea water rose so high in the boiler and pump rooms that the stokers had to wear hip boots while shoveling wet coal into the furnace from half-submerged wheelbarrows. Sometimes the pumps were flooded and the fires extinguished, so that there was no heat or circulating water until the tide fell. Four days' coal was all the Aquarium had room to store, and when the Commissioner of Parks ordered the unsightly coal shed removed, the margin dropped to two days. In the winter of 1917 the building had to be closed to visitors for several days and the living collections would probably have been lost had it not been for twenty-five tons' emergency supply of coal long hidden in an underground pipe conduit.

In 1921 the executive committee of the New York Zoological Society decided that conditions at the Aquarium really were intolerable, that the city was not going to act, and that after nineteen years perhaps the Society owed something to its foster child. It voted $75,000 for new pump and boiler rooms and larger exhibition tanks as "a gift from the Society to the City of New York." Then, as promptly as if all along it had been waiting for such a gesture, the city voted $86,000 for the enlargement of the second story, modifications along the front of the building,



The Aquarium's collecting wellboat, the Seahorse, was launched in 1920.

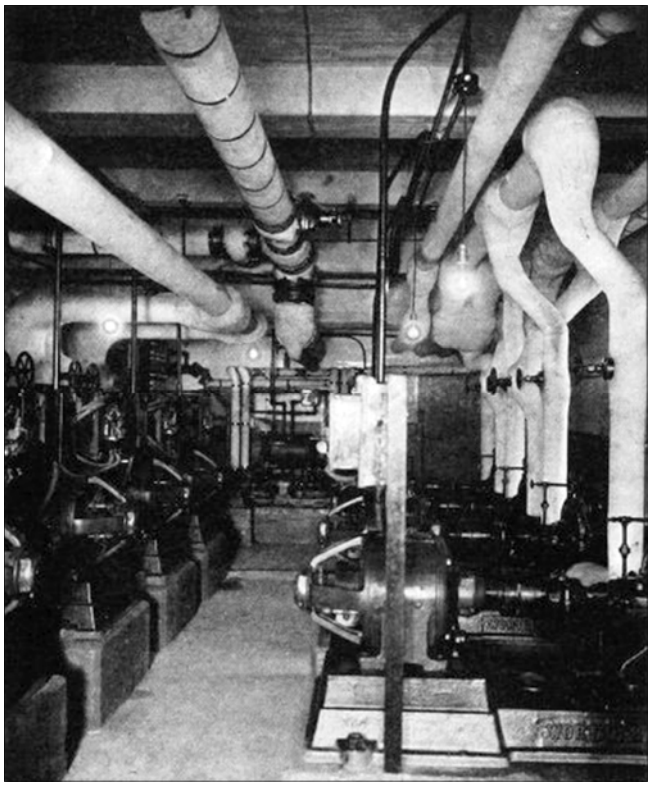
and the addition of a third story. (To my mind, however, the additions did not enhance the overall appearance of the structure. To counter-paraphrase Elizabeth Bennet in Jane Austin's *Pride and* Prejudice, '…natural beauty had been… counteracted by an awkward taste.'")

The Society's money was expended promptly and the director's annual report for 1921 was a proud showcase for photographs of the new pump rooms and boiler room. The city's part of the work proceeded more spasmodically; it was not until 1926 that the second and third floors were finished, the second given over to water distribution tanks and shops and the third to offices, a library, and a laboratory. Now the collections could be expanded by about a fifth, and the new offices allowed Townsend and his small staff to move back into the Aquarium from the basement room in Pearl Street which they had occupied while reconstruction was going on.

Townsend had little instinct to compile, document, and release his thoughts in writing. He produced no books except the *Aquarium Guidebook* in 1919, a rewritten edition in 1937, and a small (91 pages) booklet on *The Public Aquarium: Its Construction, Equipment and Management*, published by the U.S. Bureau of Fisheries in 1922 (and reprinted in 1928). He did, however, produce a steady flow of observational papers in the early years. In the Zoological Society's Annual Reports he published "Notes on the Manatee" in 1903, "Notes on Certain Pinnipeds" in 1904, "The Cultivation of Fishes in Natural and Artificial Ponds" in 1906, "Pollution of Streams - an Appeal to Anglers" in 1907, and in 1908 "Observations on Instantaneous Changes in Color Among Tropical Fishes," the first of four papers he devoted to these interesting transformations as he had seen them in the Aquarium's tanks. During World War II the Navy made use of the four-color maps he had prepared showing where whale catches had been concentrated, to give submarine commanders an indication where their sonar was most likely to be confused by whales instead of detecting enemy submarines. Townsend's publications, about 100 titles in all, were mainly devoted to fisheries, fur seals, whaling and oceanography, but he also published several papers on birds.

Exterior views of the Aquarium after the 1920's renovations.

Apart from Townsend's own limited writings, scientific work at the Aquarium was slow in getting started, even though the Society's Executive



The new pump room, 1921.

Committee had directed him when he took over his duties to make the Aquarium a center for scientific studies. The one exception was practical work on fish pathology. In 1915 the Society appointed Dr. George A. MacCallum of the College of Physicians and Surgeons of Columbia University as pathologist to the Aquarium, and in the next three years he produced five papers on trematodes and nematodes found in the collection of fishes. They were considered so important that the Society established a special journal for their publication.

However, nothing more at the time could be done at the Aquarium; there was no proper laboratory or other facility for scientific work until the third story of the building was completed in 1926. For that matter, it is doubtful whether Townsend was greatly interested in the kind of scientific work that required a laboratory. Several of his associates in the 1920s and 1930s have recalled his attitude in almost identical terms. Dr. Charles M. Breder, Jr., who succeeded Townsend as acting director in 1937, commented:

> "Dr. Townsend considered himself a 'naturalist' and indeed he was just that in the full old-fashioned sense. He became annoyed whenever anyone who worked with live animals was referred to as a biologist, or even more so if the word used was 'scientist.'
>
> He would pull himself to his full height and declare, 'We are naturalists! Naturalists describe and only scientists explain.' Frequently he would add for my particular benefit, 'That means you, too, Breder.' I still cannot quite explain that bit."

By the mid-1930's Dr. Townsend was at last beginning to think about retirement. His quirks - and they were many, of a kind perhaps more common in his day than today - had ripened and provided much innocent amusement for his staff. Among other things, he was a "string saver," with all the hoarding tricks that phrase implies. Breder wrote of him:

> "From his office windows he could see floating trash in the harbor. When something caught his fancy, often some large timber, he would send some of the boys out in the redoubtable Seahorse to 'rescue' it. This would go into the 'attic,' a capacious annular space that surrounded the skylight over the large center pool in the public area. Usually it took four or five men with a block and fall to get it up there. It usually was very heavy because of being waterlogged."

Building inspectors did not look with favor on the storing of heavy junk over a public area and periodically ordered it removed, to Townsend's great distress.

Townsend normally wrote his replies to correspondents on the back of their original letters, and much of the time he wrote standing up. He had two desks, one a normal office desk and the other an old-fashioned bookkeeper's desk intended to be worked at from a high stool. Dr. Breder commented on it:

> "The only place I can recall seeing such a piece is in one of the illustrations accompanying Dickens's *Christmas Carol* showing Bob Cratchit at his daily stint. He once told me he could not sit long in his standard swivel desk chair because of what he called his 'bone ache.' This he claimed he got from staying too long in the Pribilof Islands on the fur seal project."

However, there may have been another reason why he preferred standing to sitting. When Breder inherited the office, he found that the desk chair's seat was so sprung that the occupant sat on the ironwork beneath. It had been that way for years, but Townsend was not a man to discard a chair simply because it was broken.

Townsend was devoted to the sea and to ships, and it was a common belief among the men working at the Aquarium that anyone could get a job if he could splice a rope. He was disappointed because Breder did not know how to put in an eye splice, and Breder finally had one of the men teach him how to do it, just so his handicap would not bother the director so much!

Townsend retired in 1937, having served the Zoological Society for thirty-five years. Under the severest handicaps of an ancient and inappropriate building and always inadequate financial support, the Aquarium during his time became one of the showplaces of New York.

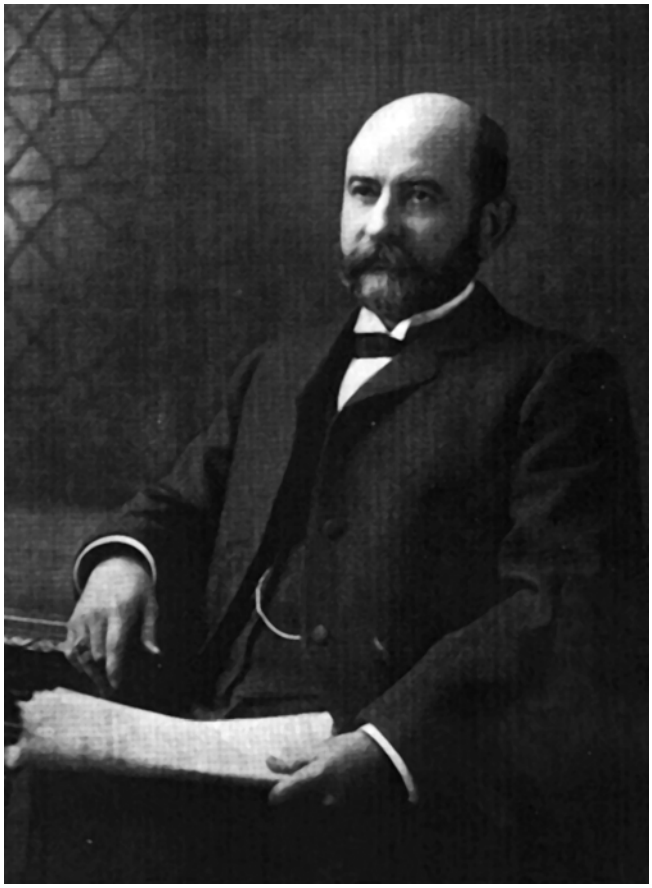
THE TOWNSEND-HORNADAY CONTROVERSY

It is ironic that Hornaday had proposed Townsend for the Aquarium job. On April 7, 1902, he wrote to Henry Fairfield Osborn, the President of the Society:

> "If you are still looking for a man to be Superintendent of the Aquarium, let me mention and strongly recommend my old friend C. H. Townsend. He is capable, vigorous, experienced, knows administrative work thoroughly, and is as fine a man personally as could be found in a years search. No man in Washington has a cleaner record."

A few years later, however, Hornaday looked upon his "old friend" as one of his worst enemies.

The Hornaday/Townsend clash was of epic proportions. At its center were the fur seals of the Pribilof Islands in Alaska, which were in a bad way around 1910. Pelagic, or ocean, sealing indiscriminately killed females and males of any age, and on land the motherless pups starved to death. International treaties put an end to pelagic sealing, but the harvesting of surplus males on land continued. Hornaday was determined to have a five-year moratorium declared on land sealing and allied with him - and even more violently aggressive and outspoken, if that is possible - was Henry Wood Elliott. Besides being best known as the savior of Alaska's fur seals, Elliott was also one of the finest watercolorists to work in the Territory. Elliott first visited Alaska in 1867 with the Western Union Telegraph Survey. Later he was the official artist for



William Temple Hornaday (1854-1937)

Henry Wood Elliot (1846-1930)

the U.S. Geological Survey expedition to the western United States. He came north again in 1872 as U.S. Treasury Agent supervising the Alaska Commercial Company's management of the fur seal industry in the Pribilof Islands. Elliott traveled more extensively in Alaska than any other late nineteenth-century artist.

Hornaday, Elliott, and their allies took on the United States government head-on but reserved some of their bitterest attacks for the advisory board of the Fur Seal Service on which Townsend was a member. Both sides agreed that pelagic sealing was bad, but harvesting the surplus of non-breeding age males on land was another matter. When Townsend was in governmental service he had spent years in the Pribilofs, making censuses and examining the logbooks of sealers to determine what and how many seals they had taken; Hornaday had never been in Alaska. Townsend and his fellow zoologists on the advisory board believed it would be safe, even beneficial, to the land herds to remove the young males and minimize the fighting for possession of the females, which often led to trampling, injury, and death of the pups. The board saw no reason why the United States government should not have the revenue that controlled killing would permit.

The jockeying and name-calling by Hornaday and Elliott, the Hornaday-produced pamphlet appeals to save the fur seals, the letters to Senators, the Secretary of State, and even to President Taft, were unremitting. Not that Hornaday attacked Townsend by name - as he did some members of the advisory board - but the "Barren Work of the 'Experts' of the 'Advisory Board'" (a heading in one pamphlet that was never circulated) left no doubt about his feelings for his fellow director in the service of the Zoological Society.

Even Osborn and Madison Grant (a lawyer by profession, Grant was Chairman of the Society's Executive Committee) got caught up in the fray, with Osborn publicly differing with "my friend Dr. Hornaday." Tensions reached a point at which the society decided it was time to call a halt. A peace agreement was declared, both directors were ordered to cease firing, and Hornaday's pamphlet entitled "The Last Fight for the Persecuted Fur Seal: New Light on an Amazing Situation" was withheld from circulation after it had been printed and was ready for distribution to the United States Senate.

Townsend's stint as an arbiter for the State Department at The Hague just before becoming director of the Aquarium also turned out to be a problem for him and an embarrassment to the Zoological Society. The dispute, between Russia and the United States, concerned a sealing vessel, the *James Hamilton Lewis*, which had been seized by Russia in her territorial waters and for which the United States asked $50,000 compensation. Townsend's role in the dispute was a minor one; he was to be called upon merely to testify about general sealing activities of the time and to provide statistics when needed. In the end, the award was made to the United States, and Townsend probably looked upon it as just another minor chore for the government.

However, in 1911 a House of Representatives committee under the chairmanship of John H. Rothermel of Pennsylvania began holding hearings to investigate the fur seal industry of Alaska where the policy of permitting killing on land under lease to a commercial company was under debate. The nationality of the owners of the *James Hamilton*

Lewis and their relation to a commercial company engaged in Alaskan sealing became one line of questioning thrown at Townsend, and Henry W. Elliott was permitted to put a series of highly irrelevant and somewhat unfair questions to him through the chairman of the House committee. Elliott was free with such comments as "Liar!" and "He dare not tell what he knows to the Committee with Elliott's eye on him." However, it is hard to see how Townsend could have answered some of the questions since they were entirely outside his frame of reference at The Hague. Elliott's excesses here are a stain on his otherwise exemplary career as a conservationist.

The charges that Townsend had been party to presenting a fraudulent claim against Russia and that he received compensation for his testimony at The Hague out of the award were widely publicized in a majority report of the Rothermel Committee. A minority report of three of the seven members completely exonerated him (politics played a greater part here than conservation; the three were Democrats, the majority four were Republicans). The Society's executive committee thereupon asked William White Niles as its counsel to make an independent investigation. On the basis of the Niles report, it was "the unanimous opinion of this Executive Committee that the honesty and integrity of Dr. Charles H. Townsend have not been impugned in any way" and that "the attack on him is unjustifiable, malicious and untruthful."

Hornaday, Elliott and their allies, however, did win the battle to save the fur seals. Some time after his retirement Hornaday wrote a fifteen page memorandum, the following being an excerpt:

> "We won! All three of our original demands; but the cost to me in old friendships forever broken up was great, and even today is painful to contemplate. I have many ex-friends who never will forgive me for having started that fur-seal salvage campaign, nor for having been successful in gaining the ends desired."

Townsend's bitterness toward Hornaday survived and years later when a member of his staff happened to be reading one of Hornaday's books and inadvertently left it lying on his desk, he angrily ordered it out of the building. "Never let me see you looking at a thing like that again!"

EARLY STAFF ASSIGNMENTS AT THE AQUARIUM

In 1904, the Aquarium staff assignments were as follows:

Charles Haskins Townsend, Director
Leonard B. Spencer, Asst. In charge of fresh-water collections
Washington I. DeNyse, Asst. In charge of marine collections

Spencer and DeNyse were two of the few who survived from the Tarleton H. Bean Directorship and Townsend came to rely greatly on these competent men. (Spencer, who had been connected with the Aquarium in the capacity of Aquarist since May 1,

Henry Fairfield Osborn (1857-1935)

Madison Grant (1865-1937)

1894, died in 1910, at the age of 73 years, and DeNyse died in 1921.)

LOUIS L. MOWBRAY

In 1916, the Aquarium staff assignments were as follows:

Charles Haskins Townsend, Director

Washington I. DeNyse, Assistant
Louis L. Mowbray, Assistant
Ida M. Mellen, Secretary
George A. MacCallum, Pathologist

I have previously mentioned Dr. George A. MacCallum's appointment in 1915. Of the two newcomers, Mowbray and Mellen, we'll take a look at Louis L. Mowbray first.

Louis Mowbray (1878-1952) was a Bermudian appointed in 1912 to be the first Director of the South Boston Aquarium. As Jerry Ryan points out in his book, *The Forgotten Aquariums of Boston* (Finley Aquatic Books, 2002), Mowbray took his responsibilities very seriously and had dreams of making the South Boston Aquarium a first class institution and a model for scientific research. In January of 1914 Mowbray was allotted $1,500, the equivalent of about $22,000 in today's currency, to purchase fishes in Philadelphia. A month later he was fired for "inefficiency and conduct injurious to the discipline of the Park Department."

Reading between the lines, Mowbray either spent the funds without Park Department approval or else the Department was dissatisfied with how, or the manner in which, the funds were spent. Mowbray did not dispute the injurious conduct charge but demanded that the accusation of "inefficiency" be struck from his record as unfounded and misleading. The Park Department complied with his request

Mowbray went from Boston in 1914 to assume the position of Assistant Aquarist at the Aquarium. He left New York in 1921 to oversee the construction of the Miami Beach Aquarium and was its director until it was sold in 1924. After another short stay (1925) in New York, this time as Chief Aquarist, he returned to his native Bermuda and went on to become one of the most famous and respected ichthyologists of his time. He served as curator of the Bermuda Aquarium until his death in 1952. Mowbray is credited with the discovery and capture of several species of rare fish, and his obituary notice in the NEW YORK TIMES notes his success in sending live eels in bottles from Florida to Denmark via parcel post; they arrived in good health!

It is interesting to note that in 1914, Mowbray and John T. Nichols described a new angelfish from Key West, naming it *Angelichthys townsendi* (BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY, vol.33, art. 37, 1914). Unfortunately, *Angelichthys townsendi* turned out to be a naturally occurring hybrid between the queen angelfish (*Holacanthus ciliaris*) and the blue angelfish (*Holacanthus bermudensis*). It is thus a junior synonym and therefore the name is invalid.

IDA MAY MELLEN

Ida May Mellen was born on January 9, 1877 in Manhattanville, an area of New York City now a part of West Harlem, to parents Andrew Jackson Mellen and Mary Davis (Sprague) Mellen whose roots respectively were in New Hampshire and Massachusetts. Her mother was usually referred to in the family as "May," hence the origin of Ida's middle name. She had two older brothers, Frank, and Fred, 12 and 7 years her senior, respectively. Unfortunately, her father died when she was but three years old, leaving her and her brothers to be raised by her mother who was only 41 years old at the time. They relocated to Brooklyn, which was not a part of New York City at the time. Her older brother, Frank, took on a job as a clerk with the American District Telegraph Company (he later became President of the Flatbush District Telegraph Company of Brooklyn) but the family was well provided for by her relations. Ida, therefore, was raised in a middle-class environment, so schooling and summer vacations typical of this economic status were not a problem.

She graduated from the Lockwood Academy in Brooklyn, a highly respected private college preparatory school, in 1893 at the age of 16. Mellen at first considered a career in teaching and enrolled in the Normal Kindergarten Training school in Brockton, Massachusetts in 1895 but evidently changed her mind. After a bout with pneumonia in 1898 she entered Browne's Business College and Academy of English situated at 246 Fulton Street in Brooklyn. Established in 1860, it was one of the leading and most distinctive institutions of its kind. She graduated in 1900 and, at various times from 1901 to 1916, she was a free-lance law reporter (i.e., a.k.a. shorthand reporter or court reporter recording testimony, etc.) in the city until 1916 when she joined the New York Aquarium as its Secretary and stenographer.

She did, however take advantage of three additional educational opportunities during the 1901-1916 period. In 1902 she received a diploma from the Young Woman's Christian Association's Nurses Training School in Brooklyn as an Attendant Nurse (in later years she also obtained credentials as a Red Cross Nurse). These were trained attendants that came into the house and cared for convalescents, chronic cases or invalidism and minor illnesses where the cost would be less and the service as satisfactory as that of the professional nurse. Women of social standing frequently took this course, which lasted 11 weeks and consisted of lectures and probationary work in a hospital. Then, during 1908-1910, she was a student in zoology at the Marine Biological Laboratory, Woods Hole, and Massachusetts. Founded in 1888, the Marine Biological Laboratory was unusual for its time in that it encouraged the enrollment of women students of science on an equal basis with men. In these early years, approximately one-third of the classes in advanced scientific studies were composed of women who came from many areas of the country. Individual women as well as women's social and educational groups had been instrumental in raising approximately half of the funds required for the

Ida May Mellen (1877-1970)

College women collecting marine specimens at Woods Hole, site of the famed Marine Biology Laboratory attended by Ida Mellen from 1908-1910.

establishment of the Laboratory. Finally, in 1912, she was a summer student at the Eugenics Research Association, Cold Spring Harbor, N.Y.

Mellen quickly became more than just the Secretary of the Aquarium, and it wasn't long before she became Aquarist, working for Mowbray. She wrote a number of monographs and articles on aquatic animals and aquariums including:

1917 - "Care of salamanders and frogs in captivity," N.Y. Zoological Society, New York Aquarium; INFORMATION CIRCULAR No. 4.
1918 - "Salt Water Aquaria at Home, AQUATIC LIFE, Vol. III, No. 5, January 1918.
1918 - "The Common Snails -Their Relation to Balanced Aquaria," SCIENTIFIC AMERICAN SUPPLEMENT, Sept. 21, 1918.
1919 - " Prehensile-Tailed Pipefishes," N. Y. ZOOLOGICAL SOC. BULLETIN, November, 1919.
1922 - "The Effects of Captivity on A Sex Character," SCIENCE MAGAZINE, November 17.
1923 - "Whitefishes Reared in the New York Aquarium," ZOOLOGICA, 2(17).
1924 - "Tyrian Purple from Sea Shells," BULLETIN NEW YORK ZOOLOGICAL SOCIETY, Vol. 27, No. 2, p. 23, March 1924.
1925 - "A Table of Information Regarding the Large Aquariums of the World," in *Twenty-Ninth Annual Report, New York Zoological Society*, N.Y.Z.S.
1926 - "New Medicines for Sick Fishes," ZOOLOGICAL SOCIETY BULLETIN, 29.
1926 - "The Goldfish Puzzle," AMERICAN SPEECH, v.2, No. 1, pp. 62-64, October
1927 - "The Natural and Artificial Foods of Fishes," AMERICAN FISHERIES SOCIETY TRANSACTIONS, Vol. 57, Issue 1.
1927 - "Plea for the Turtles, NATURE MAGAZINE, Vol. 9, February.
1928 - "The Treatment of Fish Diseases," ZOOPATHOLOGICA, vol. 11, no. 1, April.
1928 - "Aquarium English," AMERICAN SPEECH, v.3, No. 6, pp. 460-463, August.
1930 - "Can A Catfish Count?" SCIENCE MAGAZINE, June 6 (published in 1930 but written while she was still at the Aquarium).

She even found the time in 1925 to study psychoanalysis under the renowned physician, Dr. Gregory Stragnell, editor of the NEW YORK MEDICAL JOURNAL. In 1927 she presented the paper, "Limulus," read at the New York Academy of Medicine and in the same year published two books: *Fishes in the Home* (New York Zoological Society) and *Young Folks' Book of Fishes* (Dodd, Mead & Co.). The following year she toured Europe to study the operations of public aquariums. During all this time Mellen gave many lectures and lantern slide programs on the Aquarium, its operation, and its fishes.

Townsend wrote a number of *Guide to the New York Aquarium* booklets, the annual reports of the Aquarium, *The Public Aquarium* (published by the Bureau of Fisheries in 1928), and also was editor and wrote much of the ZOOLOGICAL SOCIETY BULLETIN. Townsend, however, had a great deal of difficulty with his writing. In 1905, Hornaday complained to

Madison Grant that Townsend's *Annual Report* copy needed two day's hard work – paragraphing was bad, capitalization was erratic – and suggested that it be sent back to the Aquarium's director to be rewritten. Mellen was a godsend to Townsend since she corrected and re-wrote much of Townsend's work after her arrival at the Aquarium.

Ida Mellen was a pioneer in aquatic-animal therapy. In 1928 she received national fame as "the Fish Doctor" and was covered in a number of newspapers around the country. An Ohio newspaper ran the following short feature:

> "DOCTOR' REMEDIES FISH ILLS
>
> "Doctor' Ida Mellen, of the New York aquarium, is believed to be the only woman in the world who is a physician and surgeon to fish. She has found they are heir to much the same ills as humans - they even have nervous prostration. Thirty-eight distinct fish diseases have been discovered and remedies have been found for 35 of them."

The caption to one of the drawings of her that accompanied the article read, "Only woman in the world to practice the profession of physician and surgeon to fishes."

If this were not enough, from 1922 to 1938 she presented a series of radio talks on keeping fishes and marine biology. In 1925, for example, she gave a series of radio talks on New York City Station WEAF on the following subjects "The New York Aquarium and its denizens," "Goldfishes and the care of fishes in captivity," "Carps and sea horses," "Fishes that make noises and some that can live out of the water," "Eels and flounders," "Pike, pickerel and muskellunge and how to tell them apart," "Pacific salmon : fishes that bring forth their young alive and those that build nests and defend their young," "Gars and mudfish," "How much does a fish know?" "Sharks," "Poisonous and dangerous fishes and fishes of the deep sea," "Disappearing sturgeon, depleted by over-fishing, and sardines and herrings that no amount of fishing can exterminate," "What do fishes eat?" "What is the fastest fish in the sea?" and "Why is a fish?" A concluding talk was in answer to the common question, "Is a whale a fish?" This was followed in 1926 with twelve talks, this time on Station WJZ, and in 1927 with a series of seventeen talks on Station WNYC. Most of these talks involved fishes, but she also discussed whales, porpoises, sea birds, seals, sea cows, alligators and turtles.

CHARLES M. BREDER, JR.

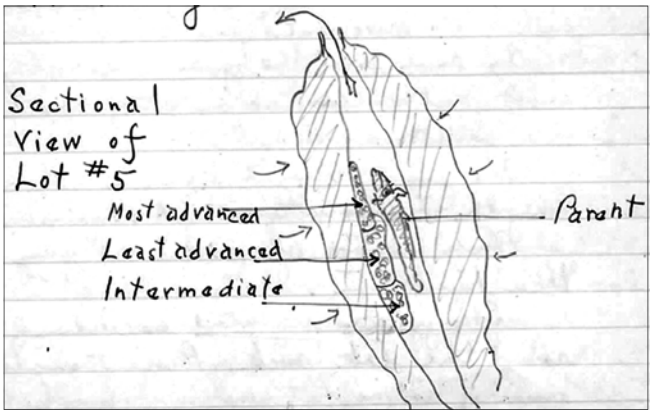
In 1921, the Aquarium staff assignments were as follows:

Charles Haskins Townsend, Director
Robert J. Lanier, Assistant
Charles M. Breder, Jr., Aquarist
Ida M. Mellen, Secretary

The Annual Report of the New York Zoological Society for this year included the following notation:

> "Mr. C. M. Breder, Jr., scientific assistant, U.S. Bureau of Fisheries, was appointed

Charles Marcus Breder, Jr. (1897-1983)



Breder's sketch of the blenny and its eggs found inside a yellow sponge mentioned in the text.

> aquarists on April 1, to fill a vacancy caused by the death of the late W. I. DeNyse, who had been in the service of the Aquarium since its inception. Mr. Breder contributed two papers to *Zoologica* (Scientific Contributions of the New York Zoological Society): The life History of the Puffer (*Spheroides maculatus*), and Hermaphroditim in the Croaker (*Micropogon undulatus*), both being illustrated with drawings by the writer."

For much of the following information I am grateful to Dr. James W. Atz, who worked for Dr. Breder for many years.

Charles Marcus Breder, Jr. was born in Jersey City, New Jersey, on June 25, 1897 and he grew up in nearby Newark. Before finishing high school, Breder had established a pattern of investigative activity to which he would follow the rest of his life: the observation of animals and plants, either in nature or a laboratory setting, followed by a published description of what he had observed and what were his thoughts on the subject. He frequently made use of apparatus that he had constructed himself, and his articles were often illustrated by his own drawings and photographs.

His earliest publication, which was written when he was 18, concerned the photography of local birds with the aid of a long-distance, electromagnetic shutter-tripper he had built for his seven-dollar, second-hand, 4 x 5 Eastman plate camera. (I have described his equipment and technique for the photographing of aquarium fish in The Toy Fish, *loc. cit.*) By the time he was 21 he had published 15 popular articles and notes, more than half of them on home aquaria, mostly in AQUATIC LIFE.

Breder was truly a self-made biologist. He once was reported to have said that everything he knew about biology and ichthyology at the time he got his first job he had learned at the Newark Public Library. In fact, Breder was a 22 year old youth with a high school education when he was hired as a scientific assistant by the U.S. Bureau of Fisheries. (His doctorate was an honorary one that was awarded to him in 1938 by the University of Newark, now the Newark campus of Rutgers University.)

Although his short period of employment with the Bureau of Fisheries was professionally successful (17 scientific publications resulted from it), he wanted to be freer to pursue his own interests and was happy to accept the position in 1921 of Aquarist at the New York Aquarium. However, in spite of its large collection of fishes and ambitious plans for a new laboratory, things did not turn out as expected. As I have previously mentioned, Townsend had a sharply ambivalent view of scientific research in a public aquarium, and for the next 16 years, he and Breder skirmished intermittently over the number and kinds of investigations Breder wanted to carry out.

However, Breder took advantage of the many opportunities to make worthwhile observations that were presented by the Aquarium's diverse fish population, and also conducted successful experiments despite its limited facilities. Moreover, he arranged to spend significant periods of time in the field: three months on the Rio Chucunaque in eastern Panama in 1924; two months on the Dry Tortugas in 1929; two months in the Bahamas, especially Andros, in 1930, 1932, and 1933; one and one-half months aboard the Atlantis in the Sargasso Sea and Caribbean in 1934; several months on the Florida west coast 1938 through 1942; one month in San Luis Potosi, Mexico in 1940; and one month in the Gulf of Guayaquil in 1942.

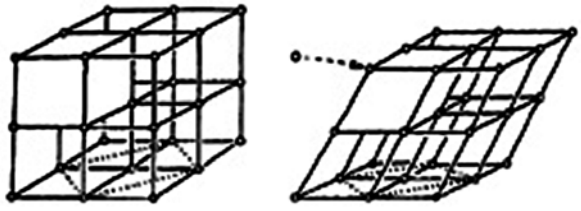
A particularly noteworthy accomplishment of Breder's research program at the Aquarium was the development of a simple method of controlling the progressive acidification of seawater that occurs in all closed circulations of aquariums without ready access to the unpolluted ocean. Subsequent studies have shown this procedure, the periodic addition of sodium bicarbonate, to be the only practical way of keeping recirculated seawater alkaline enough for delicate captive marine animals. When Townsend retired on November 1, 1937, Breder was appointed Acting Director, and 27 months later, Director. At the end of 1943, Breder left the Aquarium to become chairman of the department of fishes at the American Museum of Natural History.

If Breder had any quirks it was his reluctance for administrative positions. Early in his career he fulfilled his share of administrative chores, but as time went on he became less willing to do so. Although not indifferent to peer-recognition, he wanted no part of any of the public activities that so often came with it. In 1925, for example, the New York Academy of Sciences awarded him the A. Cressy Morrison Prize for his pioneering and penetrating analysis of fish locomotion, and during 1939–45 he served as Secretary and as President of the Academy's Section on Biology and as a member of its council. When, however, it became apparent that he was on the way to becoming the President of that prestigious organization, Breder resigned from it. Conversely, he served as President of American Society of Ichthyologists and Herpetologist in 1932, but thereafter attended less than half a dozen of its annual meetings. In 1941 he reluctantly became an adjunct professor in the Graduate School of Arts and Science of New York University, and through the years he taught a successful course in ichthyology and sponsored a small number of doctoral candidates (one of his students was Eugenie Clark).

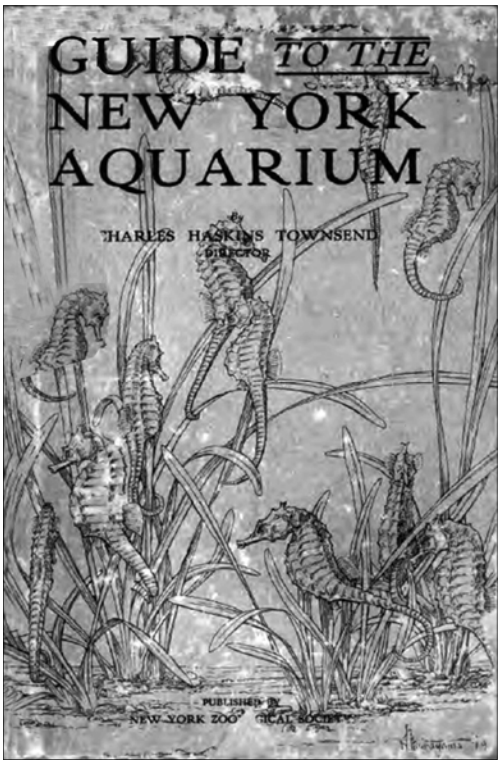
Breder was a careful observer. The following is taken from the handwritten diary he kept that documented his field activities in Florida in 1938. While studying the habits of the blenny, *Auchenopterus*, he found one fish and some eggs in the lumen of a yellow sponge and commented as follows:

> "There are three distinct patches evident each in a different state of development. Since these eggs seem to be both light sensitive and have a relatively high oxygen requirement, as based on the difficulty there is in rearing them, together with the fact that they are agglutinated in a flat mass many eggs deep, it would seem that some such special environment as the interior of some fast pumping sponge such as the yellow ones would be necessary for their successful incubation. The species is evidently pugnacious as evidenced by their behavior towards each other in aquaria or even in a collecting bucket. They advance open mouthed with their pectoral fins spread toward each other or for instance a large snapping shrimp and give a sudden lurch forward snapping their jaws which is usually followed by the retreat of the intruder. It would thus seem that the gnarling parent does little more than 'guard'. A peculiar trick of this species is to walk along the bottom on their delicate ventral fins, alternating them like legs."

He was also a behavioral ichthyologist par excellence. In his paper, "Fish Schools as Operational Structures" (BULLETIN, U.S. Fish and Wildlife Service, 74, pp. 471-502, 1976), Breder looked into the chaotic blur of the fish school and argued that schooling fish arrange themselves not willy-nilly, but according to a specific geometric pattern. Breder quickly dismissed the face-centered



Right: The face-centered cubic (FCC) lattice pattern. Left: The rhombic or hexagonal close -packing (HCP) lattice. A shove on one corner of the former produces the latter.



The 1919 Guide to the New Aquarium in which Mellen contributed sections on small saltwater aquaria and on salamanders and frogs. Mellen came a long way in the little over two years she had been at the Aquarium. Mellen made numerous corrections to Townsend's text.

cubic (FCC) lattice pattern whereby, arranged by this model, schools would display unnatural regimentation, like the files and ranks one sees in a marching band. He proposed a close cousin of the FCC lattice, known as rhombic or hexagonal close-packing (HCP). This configuration can be envisioned, Breder noted, by "figuratively pushing the cubic lattice askew." (Place a fish sphere at each vertex of the lattice, taking care to point them all in the same direction, and we arrive at Breder's theoretical school.)

But why would fish want to pack in this manner so closely? Breder believed that the answer lies partly in schooling's elusive hydrodynamic benefits:

> "The advantages of the regimented life in a school, as against the freedom of action common to the more or less solitary life, are evidently related to the effectiveness of the drag-reducing mucus in the vortices. The fishes with the least effective mucus appear to take advantage of the schooling life while those with the most effective mucus are more likely to be solitary."

In other words, the fluids released by each schooler's body lubricate its fellows in the water, reducing the ocean's resistance to their movement. Schooling fish close-pack, Breder argues, in order to immerse themselves in as much of their friends' slime as possible.

Although Breder is probably best known for his work on the reproductive, schooling, and other social behaviors of fishes, as well as the evolution and behavior of blind cave characins from Mexico, the investigations that gave him the greatest satisfaction, however, were the off-beat ones, i.e., unexpected productions of an ichthyologist that involved unusual observations and techniques and led to original, speculative conclusions. He did, however, harbor a dim view of taxonomy, with which he appeared to equate Systematics. This he tended to regard as a necessary evil - a point of view common among experimentalists and ecologists of his generation. Nevertheless, he himself described at least five new genera and 23 new species.

The accomplishments of Charles Marcus Breder, Jr. have never been equaled by any other experimental or behavioral ichthyologist. In 160 papers, occupying more than 2275 journal pages, he recorded an unparalleled array of field and laboratory investigations. To these must be added 609 more pages, as well as a 369 page book, devoted to 39 systematic and distributional studies. A 956 page monograph review and some 300 pages of popular pieces, most of which contain original data of scientific merit, complete his prodigious professional output.

THE TOWNSEND-MELLEN CONFLICT

In 1924, the Aquarium staff assignments were as follows:

Charles Haskins Townsend, Director
Louis L. Mowbray, Chief Aquarist
Charles M. Breder, Jr., Research Associate
Ida M. Mellen, Aquarist and Secretary

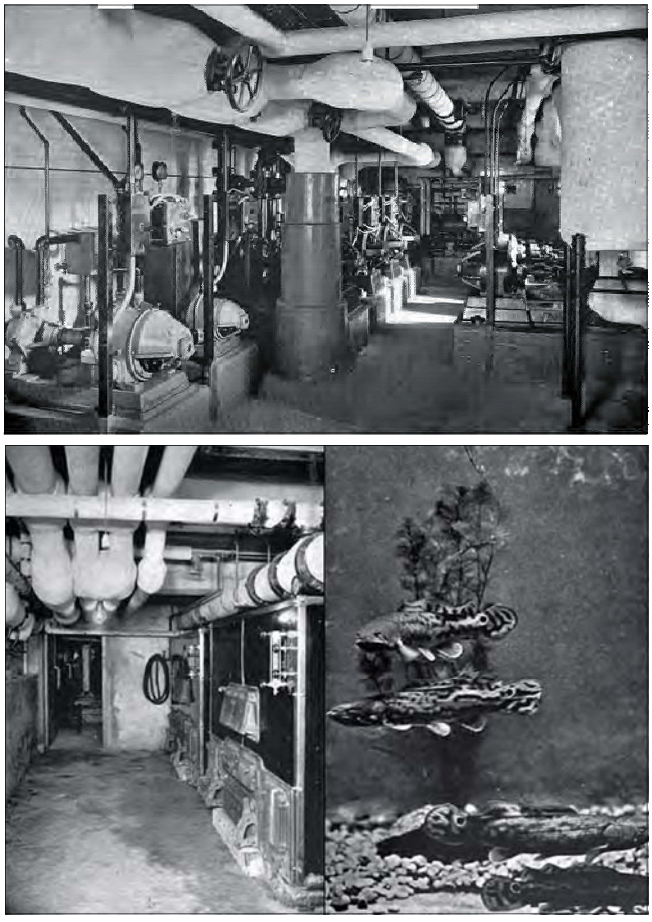
This was the year that Louis Mowbray returned to the Aquarium for a short stay before leaving for Bermuda. Ida Mellen was now recognized for her talents and was listed as Aquarist, with Secretary following this duty. From this point on, Ida Mellen produced most of the articles she had written while at the Aquarium, and began to obtain widespread recognition among New Yorkers and the aquarium world in general.

Townsend's publications, about 100 titles in all, were mainly devoted to fisheries, fur seals, whaling and oceanography but he also published several papers on birds. In fact, Breder always felt that Townsend was "at heart an ornithologist and he gave me the impression that he rather disliked fishes." Appendix C of Townsend's *The Public Aquarium* (about 11% of the book), consisting of information about the public aquariums of the world, was written by Ida Mellen, and Appendix A (about 7% of the book) is essentially a re-write of material taken from his *Guide to the New York Aquarium* published in 1919 and which Mellen most likely had edited. In any event, Mellen's papers include a copy of the 1928 edition which has been heavily scored and corrected.

Osborn and Grant wanted the Aquarium to become a center for science but this was an uphill battle with Townsend who boasted to a newspaper reporter when he retired that he had never used a microscope.

Townsend received credit with having saved three varieties of rare "critters" (his invariable term) from extinction: the giant Galapagos tortoise, the Alaskan reindeer (popularly known now in this country as the caribou) and the fur seal. However, the major credit for saving the fur seals belongs to Elliott, not Townsend, and the credit for saving the Alaskan reindeer belongs to Sheldon Jackson, Alaska's Director of Education. Although bringing domestic reindeer to Alaska was originally proposed to Congress by Townsend in 1885 it was Jackson who in 1891, unable to obtain any federal funds to implement his ideas, raised private funding to enable him to acquire reindeer from herders across the Bering Strait.

Townsend's 1925 paper, "The Galapagos Tortoises in Their Relation to the Whaling Industry" is widely cited as evidence for crediting him with saving the tortoises, but this was hardly the objective of the report which was, in Townsend's own words, "to report upon the hitherto overlooked records of the whaling fleet" and "the problem of the origin of the tortoises for which the Galapagos Islands are chiefly celebrated." Of this document of over 28,000 words, only 281 are concerned with the preservation of the tortoises.



Improvements at the Aquarium, 1921. From the top, clockwise: General view of the new electric pump room; the new boiler room; Bowfin tank.

To this list of misplaced credits we can add the name of Ida Mellen, who was responsible for much of the accomplishments at the Aquarium during her tenure. After DeNyse died in 1921, Ida Mellen, along with the tank men, in effect was running the Aquarium. Indeed, because of the high visibility she had attained as a result of her radio talks, lectures and publications, both the public and the scientific community regarded her as the head of the Aquarium. When visitors arrived and asked to see the Director, they were astonished to find out it was not she. Mellen would tell them she was not the Director and the usual reply was, "Well, we don't know him, it's you we came to see." In her book, *New York Is Everybody's Town*, published in 1931, Helen Josephy wrote:

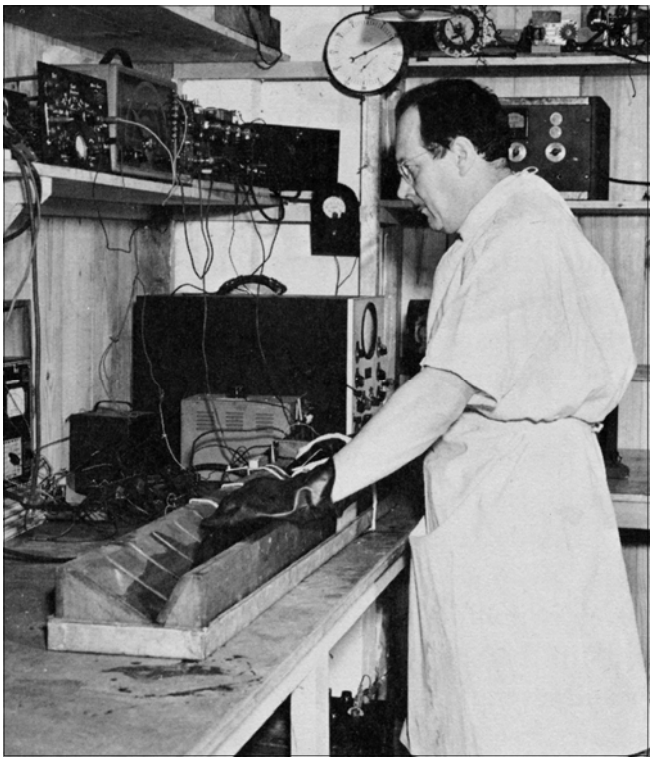
> "In our early newspaper days we learned about eels from Miss Ida Mellen of the New York Aquarium, a lady who knows more of fish and near-fish than anybody in New York. Eels, incidentally, are strange migratory creatures with curious mating habits. We also saw the Aquarium under Miss Mellen's guidance and for days were a mine of voluntary information on the length of life, value as food, and habitats of giant turtles, alligators, pig-fish, sea lions and sharks."

Mellen knew many of the important political figures of the day and it was she who suggested to Robert Moses that a new Aquarium be built at Coney Island. Moses valued her opinion and because what Moses wanted he usually got, its present location, therefore, is largely due to her.

Townsend reacted to this with an irrational jealousy, treating her in an offensive and detestable manner, spreading falsehoods about her along the way and taking credit for many of the things she did. On one occasion, for example, Townsend told his staff (to whom he referred to as "his boys") that he would give anyone a substantial financial reward for a study of the natural foods of fishes. Mellen did the study and produced the paper, but Townsend not only credited Breder for the work, he went back on his promise and Mellen was never paid. Mellen did get even, however. She joined the American Fisheries Society who published her paper, "The Natural and Artificial Foods of Fishes," cited previously. Again and again, Townsend promised raises to Mellen but gave them to others on the staff instead and when she complained, Townsend would say, "Well, I can't give raises to everybody."

Although Townsend is touted for going to the Galapagos on a mission in 1928 on the Albatross II of the U.S. Bureau of Fisheries (which happened to be idle at the time, waiting on a new government appropriation) to save the giant land tortoises, it was Ida Mellen who suggested that he go in the first place. Townsend, with inadequate preparation, rushed off without any specific objectives, much less plans for how to achieve them. Mellen was disappointed with the results, noting that rather than advancing the idea of conservation, all Townsend accomplished was to bring back 180 tortoises that in due course were distributed to the Canal Zone and the Florida keys (where they eventually disappeared), the Bermuda Aquarium, the San Diego, Houston, New Orleans and Bronx zoos, and an arboretum in Arizona. What Mellen had in mind wasn't to appear until 1959 when the Charles Darwin Foundation was founded whose primary objectives were to ensure the conservation of unique Galapagos ecosystems and to promote the scientific studies necessary to fulfill its conservation functions.

In 1929 Townsend was 70 years old. He took little part in the day-to-day decisions about the management of the Aquarium and his behavior had taken an eccentric turn. Because of this, Mellen was approached by several influential people requesting her permission for them to approach Osborn to persuade him to retire Townsend and replace him with Mellen. This she refused to do, remarking that she wanted Townsend to finish his tenure at the Aquarium. This was partly because of compassion on her part for Townsend but also because the situation of women at this time was vastly different from that today and would have placed Mellen in an even more uncomfortable position at the Aquarium. The glass ceiling at the New York Zoological Society was so firmly in place that no woman could ever expect to achieve the level of Director of the



Christopher W. Coates (1899-1974)

Aquarium. When Townsend made his trip to the Galapagos in 1928, for example, although Mellen had seniority it was Breder who was appointed Acting Director.

One of the most important things Ida Mellen did during her last year at the Aquarium was to approach Mrs. Alma C. Damon to make a donation to the New York Zoological Society. The income from the amount - $10,000 (equivalent to about $114,000 today) – was to be in memory of her husband, William Emerson Damon, who had been one of the original members of the Society's aquarium committee in 1902 and a pioneer in the history of the aquarium hobby in America.

Although this was a significant bequest, it would have been closer to $15,000-$25,000 had Mellen acceded to Mrs. Damon's request that Mellen consent to be the curator of the exhibition. This she declined to do, feeling that it would be interpreted as soliciting the donation for her own benefit when that was far from her intention.

In any event, tired of her disgraceful treatment at the hands of Townsend, Mellen resigned and went on to pursue an active independent writing career for which she is well-known in the aquarium hobby. Her 1935 book (revised in 1953), *1001 Questions Answered About Your Aquarium* (co-authored with Robert J. Lanier, a former tankman at the New York Aquarium who went on to become Superintendent of the Steinhart Aquarium), for example, is arguably the best of all the aquarium books published in this country prior to World War II.

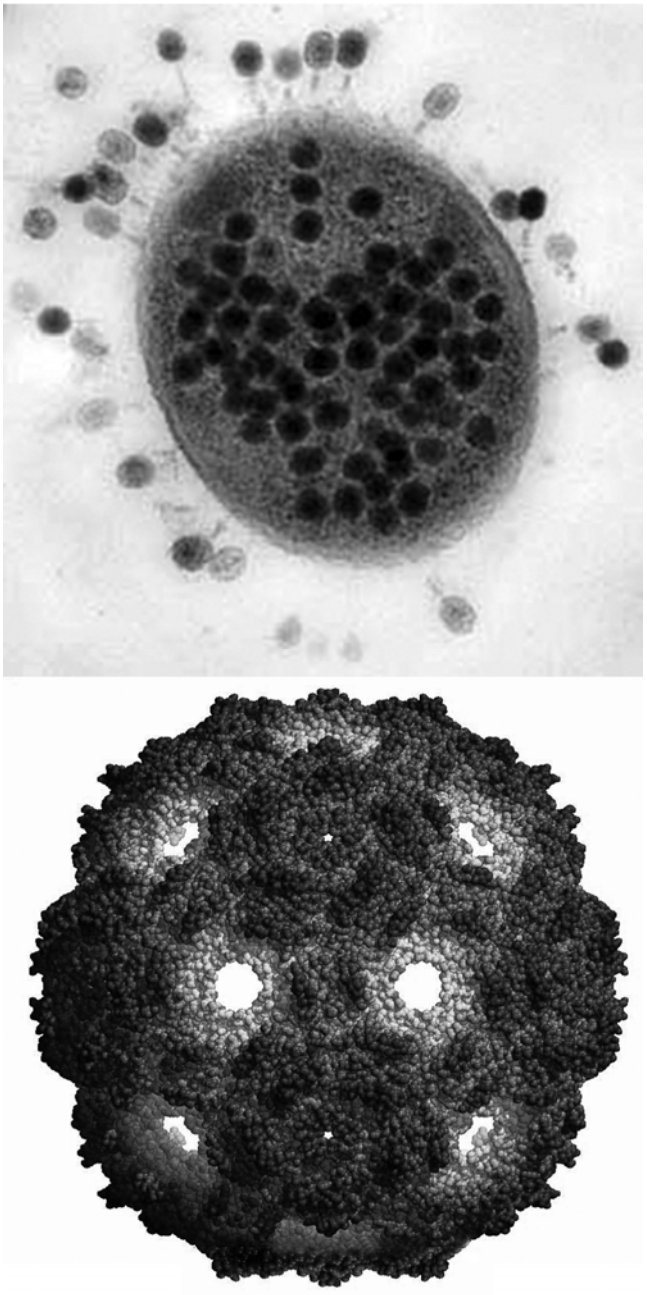
ENTER CHRISTOPHER COATES

Christopher William Coates was borne May 8, 1899 on part of what is now the site of Rockefeller Center. As a child he was presented with a bowl of goldfish and was full of questions about them but could find no one who could completely satisfy his curiosity. So, at age 17, he went down to the Battery where the Aquarium was then situated and operated by the city, and soon discovered that he often had learned more about fishes than had many adults.

Coates dropped out of high school to pursue his study of fishes, lied a little about his age to get into the Army in World War I, and later pressed on with his self-study of ichthyology, chemistry, botany, geology and ecology. Coates became a broker on the New York Produce Exchange, but continued his interest in fishes, especially tropical species. The depression had hit the trade hard and Coates was looking for other work. Then, in 1930, an unexpected opportunity came his way when Mrs. Damon's bequest of $10,000 was received by the Aquarium. It enabled the Aquarium to enter into what was essentially a new field for it: a display of freshwater tropicals in seventy-two small tanks around the balcony. Its management required a specialist; the person selected was Christopher W. Coates, and he was hired on the staff as an Aquarist.

THE COATES BACTERIOPHAGE EPISODE

Among Coates' assets was a publicity sense not equaled by anyone on the Society's staff except perhaps for Raymond L. Ditmars, the snake expert at the Bronx Zoo. Soon after his arrival, stories about



**Top—Bacteriophage.
Bottom—Graphical representation of a bacteriophage.**

the Aquarium came to be a staple of New York City newspapers. For some weeks in 1933 a Coates story had a runaway success and caused the Aquarium a certain amount of embarrassment. It concerned the discovery of a mysterious bacteriophage (bacteria eater) in the waters of the tropical fish tanks.

Breder had for some years been interested in the phenomenon of tanks that were kept clear and habitable by fishes even though fish food decayed in the water and large amounts of bacteria were formed. Something was destroying the bacteria, and in 1931 he announced the presence of a lytic (dissolving) agent - the bacteriophage - in both old aquarium water and in the intestinal contents of fish (in this case, the small-mouthed black bass), but did not publish any further reports.

The Aquarium's tank men were well aware that something was going on in the waters into which they dipped their hands so many times a day; working with glass as they did, they often got small cuts and these healed rapidly and without infection. To them it was just something that happened, but Coates sensed its news value and mentioned it to a reporter. The exact chronology of the story's development is not entirely clear, but according to most newspaper accounts the bacteriophage's wonder-working properties were realized after Coates cut his hand and the wound healed in three days while being exposed repeatedly to fish tank water in the normal course of his work. (In one account he was supposed to have asked himself, "If the phage destroyed bacteria in aquarium water, why shouldn't it destroy them in human infections?" From the intestinal contents of fish he allegedly prepared a concentrated solution of the bacteriophage and then deliberately set about getting his own hands infected, dipping them repeatedly in his phage solution and soon saw them healing up.) Whatever the real truth of the story, THE TIMES wrote about it in 1933:

> "Strange tales come from New York's Aquarium - recalling the healing springs of medieval days. People afflicted with skin diseases beg for permission to dip their hands into tanks teeming with tropical fish. Dr. Coates' own festered hand healed wonderfully when accidentally brought into contact with aquarium-water bacteriophages. Cases of skin diseases have been similarly cured. With commendable caution further treatments are denied. A mystery must first be solved."

Soon scores of sufferers from undetermined kinds of skin disease flocked to the Aquarium, which took the precaution of having them sign a form saying that the treatments were at their own solicitation and risk, and that if the expected results did not materialize the Aquarium would not be held responsible. THE TIMES quoted Coates as saying that nineteen volunteers had tried the water "and in all of them the results could be described as encouraging." One man whose hand was so afflicted that he could not close it had reported that he was now able to grasp a golf club for the first time in twenty years.

Foreseeing that it was going to be swamped by sufferers, the Aquarium turned its "patients" away and passed the problem to a couple of New York City hospitals for proper scientific investigation. As it turned out Coates was wrong; the results were inconclusive (apparently even if bacteriophages were present they were too weak to be of any therapeutic value) and the bacteriophage story died out.

ELECTRIC EELS

Coates did, however, engage in meaningful research work that justifiably earned him a reputation as an expert in the field of electric fishes. His interest in electric eels dated from his earliest years at the Aquarium. He knew that such great scientists as Sir Humphrey Davy and Michael Faraday had worked with electric fishes, and that Faraday had demonstrated that externally the eel's current flows from head to tail. But how powerful was the current? Coates tried running it through voltmeters, ammeters, and galvanometers - all of which either burned out or failed to register anything. The eels were giving off plenty of electricity, all right; many times he was knocked off his feet by discharges. But no combination of wiring would cause them to light up an ordinary electric bulb.

One Saturday afternoon in 1935 he happened to be testing a new kind of neon lamp, of the type commonly used nowadays as a night light. Tired and getting careless, he made a connection that gave him a heavy shock, and as he was falling backward he saw the neon pip (a neon bulb is made of glass sealed in two areas, one of which is called the pip) light up with an orange glow. He traced the wiring, found that the pip was in a simple direct circuit with the eel, and then he got repeated glows every time he stimulated the eel with a rubber-gloved hand. The explanation of earlier failures was simple: the lamps and electrical apparatus he had been using have a "warm-up lag," and the eel's discharge was too brief to actuate them; on the other hand the neon pip's reaction time is instantaneous.

Since it takes at least eighty volts to excite a pip, he now had a crude way to measure an electric eel's voltage, and enough general knowledge of eel behavior to interest a specialist. He found one in Dr. Richard T. Cox, at that time professor of physics at New York University, who contributed a portable cathode-ray oscilloscope to the experiments. With such sensitive instruments Coates and Cox recorded voltages up to 550 and found that an average discharge in water amounted to some forty watts. Dr. Cox was so enthusiastic about the studies that in 1937 he led an expedition to the mouth of the Amazon to study the electric eel at home, taking with him an "eel caller" devised in the Aquarium. It was a device to discharge five hundred volts in a thousandth of a second, a discharge much like the eel's natural one, and it was intended to lure electric eels into the vicinity of the electrodes where they could be captured. It worked.

The electric eel exhibit in the Lion House of the Bronx zoo.

Ross F. Nigrelli (1902-1989)

Among the scientific papers authored or coauthored by Coates are: with Charles M. Breder, Jr., "Reproduction and Eggs of *Pomacentrus Leucoris*," AMERICAN MUSEUM NOVITATES, 1933; with Abner Weisman, "Ovarian Activity of *Xenopus laevis* While in Captivity," THE AMERICAN NATURALIST, 1944; with James W. Atz, "A Remarkable Instance of Parallelism among Teleost Fishes," COPEIA, 1957; and with Carleton Ray, "A Case of Poisoning by the Lion Fish, *Pterois volitans*," COPEIA, 1958.

Unfortunately, Coates had something of a disdainful and domineering personality and was jealous of Mellen's achievements and stature and, given the times, all the more so because she was a woman and was much better educated. Coates' sneering at his peers and superiors was not confined to Ida Mellen, however. In a personal communication to the author from Dr. James W. Atz who worked for Coates for 17 years, Dr. Atz wrote:

> "I don't remember anything ever being said about Breder's not getting on with Mellen, but Coates could well have tried to convince him of her professional frailties…, *as he often did of Breder to me*." (The italics are mine.)

Perhaps Coates resented the fact that in 1938 Newark State College gave Breder an honorary Doctor of Science and that Mellen received hers a few years later. No such honor ever came Coates' way. It should also be noted that although Coates had no doctorate, earned or honorary, he let the assumption go uncorrected in the New York Times articles of July 7, 1933 ("Bacteria Eaters"), April 30, 1938 ("Strange tales come from New York's Aquarium") and August 11, 1943 ("Five Electric Eels Spark War Drive And Slip Into Secret Research Job").

Coates most likely was not pleased either when Mellen's ground-breaking March 1931 article, "Tropical Toy Fishes," appeared in THE NATIONAL GEOGRAPHIC MAGAZINE, further increasing her stature and popularity with the public. It is interesting to note that each of Ida Mellen's five scrapbooks in which she collected printed references to her work was labeled "Conceit Book." Coates undoubtedly also maintained such scrapbooks but I doubt that they were labeled as modestly.

Although Coates had a fish named after him (*Gymnotus coatesi*, LaMonte 1935), Ida Mellen also was honored in this manner. In 1927, she first noticed an outbreak of a monogenean species (monogeneans are fish parasites popularly known as "flukes") from a spadefish (Ephippidae) and an angelfish (Pomacanthidae) in the New York Aquarium that was subsequently named in her honor, i.e., *Epibdella* (now *Neobenedenia*) *melleni*. As the most common species, *N. melleni* causes problematic disease in public aquariums. As Ian D. Whittington of the South Australian Museum remarked,

> "Ida Mellen, a zoologist of note herself, probably had no inkling that her namesake monogenean would become a parasite of such notoriety!"

Clearly not only was Ida Mellen a significantly more cultivated and accomplished individual in every way

than Christopher Coates, she was a patently more important person in the history of the aquarium hobby in America. Her aquarium publications certainly surpassed anything Coates ever wrote and her *1001 Questions Answered About Your Aquarium* far out-shined his *Tropical Fishes for a Private Aquarium* published two years earlier. Had she not been forced out of the Aquarium by Townsend in 1929, there is no telling what this marvelous woman might have achieved there over the ensuing years.

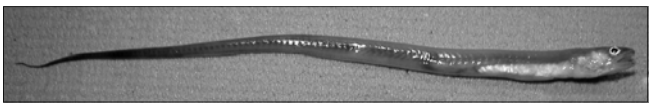
ROSS NIGRELLI

In 1934 Ross Nigrelli joined the Aquarium as its pathologist, MacCallum having retired. Born Ross Franco Nigrelli on Dec. 12, 1903, in Pittston, Pa., he did his undergraduate work at Pennsylvania State University and received his Ph.D. in biology from New York University in 1936. Nigrelli gained a worldwide reputation for his work on the diseases of fish and other aquatic animals and was among the first to discover virus-induced tumors in fish. He was also an authority on the effect of pollution and changes in salinity and water temperature on the health of aquatic animals. In 1959 he wrote a report of special interest to aquarists, "Longevity of fishes in captivity, with special reference to those kept in the New York Aquarium." in 1964 he founded the Osborn Laboratories of Marine Sciences and was director of the laboratories from that year until 1973 when he was named senior scientist. Concurrently, from 1966 to 1970, he was also director of the New York Aquarium.

Nigrelli was one of the earliest scientists to investigate the poisons released by marine organisms and to investigate plankton blooms, like the red tide that killed millions of fish along the Gulf Coast of Florida in the 1940's and off Long Island in the 1950's. He also experimented with the use of marine organisms as tools in medical research and as potential sources of drugs. A well-publicized development occurred when he discovered that when the sea cucumber is attacked, it secretes a poison that even in minute quantities is fatal to fish. (The excretion also inhibits the growth of tumors in mice.) Zoologists have known for years of the sea cucumber's propensity for defensive vomiting, but its toxic properties weren't discovered until the early 1950's, when Nigrelli noticed at the Aquarium that the creature's upchucked innards could kill. To explore the matter further, he took a one-ounce sample of the toxin and placed it in a tank holding several fish and 750 gallons of water. The fish died within 30 minutes.

The study by Nigrelli of this natural toxin (named later by other scientists as a "holothurin") reveals the hazardous existence of many small creatures that live in association with another. The sea cucumber attracts a number of such animal associates (called "commensals") and one particular species living within the shelter of the sea cucumber in which the respiratory activities of the cucumber keep supplied with well-oxygenated water very often is a small pearl fish, Fierasfer. But the well-being, and indeed the very life of the small Fierasfer seem to be constantly endangered, for the fish is actually living beside a vat of deadly poison!

Even more famous to aquarists is what is popularly known as "Fish Tank Finger." In 1953 Nigrelli published a paper describing a new disease in neon tetras ("Two diseases of the neon tetra, *Hyphessobrycon innesi*," AQUARIUM JOURNAL, 24, 203-208, 1953), but the organism wasn't identified until some years later when it was described as a new bacterium, *Mycobacterium fortuitum*. The *Mycobacteria* are slowly growing bacteria, related to tuberculosis and normally found in bodies of fresh or salt water in many parts of the world, that can cause disease in fish and people in contact with water from an aquarium. When it infects the skin, it causes localized microscopic nodules, called granulomas, to form. They occur at sites of skin trauma where there are scratches, cuts, and the like. The following is an account of a case reported in 1962:



A Fierasfer, the fish that lives besides a vat of deadly poison.

James W. Atz

"When the 37-year-old woman who ran a pet shop in a Los Angeles suburb cut her right middle finger on the metal rim of a tropical-fish tank, she thought nothing of it. The cut seemed to be clean, and it healed quickly. But within a month, abscesses formed under the skin on the back of her finger and hand. They were not painful, but they were unsightly, and occasionally one of them burst and oozed a sticky fluid until a new scab formed. The woman's 18-year-old son cut his finger on the same tank, and soon he too had an abscess on his hand."

JAMES WARD ATZ

After serving as a volunteer in 1936 (at which time he had finished his B.A. from Cornell University), James Atz was hired by Breder as a laborer by the Aquarium in the summer of 1937, but by the time he joined the army in April of 1941 he was serving as laboratory technician and tankman, and had written both scientific and popular articles on fishes. When he was discharged from the Army at the end of 1946, he became the Assistant Curator, then Associate Curator (during these times his boss was Christopher Coates), and then Curator of the Aquarium. He obtained his M.S. and Ph.D. from New York University in 1958 and 1959, respectively (his respective theses were "Narial breathing in fishes and evolution of internal nares," and "Morphological and genetic studies on the pigmentary patterns of xiphophorin fishes and their hybrids").

From 1963 to 1967 he was a Consultant and member of the Study Team for the National Fisheries Center and Aquarium, Washington, D.C. and from 1970-1981 was Curator and Dean Bibliographer of the Department of Ichthyology of The American Museum of Natural History, and Adjunct Professor of Biology at New York University. He wrote *Aquarium Fishes* (Viking Press, 1971), and his many articles and papers have appeared in leading scientific publications as well as in popular magazines, including THE AQUARIUM, TROPICAL FISH HOBBYIST, AQUARIST AND PONDKEEPER, and THE MARINE AQUARIST. He is co-author, with Grace E. Pickford, of the standard reference book, *The Physiology of the Pituitary Gland of Fishes* (New York Zoological Society, 1957).

Atz wrote an interesting article on candirús that he observed both at the Cleveland Aquarium and the New York Aquarium. This fish has been reported as attacking the anal region, gills, and fins of dead, dying, or disabled fishes, and is the only vertebrate parasite of man, attaching itself to the submerged legs of bathers and even entering the genital cavities of both sexes. The following is an excerpt from his article that involved 4 candirús, 2 to 2-1/3 inches, identified as belonging to the genus *Vandellia*:

"When the candirús arrived in Cleveland, attempts were made to feed them frozen brine shrimp, living white worms, chopped earthworms or raw smelt, minced gills from smelt or freshly killed goldfish, and goldfish blood, administered by means of an eyedropper with an extension of plastic tubing to enable the material to be presented with minimum disturbance. None of these elicited any positive response. Three days after the

arrival of the fish, a live half-pound goldfish of the black moor type was put into their aquarium. The candirús at once began what seemed to be searching movements directed mostly toward the anterior end of the goldfish, and 3 of them soon fed on blood extracted from its gills.

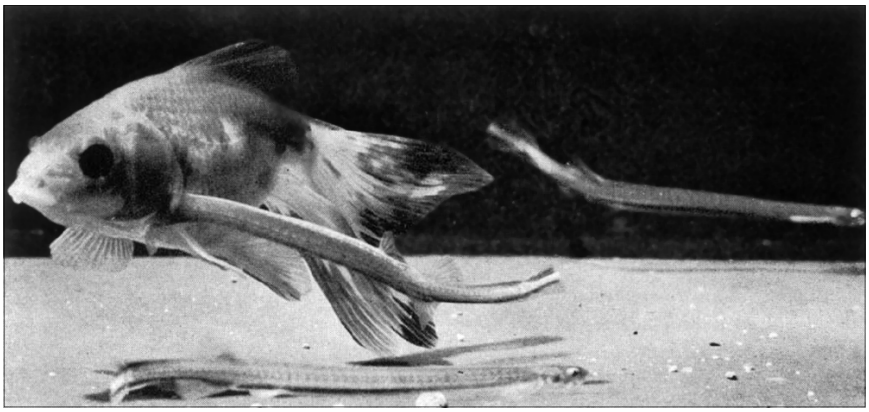
"Whenever a goldfish was introduced into the candirús' aquarium, they swam rapidly around its head, touching, or nearly touching it with their own. Frequently the candirús swam parallel to the side of the goldfish, and they usually entered the gill chamber from this position. They did not appear to force an entry, but may have taken advantage of the periodic opening of the operculum during respiration. Almost immediately after the anterior part of a candiru had disappeared under the gill cover, its belly would begin to swell with blood. In some cases, the whole feeding procedure lasted only about half a minute, but the candiru might remain in the feeding position for as long as 3 or 4 min after its belly appeared completely full. After leaving its prey, the candiru usually dropped to the bottom and lay there quietly. When not feeding, the candirús rested on the bottom, swam more or less at random about the tank, or engaged in vigorous, anguilliform swimming motions while remaining in the same place, which often was a corner, the fish maintaining a vertical, head-up position.

"The goldfish exhibited little or no reaction to the preliminary attentions paid them by the candirús, nor did they try to avoid the smaller fish. Immediately after the entry of a candirú into one of its gill chambers, a goldfish usually would flex its body once or twice, and smaller ones often settled quietly to the bottom. None was ever observed to attempt to dislodge its attacker after blood letting commenced. That damage was done to the gills was apparent because bits of tissue were commonly observed streaming from under the operculum during the feeding. On one occasion, a large goldfish ate a little of its own gill tissue while being fed upon by a candirú. Although large goldfish survived candirú attacks and, in fact, were repeatedly used to supply food, small ones sometimes died immediately or soon after a single attack."

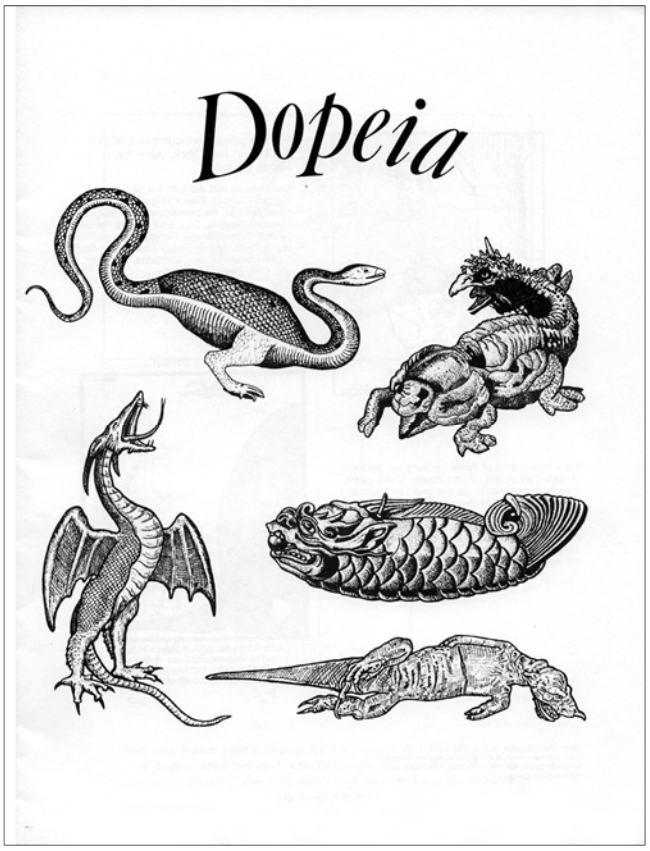
There are two things Jim Atz is especially noted for among aquarists, the first being his love of aquarium hobby history (indeed, his own interest in aquarium history predates mine by at least 17 years).

The second is his refutation of the concept of the "Balanced Aquarium." Briefly stated, the "Balanced Aquarium" is one in which the products of animal and of plant life more or less completely counterbalance each other. The fish absorb oxygen but emit carbon dioxide. The former is necessary for fish life and the latter, if exceeded, can be fatal. The plants absorb carbon dioxide, thus removing that danger to the fish, and return, under the influence of light, oxygen required by the fish. The following is the introduction to a seminal article Atz wrote in 1949 ("The Myth of the Balanced Aquarium," Natural History, 72-79, February):

"The idea that the animals and plants of an



Atz experimented with and wrote about the parasitic catfishes known as candirús.,



A June 1991 copy of DOPEIA, the satirical burlesque on COPEIA, edited by James W. Atz.

> aquarium balance each other in their production and consumption of carbon dioxide and oxygen was a little over 100 years old when it was proved wrong. Although it was disproved more than seventeen years ago, the myth of the balanced aquarium still holds sway - in the tropical fish fancy, in the schoolroom, and in the laboratory. Such is the power of the too felicitous phrase, the too trim theory."

In this article he drew heavily on a paper read by Charles M. Breder, Jr. at a meeting in 1931 before the American Society of Ichthyologists and Herpetologists titled, "On the Organic Equilibria in Aquaria." In this paper Breder found that (1) Plants release oxygen in unimportant quantities, and (2) Because of the rapidity of the transfer at the air-water interface, aquarium water is always saturated with oxygen.

Atz added to Breder's work with the following observations. (1) The major portion of the carbon dioxide in the water is released to the air via the air-water interface of the aquarium, the amount absorbed by the plants being inconsequential. (2) The transfer of carbon dioxide at the air-water interface is slow. In an overcrowded tank, therefore, fish die from carbon dioxide poisoning, not from oxygen deficiency. (3) In a poorly illuminated tank, plants produce more carbon dioxide than they absorb. The bottom line to the Breder and Atz research therefore is that overcrowding is the key to failure in fishkeeping, with neither the carbon dioxide absorption nor the oxygen production by plants being of any consequence in the aquarium.

Unfortunately, the science writers of the day completely misunderstood the Atz article, particularly with regard to the finding that in a poorly illuminated tank plants produce more carbon dioxide than they absorb. Dire warnings went out to aquarists over lurid headlines, such as the following one that accompanied an article written by Dr. Roy K. Marshall, the distinguished Science Editor of the PHILADELPHIA EVENING BULLETIN: "Your Balanced Aquarium May Be Death For Fishes." The fact is, of course, that no aquarium fish has ever been killed by living plants. Even in an aquarium where the air-water interface is covered with a thick layer of floating plants such as duckweed or *Salvia,* the fish suffer no ill effects. As William T. Innes commented: "…we have never seen nor heard of fishes showing distress after hours of darkness in a thickly planted, uncrowded tank."

Atz (personal communication) pointed out that later research showed that Breder's assertion that photosynthesis has little influence on the concentration of dissolved oxygen cannot be accepted as an accurate generalization that fits all cases. The difficulty is that its influence cannot often be calculated quantitatively because of an inadequate knowledge of the rates of consumption or evolution of oxygen by fish or plants under given conditions. However, approximate average values of these rates

for certain fishes and plants are known, and I myself have used these rate equations to predict the variation of dissolved oxygen in aquaria containing *Valisneria* and without them for zebra danios and certain native fishes. For the typical home aquarium where oxygen deficiency is not a problem, Breder's and Atz's conclusions do hold.

Not to be forgotten is that Jim Atz has a keen sense of humor. For many years, with the assistance of like-minded colleagues with a well-developed funny bone, he published a satirical burlesque of COPEIA, the publication of the American Society of Ichthyologists and Herpetologists, called "DOPEIA." The publication, which varied in size over the years, featured mostly cartoons concerning fishes and herptiles, but on occasion had some humorous written pieces as well.

MYRON GORDON

Myron Gordon (1899-1959) emigrated into the U.S. from Russia with his family when he was five years old. Although he was brought up in Harlem in the heart of populous Manhattan where he met Hermann Rabenau and other notables of the day (I have described his early life in *The Toy Fish*, loc. cit.), his interest in animals and plants soon manifested itself, and by the time he had matriculated at Cornell University he had kept innumerable fishes as pets and had worked in the Bird House at the Bronx Zoo and on a farm raising game birds.

He received a B.S. degree in 1925 and a Ph.D. in zoology four years later. In 1924, he had organized a fish genetics laboratory at Cornell under the joint sponsor-ship of three departments, Plant Breeding, Aquiculture and Zoology, and his thesis concerned the morphology of heritable color patterns in *Xiphophorus maculatus*, one of the species he maintained there. In 1937, Gordon left Cornell and for approximately one year he continued his research under the auspices of the Yale School of Medicine. He joined the Aquarium staff in 1938 and a year later he established the Xiphophorus Genetic Stock Center to provide a reliable supply of genetically identical fish to be used in cancer research, and the lines he established remain widely used today. When the original building of the New York Aquarium, which was located at the Battery, was closed down in the fall of 1941, the Genetics Laboratory was moved uptown to the American Museum of Natural History, where the Department of Birds generously provided space and facilities.

Because of Gordon's academic reputation and ability to write clearly on any level, he was recruited to write a very popular series of booklets and magazine features aimed at tropical fish hobbyists (e.g., *Guppies As Pets*, *Siamese Fighting Fish*, and *Swordtails*). He is best known for his work on the inheritance of melanoma in hybrid fishes. This pigment-cell cancer is uncommon but especially malignant in man; it occurs in many other animals but can be produced at the will of the experimenter only by crossing certain fishes belonging to the genus *Xiphophorus*. Although his work had pertinence to medical science, Gordon always looked at it from the zoologist's point of view, for his early training was not as an oncologist, but as an ichthyologist and geneticist. He focused most of his attention and almost all of his research effort on *Xiphophorus*, whose adaptability to laboratory life,

Myron Gordon (1899-1959)

The Xiphophorus Genetic Stock Center now located at Texas State University.

pigmentary polymorphism and ability to produce fertile interspecific hybrids make them uniquely useful experimental animals. He published 72 papers on the members of this genus, as well as many abstracts and popular articles and a number of summaries of his work. During his collection trips he discovered and named several new species, and in 1963, Robert Rush Miller and W. L. Minckley named *Xiphophorus gordoni* in his honor.

An interesting anecdote concerning Gordon occurred when he was part of the 1932 Cornell University Mexico Expedition, which was supported by private funds from hobbyists, commercial tropical fish breeders, and the Heckscher Research Foundation at Cornell. The Shedd Aquarium in Chicago and the New York Aquarium also promised to buy exotic fish that the expedition hoped to bring back. The expedition arrived at the border in Laredo on March 12th, where it was unexpectedly delayed. Gordon had shipped 120 one-gallon cans by the Railroad Express Agency to the border, to be reshipped to various small Mexican railroad stations near areas where the expedition hoped to collect fish. The cans, painted on the inside with asphaltum varnish, were the shipping containers. A permit had been requested to bring the empty cans across the border free of customs duty - because they would eventually be returned to the United States – but it had not yet arrived. The customs officer demanded US $1.00 per can ($13.70 in current dollars), and this was far more than Gordon could afford. Frantic telegrams exchanged between Laredo and Mexico City elicited sympathetic advice but led nowhere. “Why don’t you buy goldfish,” Gordon was told, “and place them into your jars? There is no duty on importing goldfish into Mexico, and your cans then become the shipping containers, which are not taxed.” It was an interesting exercise in Mexican economics, and Gordon eventually was forced to pay.

THE OLD AQUARIUM COMES DOWN

Although he never held elected office, Robert Moses was arguably the most powerful person in New York state government from the 1930’s to the 1950’s. He changed shorelines, built roadways in the sky, and transformed neighborhoods forever. His decisions favoring highways over public transit helped create the modern suburbs of Long Island and influenced a generation of engineers, architects, and urban planners who spread his philosophies across the nation.

In the late 1930’s a municipal controversy raged over whether an additional vehicular link between Brooklyn and lower Manhattan would be a bridge or a tunnel. Bridges can be wider and cheaper but tall ones use more ramp space at landfall than tunnels. A bridge would have destroyed Battery Park and physically encroached on the financial district. The bridge was opposed by historical preservationists, Wall Street financial interests and property owners, various high society people, construction unions (since a tunnel would give them more work), the Manhattan borough president, Mayor Fiorello LaGuardia, and Governor Herbert H. Lehman.

However, Robert Moses favored a bridge. It could carry more automobile traffic than a tunnel and would also serve as a visible monument. More traffic meant more tolls, and more tolls meant more money and therefore more power for public improvements. LaGuardia and Lehman, as usual, had no money to spend and the federal government, by this point, felt it had given New York enough. Moses, because of his control of the Triborough Bridge, however, had

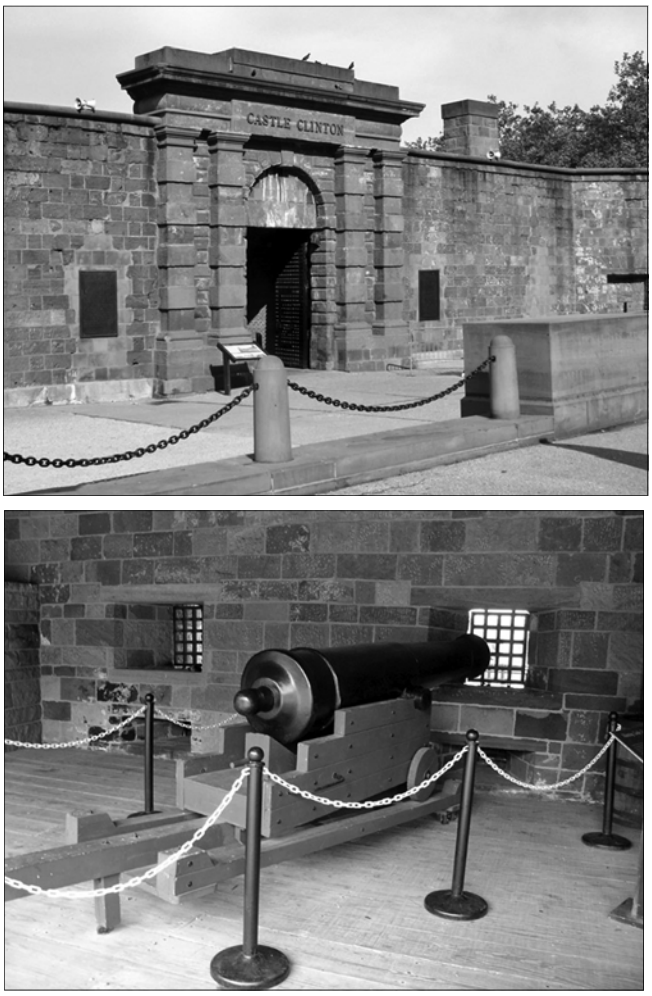
money to spend, and he decided his money could only be spent on a bridge.

Only the lack of a key Federal approval thwarted the bridge scheme. President Roosevelt ordered the War Department to assert that a bridge in that location, if bombed, would block the East River access to the Brooklyn Naval Yard upstream. Although it was a dubious claim for a river already crossed by bridges, it nevertheless stopped Moses. In retaliation for being prevented from building his bridge Moses closed the New York Aquarium in 1941. He had beams and architectural elements around the fort placed to make it appear structurally unsound, and almost succeeded in having the fort completely razed. In late summer of the year the Executive Committee of the Society reached an agreement with Commissioner Moses whereby the city would compensate the Aquarium for the loss of its valuable collection, pay the salaries of a nucleus staff and attendants for an "interim" aquarium in the lion house in the Zoo, and permit distribution of unwanted exhibits to other public aquariums.

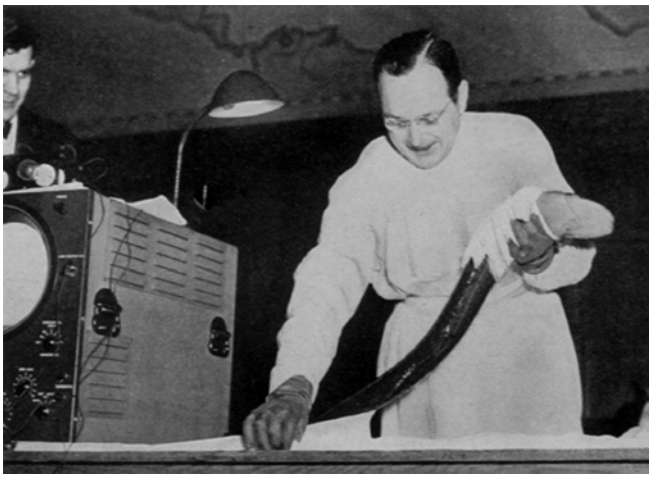
World War II stopped both the progress of the Tunnel and of the destruction of Castle Clinton. The public outcry at the loss of a popular recreation site and landmark stymied his effort at demolition. As a result of the controversy Congress declared the historic structure a National Monument on August 12, 1946. The new tunnel would be completed and the old fortress would remain. But before the building had received congressional protection, the wrecker's ball had already removed the upper story, roof, and other additions that had been added in its middle years. What was left when the National Park Service took over was the basic structure that had begun life back in the early 19th century. In the summer of 1975, after much restoration work, Castle Clinton reopened the doors that had been shut for 34 years.

It was no simple thing to dispose of some ten thousand fishes, mammals, reptiles, and birds. The sea lions, freshwater reptiles, amphibians, and penguins could be absorbed easily enough by the Zoo. The Damon collection of freshwater and marine tropicals was too valuable to let go and had to be taken to the Zoo, along with young tarpon from the Aquarium's tarpon research station on Palmetto Island in Florida, the popular electric eels, and the blind cave fish Dr. Breder had collected on an Aquarium expedition to La Cueva Chica in San Luis Potosi, Mexico in the spring of 1940. Everything else had to be given away to the aquariums at Boston, Philadelphia, and Washington, liberated in ponds and streams near New York City, or returned to the ocean. A scow hauled several hundred marine fish to Sandy Hook in mid-September where they were "liberated," no doubt, as a newspaper suggested, to their great disgust at having to forage for themselves instead of being fed by the Aquarium.

Coates and Nigrelli, on the other hand, occupied rooms at either end of the exhibit panel in the Lion House, but since there was simply no room for them



Details of the Castle Clinton reconstruction , 1975



Coates demonstrating the electric production of an electric eel, a popular show at the Aquarium.

there, Breder and Gordon found laboratory space in the American Museum of Natural History.

As an outcome of his work with electric eels, Coates hooked up a circuit connected with the tank of an electric eel on exhibition in the Lion House. At intervals during the day a rubber-gloved tankman stroked the eel until it discharged its five hundred volts, thereby causing a series of neon pips to spell out "ELECTRIC EEL," a loudspeaker to crackle with static, and wavy blue lines to flicker across the face of an oscilloscope. It was a popular show, and it still is at the new Aquarium.

However, the exhibition electric eel was not quite so popular with the Lion House keepers. Its tank happened to be directly opposite the cage occupied by Dacca, the Zoo's prolific tiger mother. (She had thirty-two cubs between 1948 and 1959.) During several of her pregnancies she took a fierce dislike to the eel, watching it intently and clawing at the wire front of her cage when the eel rose to the surface to take a gulp of air. For the sake of Dacca's peace of mind, the eel tank was kept covered during the critical weeks.

Coates pressed ahead with his studies of the electric eel, which had - it was revealed after the war - contributed to chemical warfare research. Nobody talked about it at the time, but during the last two years of the war some two hundred electric eels lived briefly in twenty-two great wooden tanks in a hideaway laboratory in the basement of the Lion House until they were sacrificed so that their electric tissue could be used to measure the activity of a deadly gas, diisopropyl fluorophosphate, which destroys nerve activity (although it is much less toxic than tabun or sarin).

Postscript: The electric eel was supposed to have other esoteric properties besides producing real electricity. In 1909 a Pennsylvania man had written to the Aquarium:

> "Can you tell me where I can get an electric eel to be used for medicine to cure my brother of drinking? It must be put into a vial with the other ingredients until dead, then taken out and the medicine given."

EPILOGUE

This early history of the New York Aquarium held a special interest for me. As a youngster I visited the Aquarium at Battery Park before it was torn down, and much later personally became acquainted with many of the aquarists discussed here. My wife and I both worked at the New York Public Library where Ida Mellen was a frequent visitor, and I particularly remember a visit in the early 1960's to the American Museum of Natural History (which I also haunted as a youngster) where my good friend Jim Atz showed me and my family a coelacanth preserved in formaldehyde in an old freezer dedicated to this purpose. My two sons and daughter, however, were more impressed with the stench of formaldehyde than with the fish! I was also fortunate to be privy to the top floor of the Museum where Myron Gordon and Klaus Kallman conducted their platyfish cancer research in a plethora of ancient aquaria under the skylights of the Museum. With all that glass it was a mystery to me how they kept that place warm in the winter, but then heat does rise and the Museum is a multi-storied building!

One of the goals I had in writing this monograph was either to verify or to refute the stories I had heard over the years to the effect that Christopher Coates

was responsible for Ida Mellen leaving the Aquarium. I now know that it was Townsend, not Coates, although neither man merits much sympathy. There are far more deserving personalities to be admired in the history of the aquarium hobby in America.

Those readers interested in a literary reference to the New York Aquarium are directed to Stuart Palmers 1931 novel, *The Penquin Pool Murder*, which featured a spinster school teacher as a crime solver - Hildegarde Withers - and her accomplice in crime detection, Inspector Piper. The novel was brought to the screen as a movie by RKO in 1932 and starred Edna May Oliver as Hildegarde and James Gleason as Piper (it airs on television occasionally and is available on DVD). The location shots of the Aquarium are excellent and while the interiors were studio recreations, they were very authentic and true to my recollections. As a result, the movie provides an excellent way to get the "feel" of the Aquarium as it was in the early 1930's. Oddly enough, the movie version of the book mirror reverses the parity of the Aquarium: what goes from left to right in the book's illustration goes from right to left in the film's sets.

The director of the museum is played very broadly as humorless and dyspeptic, and skirts the fringes of outright comedy for a character we're supposed to take much more seriously. I have always wondered what Townsend thought of this portrayal of his character and whether he had to undergo ribbing from his colleagues!

ACKNOWLEDGEMENTS

It should be acknowledged that most of what a man knows or writes is derived from other men's hard work and, for the most part, I acknowledge their contributions collectively rather than individually. Specifically, however, although my sources for this monograph were many, there are three I would especially like to mention.

Most of my information on Charles Haskins Townsend and his relationships with Hornaday, Osborn, and Grant came from William Bridges' *Gathering of Animals, An Unconventional History of the New York Zoological Society* (Harper & Row, 1974). Unfortunately, he passes over not only the importance and contributions of Mellen to the Aquarium (there are only two sentences that mention her, plus a short excerpt from an article she wrote on the plural of fish), but the controversy as well.

In the preface to his book Bridges, who at various times was publicity director and curator of publications at the Bronx zoo, writes: "I had worked alongside… Townsend and Breder… at the Aquarium." One wonders if the work consisted simply in cleaning out the tanks on weekends for, unless a conscious decision was made to cover up both her contributions and the controversy, it is difficult to explain away these omissions. But then Bridges also fails to mention the letter from Adolf Hitler to Madison Grant in which Hitler thanks Grant for writing *The Passing of the Great Race* and notes that "the book was his Bible." This raises the question of whether there was selective editing when it came to Henry Fairfield Osborn, Madison Grant, Charles B. Davenport (he was on the Aquarium committee) and others who had defects of character that would not have reflected well upon the New York Zoological Society.

Insights into the Breder-Coates years at the Aquarium came from my old friend, Dr. James W. Atz, an aquarium hobby historian of first class rank and reputation who has been a major source of inspiration for me these past forty years.

Special mention must be made with regard to the material on Ida Mellen, which was a collaborative effort with my wife, Harriet Joy Klee. Joy, as I am, is a Mellen buff and in addition to editing this monograph assisted me in data acquisition from the Mellen Papers at the New York Public Library, a daunting and time-consuming task. For this I express my appreciation and heartfelt thanks.

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The New York Aquarium and Judge Crater: Sleeping With the Fishes

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 22, 2009)

Joseph Force Crater (1889 – date of death unknown) was a judge in New York City who suddenly disappeared on the night of August 6, 1930. He was last seen leaving a restaurant and entering a taxi. He had stated earlier that he was planning to attend a Broadway show. His disappearance became one of the most famous in American history and pop culture, and earned him the title of, "The Missingest Man in New York."

Crater was an Associate Justice of the New York Supreme Court. He had been appointed to the state bench by then-Governor Franklin D. Roosevelt just four months before his disappearance. He had been educated at Lafayette College (Class of 1910) and Columbia University.

In the summer of 1930, Judge Crater and his wife, Stella Mance Wheeler, were vacationing at their summer cabin at Belgrade Lakes, Maine. In late July, he received a telephone call but offered no information to his wife about the content of the call, other than to say that he had to return to the city "to straighten those fellows out."

The next day, he arrived at his Fifth Avenue apartment, but instead of dealing with business he made a trip to Atlantic City in the company of a showgirl. He returned to Maine on August 1, and traveled back to New York on August 3. Before making this final trip, he promised his wife he would return by her birthday, on August 9. Crater's wife stated that he was in good spirits and behaving normally when he departed for New York City. On the morning of August 6, Crater spent two hours going through his files in his courthouse chambers. He then had his assistant, Joseph Mara, cash two checks for him that amounted to U.S. $5,150 (equivalent to about $60,000 in 2006). At noon, he and Mara carried two locked briefcases to his apartment and he let Mara take the rest of the day off.

Later that evening, Crater went to a Broadway ticket agency and bought one seat for a comedy called "Dancing Partner" that was playing that night at the Belasco Theater. He then went to Billy Haas's Chophouse on West 45th Street for dinner. Here, he ate dinner with his friend, a lawyer, and his mistress, a 22- year-old showgirl called Sally Lou Ritz. The lawyer later told investigators that Crater was in a good mood that evening and gave no indication that anything was bothering him. The dinner ended a little after 9 pm, a short time after the curtain rose on the show for which Crater had bought a ticket, and the small group went outside.

Crater then waved goodbye to his friends and hailed and entered a cruising taxi on West 45th Street. What happened to him after that remains a mystery. Theo-

Joseph Force Crater

ries about his disappearance have suggested that he was murdered, that he ran off with another woman, or that he had been involved in corrupt practices that were about to be revealed.

Strangely, there was no immediate reaction to Judge Crater's disappearance. When he did not return to Maine for 10 days, his wife began making calls to their friends in New York, asking if anyone might have seen him. Only when he failed to appear for the opening of the courts on August 25 did his fellow justices become alarmed. They started a private search but failed to find any trace. The police were finally notified on September 3 and after that, the missing judge was front-page news.

The story captivated the nation and a massive investigation was launched. The official investigations started vigorously, but quickly slowed. Detectives discovered that the judge's safe deposit box had been emptied and the two briefcases that Crater and his assistant had taken to his apartment were missing. These promising leads were also quickly bogged down by the thousands of false reports coming from people claiming to have seen the missing man.

In October, a grand jury began examining the case, calling 95 witnesses and amassing 975 pages of testimony. The conclusion was that "The evidence is insufficient to warrant any expression of opinion as to whether Crater is alive or dead, or as to whether he

has absented himself voluntarily, or is the sufferer from disease in the nature of amnesia, or is the victim of crime."

None of the investigations succeeded in discovering the judge's fate or possible whereabouts, and Crater was officially declared dead "in absentia" on June 6, 1939, and his case — Missing Persons File No. 13595 — was officially closed in 1979. Sally Lou Ritz, by the way, disappeared in August or September 1930, and was never seen again.

On August 19, 2005 authorities revealed they received a letter written half a century before by Stella Ferrucci-Good. It - a handwritten letter – was in an envelope marked "Do not open until my death," found by her granddaughter, Barbara O'Brien, in a metal box in her grandmother's home. The metal box also contained yellowed clippings about Crater's disappearance, with scribbled notations in the margins. In it, the woman identified a location near West Eighth Street in Coney Island, Brooklyn, at the current site of the New York Aquarium, where she claimed the judge was buried under the boardwalk. Moreover, the letter identified Crater's killers as her husband, Robert Good, NYPD Officer Charles Burns, and Burns' brother Frank, a cab driver. Ferrucci-Good claimed that Charles Burns was one of the cops guarding the notorious Murder Inc. killer, Abe "Kid Twist" Reles when he somehow plummeted to his death from the sixth-floor window of a Coney Island hotel in 1941. Reles had become a mob informant to escape the electric Chair, testifying against a slew of Murder Inc. killers; his suspicious death plunge came just hours before he was due to rat out mob boss Albert Anastasia.

Police confirmed that five skeletal remains had been discovered at that site in the 1950s. Modern DNA techniques, unavailable in the 1950s, would have made it easy to determine whether a set of remains were Judge Crater's. However, the bones discovered were almost immediately reburied in a Potter's Field on Hart Island, New York, among hundreds (if not thousands) of other unmarked and unidentified remains, and it would now be a daunting task to find those bones among so many. Police sources also confirmed that a police officer named Charles Burns served with the NYPD from 1926 to 1946, and that he spent part of his career assigned to the 60th Precinct in Coney Island.

Ferrucci-Good was 91 when she died in April 2005. Her husband, Robert Good, a Parks Department supervisor and lifeguard, died in 1975. Crater's wife remembered his disappearance every year for the rest of her life by visiting a bar in Greenwich Village on August 6. She'd sit by herself, order two drinks and down one after saying, "Good luck Joe, wherever you are."

If the letter left behind by Ferrucci-Good is right, he's been sleeping with the fishes all these years.

Excavation of supposed grave of Judge Joseph F. Crater.

WHO INVENTED THE AQUARIUM?

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 17, 2012)

INTRODUCTION

Any attempt to pin down "firsts," such as "the first aquarist," is fraught with difficulties. The following is from Newman (1873):

"The birth of the aquarium is of such remote antiquity that we fail to ascertain the date with any certainty. The point at which, any vessel containing water and fishes becomes an aquarium is equally open to discussion. There is abundant reason to suppose that the Chinese and the Japanese had their fresh-water aquariums thousands of years before the Christian era; the Romans certainly had theirs; but in neither of these instances is there any evidence of their being considered, as now, a noteworthy institution; by the Romans they were established for economic purposes and nothing more."

Newman goes on to mention Pepys, who established the fact that fishes were kept in confinement at Lady Pen's in 1665, but was not aware of Guillaume Rondelet's wife, Jeanne, whom Rondelet claimed had kept a fish alive in a glass of water for three years (Klee, 2003). In 1790, Sir John Graham Dalyell (1775-1851) - who might be termed a legal consultant but one who had a keen interest in natural history - managed to keep a sea anemone alive for twenty-eight years (and numerous other marine animals for lesser periods), but only because he was wealthy enough to be able to arrange for a fresh supply of salt water to be brought round to his house every morning. This was an expensive proposition until about 1850 when the development of the railroad system facilitated access to the coasts. However, Sir John knew nothing of employing plants to evolve oxygen and so did not apply any particular principles of fish keeping.

Figure 1: Charles Robert Alexandre des Moulins (1798-1875)

THE FRESHWATER AQUARIUM SANS FISHES

Charles Robert Alexandre Des Moulins (1798-1875) was a French (Bordeaux) botanist and malacologist. He was president of la Société linnéenne de Bordeaux. Moulins named and described numerous species of snails and in turn, in recognition of his services to malacology, a number of species of mollusks were named after him, e.g., *Pisania desmoulinsi* and *Nerita desmoulinsiana*. These species included both fossil and recent, both bivalves and gastropods and were mainly non-marine. In 1831 he published his "Etudes sur les échinides."

Perhaps the earliest mention of keeping aquatic life alive in artificial containers was by Moulins in his "Note on the means of preventing the corruption in jars in order to keep aquatic animals alive" (Moulins, 1830a):

Le 25 Avril, je rapportai de la campagne une pincée de Riccia fluitans et de Lemna minor que je mis dans le bocal avec des Planorbes, des Physes et des Limnées que je voulais étudier. J'y versai en même temps l'eau que j'avais rapportée des fossés stagnans où j'avais récolté ces divers objets. Elle contenait de gros Cyclopes verts avec leurs paquets d'œufs, et une autre espèce plus

petite, blanchâtre, ainsi que des Daphnies. La température était élevée pou la saison, et l'eau, recueillie depuis plus de 24 heures, était fort sale et déjà sensiblement puante. Mon étonnement fut grand, lorsque le lendemain, je trouvai toute l'eau du bocal pure et transparente comme du cristal, et absolument sans, odeur. Je résolus de ne plus changer l'eau du tout, cette expérience m'a parfaitement réussi. Je me suis borné, lorsque l'évaporation en avait enlevé un demi-pouce ou un pouce, à y ajouter soit de l'eau propre, soit de l'eau de ruisseau ou d'étang que je rapportais de mes excursions. Je me suis procuré un bocal plus grand où; j'ai versé tout le contenu du petit; là, la touffe de Riccia a triplé de volume; les lentilles d'eau ont pullulé dans la même proportion, et les détritus qui proviennent de leur décomposition successive forment au fond du bocal une sorte de vase très-fine et peu abondante qui suffît pourtant à la demeure des animaux qui ne vivent pas habituellement en pleine eau. Il est donc hors de doute que c'est à la végétation vigoureuse de ces plantes flottantes que je dois la conservation de la transparence, de la pureté et de la salubrité du liquide.

"L'expérience que je viens de relater nous conduit à une remarque générale et bien importante : sans les plantes flottantes que la bonté de la divine Providence a répandues avec tant de profusion sur les eaux stagnantes, les habitant des contrées marécageuses périraient dévorés par les fièvres épidémiques. Mais le carbone dégagé par la décomposition des tissus organiques est absorbé par ces végétaux aquatiques, employé à leur nutrition, et ils fournissent en échange une exhalation abondante d'air respirable et salubre.

What follows is my translation:

On April 25, I brought from the countryside a pinch of Riccia fluitans and Lemna minor that I put in the jar with the Planorbis and Physa snails I wanted to study. I used the same water from the stagnant ditches where I collected these objects. It contained large Green Cyclops with their packages of eggs, another smaller species (whitish) and Daphnia. The temperature was somewhat high because of the season, and the water, collected over 24 hours, was very dirty and already stank significantly. My astonishment was great when the next day I found the whole jar of water pure and clear as crystal, and absolutely free of odor. I decided not to change the water at all and my experience has been very successful. I restrained myself when evaporation removed half an inch or an inch of water, or to add clean water or water from a stream or pond that I brought from my excursions. I bought a larger jar and poured the entire contents into it from the smaller one; the clump of Riccia has tripled, the duckweed has multiplied in the same proportion and the detritus from their successive decomposition formed at the bottom of the jar was of a very fine mud and that will do, however, for the abode of animals that do not usually live in open water. There is no doubt that it

is the vigorous vegetation of these floating plants I have been able to conserve the transparency, purity and safety of the liquid.

The experience I have just described leads us to a general remark and a very important one: without floating plants that the goodness of Divine Providence has showered so profusely on stagnant water, the inhabitants of marshes would perish, devoured by an epidemic of fever. But the carbon released by the decomposition of organic tissue is absorbed by these aquatic plants and used for their nutrition, and in exchange they provide abundant and healthy oxygen for breathing.

Moulins also set out the type of vessel to be used, i.e., a shape where the animals are not distorted by the glass, i.e., cylindrical with a flat bottom and thin enough so the colors of the animals can be observed. He recommended canning glass available from pharmacies.

In another article (Moulins 1830b) Moulins wrote, "Notice sur la ponte de la Planaire lacteé (Instructions on spawning the Milky Planar)" on breeding *Planaria lactea*, a non-parasitic flatworm, he states: **Enfin, le 26 Avril, j'ai mis dans le bocal un paquet de *Riccia fluitans* et de *Lemna minor* qui, jointes aux conferves , entretiennent par leur végétation la pureté de l'eau** (**Finally, on April 26, I placed in the jar a bundle of Riccia fluitans and Lemna minor which, together with conferva, maintain the purity of the water**).

It should be noted, however, that Moulins' experiments were with univalve and bivalve snails, microscopic crustaceans (such as planaria, daphnia and cyclops) and leeches. He mostly used floating plants such as *Riccia* and *Lemna.* He also used *Myriophyllum* but let it float.

THE FRESHWATER AQUARIUM WITH FISHES

In short, Nathaniel Bagshaw Ward (1791-1868) was an English doctor who popularized a case for growing and transporting plants which was called the Wardian case, the forerunner of the modern aquarium tank. (A much more detailed biography can be found in Klee, 2003.) A case for the development of the freshwater aquarium by Nathaniel Bagshaw Ward (and also for the marine aquarium by Anna Thynne) was made by Ward's son, Stephen H. Ward (Ward, 1859):

"Now, these counterbalancing actions of animal and vegetable life which are ever going on in the world without, and which are among the greatest marvels in the economy of Nature, may be realised most completely in one of these cases. Mr. Ward felt this, and accordingly in 1841 established in his largest fern-house, in a capacious earthenware vessel given to him by Mr. Alfred White, an aquarium for fish and plants. In this vessel, which contained twenty gallons of water and which he surrounded with rock-work raised several feet above its margin, he placed gold and silver fish in Company with several aquatic plants, viz. Valisneria spiralis, Pontederia crassipes, Pistia stratiotes, and Papyrus elegans.

Figure 2: Nathaniel Bagshaw Ward (1791-1868)

In this miniature lake, the water of which was never changed, but kept in a constantly pure state by the action of the associated plants, the animals lived in a healthy condition for many years. This aquarium or vivarium soon gave the hint to Mr. Bowerbank who procured a large glass-jar, in which he placed stickle-backs, minnows, and snails, with plants of *Valisneria*, and covered in the jar with a piece of glass. Mr. Mitchell of the Zoological Society states that the jar just noticed, gave him the suggestion for the interesting vivaria at the Gardens. Aquaria in open bottles would seem to have been ornaments of the philosopher's study nearly a hundred years ago, as a coloured illustration in a work by Leder-müller, published in 1763 will prove. All that Mr. Ward claims credit for, is the having introduced them into his closed cases, and depended for success entirely upon the counterbalancing actions of animal and vegetable life."

The problem here is that Ward did not publish his findings. All of his publications had to do with growing plants in "closely glazed cases," as the expression of the day went; fish were never mentioned, not even in his 1842 book. Although fish were mentioned in his 1852 edition, Warington had published his findings two years previously. I have no doubt that what his son said was true, but publishing priority is a generally accepted and important factor in deciding who gets the credit. After all, if you discover something but don't tell anyone about it, it does no one any good at all.

William Stimson is another one who is credited with the invention of the freshwater aquarium (James, 1858):

In our own country William Stimson, the collector and curator of the aquaria in the Smithsonian Institution at Washington, without any previous knowledge of Dr. Johnson's experiments in England, had, as early as the year 1849, made seven or eight small aquaria, which were perfectly successful; inasmuch as he kept some of them in a healthy condition for several months without change of water. He published no account of his success, not knowing that it was a subject which was just beginning to awaken attention in England, and fated eventually to excite such universal interest. To him may safely be assigned the credit of having made the first systematic attempt at constructing an aquavivarium, although in all the works before us that honor is given to Mr. Robert Warrington, who in 1850 communicated to the Chemical Society of London a paper On the Adjustments of the Relation between the Animal and Vegetable Kingdoms.

The difficulty here is the same as just mentioned for Nathaniel Bagshaw Ward.

The man who did meet the criterion, however, was Robert Warington. Warington (1807-1867), a chemist, started a movement in 1839 to found the Chemical Society of London (from 1848 the Chemical Society) and was elected honorary secretary. He was appointed chemical operator to the Society of Apothecaries, a position which he held to within a year of his death. The primary purpose of the Society was to exercise control over the practice of what we should nowadays recognize as the greater part of the twin professions of medicine and pharmacy, and as such was responsible for the standardization and prevention of adulteration of drugs.

Figure 3: William Stimson (1832-1872).

In 1846 he took part in the formation of the Cavendish Society, of which he was secretary for three years, and from this time onwards he had many engagements as a chemical expert in legal cases. In the year 1844 he began a series of investigations into the adulteration of tea, and gave evidence at the parliamentary inquiry on adulteration in 1855. He was also one of the founders of the Royal College of Chemistry. In 1851 he revised the *Translation of the Pharmacopeia of the Royal College of Physicians* into English, left unfinished by Richard Phillips. In 1854 Warington was appointed chemical referee by four of the metropolitan gas companies, and held this post for seven years. In 1864 he was elected fellow of the Royal Society and the Society's catalogue contains a list of forty-seven papers written by him. In this same year, Warington was also engaged in the construction of the *British Pharmacopeia.*

In 1849 he began his investigations on aquaria and the means necessary to prevent the water therein from becoming stagnant. His position in the Society of Apothecaries was a full time occupation and Warington's interest in the aquarium perforce had to be an avocation. He wrote several papers (his work actually was the origin of our modern aquaria) and in 1857 delivered a lecture at the Royal Institution on this subject.

Robert Warington is generally acknowledged as being the first to maintain a balanced freshwater aquarium and the following is the article that establishes the claim (Warington, 1850):

Observations on the adjustment of the relations between the Animal and Vegetable Kingdoms, by which the vital functions of both are permanently maintained.—
This communication will consist of a detail of an experimental investigation, which has been carried on for nearly the last twelve months, and which appears to illustrate, in a marked degree, that beautiful and wonderful provision which we see everywhere displayed throughout the animal and vegetable kingdoms, whereby their continued existence and stability are so admirably sustained, and by which they are made mutually to subserve, each for the other's nutriment, and even for its indispensable wants and vital existence. The experiment has reference to the healthy life of fish pre-served in a limited and confined portion of water. It was commenced in May, 1849, and the subjects chosen were two small gold-fish. These were placed in a large glass receiver of about twelve gallons capacity, having a cover of thin muslin stretched over a stout copper wire, bent into a circle, placed over its mouth, so as to exclude, as much as possible, the sooty dust of the London atmosphere, without, at the same time, impeding the free passage of the atmosphere air.

This receiver was about half filled with ordinary spring water, and supplied at the bottom with sand and mud, to-gether with loose stones of larger size of limestone tufa, from the neighbourhood of Matlock, and sandstone; these were arranged so that the fish could get below them, if they wished so to do. At the same time that the fish were placed in this miniature pond, if I may so term it, a small plant of the Vallisneria spiralis was introduced, its roots being inserted in the mud and sand, and covered by one of the loose stones, so as to retain the plant in

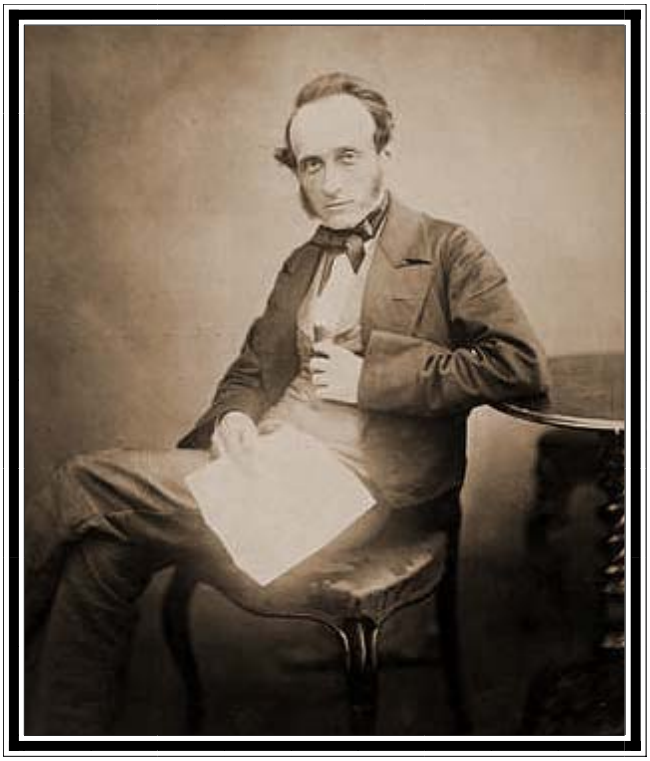


Figure 4: Robert Warington (1807-1867)

its position. The Valisneria spiralis is one of those delicate aquatic plants generally selected by the microscopist for the exhibition of the circula-tion of the sap in plants. It throws out an abundance of long, wiry, strap-like leaves, of about a quarter of an inch in breadth, and from one to three feet in length; these leaves, when the sun shines on them, evolve a continued stream of oxygen gas, which rises in a current of minute bubbles, particularly from any part of the leaf which may have received an injury.

The materials being thus arranged, all appeared to go on well for a short time, until circumstances occurred which indicated that another and very material agent was required to perfect the adjustment, and which, from my not having thought of it at the time of commencing the experiment, had not been provided against. The circumstances I allude to arose from the internal decay of the leaves of the Vallisneria, which became yellow from having lost their vitality, and began to decompose; this, by accumulation, rendered the water turbid, and caused the growth of mucus, or green, slimy matter on the surface of the water, and on the sides of the receiver. If this had been allowed to increase, I conceive that the healthy life of the fish must have suffered, and probably their vital functions have been destroyed. The removal of these decaying leaves from the water, therefore, became a point of permanent importance to the success of the experiment. To effect this, I had recourse to a very useful little scavenger, whose beneficial functions have been too much overlooked in the economy of animal life,—I mean the water-snail, whose natural food is the very green, slimy growth, or mucus and decaying vegetable matter, which threatened to destroy the object which was wished to be obtained. Five or six of these creatures— the Limnaea stagnalis—were consequently introduced, and, by their continued and rapid locomotion and extraordinary voracity, soon removed the cause of interference, and restored the whole to a healthy state, thus perfecting the balance between the animal and vegetable inhabitants, and enabling both to perform their vital functions with health and energy.

So luxuriant was the growth of the Vallisneria under these circumstances, that, by the autumn, the one solitary plant that had been originally in-troduced, had thrown out myriads of off-shoots and suckers, thus multiplying to the extent of upwards of thirty fine, strong plants; and these threw up their long, spiral, flowering stems in all directions, so that, at one time, more than forty blossoms were counted lying on the surface of the water. The fish have been lively, bright in colour, and appear very healthy, and the snails also—judging from the enormous quantity of gelatinous masses of eggs which they have deposited on all parts of the receiver, as well as on the fragments of stone—appear to thrive wonderfully, and, besides their functions in sustaining the perfect adjustment of the series, afford a large quantity of food to the fish in the form of the young snails, which are devoured as soon as they exhibit signs of vitality and locomotion, and before the shell has become hardened. Thus we have an admirable balance sustained between the animal and vegetable kingdoms, and that in a liquid element.

The fish, in its respiration, consumes the oxygen held in solution by the water as atmospheric air; furnishes carbonic acid; feeds on the insects and young snails; and excretes material well adapted as a rich food to the plant, and well fitted for its luxuriant growth. The plant, by its respiration, consumes the carbonic acid produced by the fish, appropriating the carbon to the construction of its tissues and fibre, and liberates the oxygen in its gaseous state to sustain the healthy functions of the animal life, at the same time that it feeds on the rejected matter, which has fulfilled its purposes in the nourishment of

the fish and snail, and preserves the water constantly in a clear and healthy condition, —while the slimy snail, finding its proper nutriment in the decomposing vegetable matter and minute confervoid growth, prevents their accumulation by removing them from the field, and, by its vital powers, converts what would otherwise act as poison, into a rich and fruitful nutriment, again to constitute a pabulum for the vegetable growth, while it also acts the important part of a purveyor to its finny neighbours.— Robert Warinqton.

The paper was subsequently published in the *The Zoologist* (Vol. 8, pp. 2868-2870, 1850), the *Quarterly Journal of the Chemical Society of London* (Vol. 3, pp. 52-54, 1851), and also in the *Literary Gazette*, *Gardeners Chronicle*, and *Bicks Floristry*. Talk about literary overkill! In some of these papers the following addendum appeared: **Since the reading of this paper, twenty-eight strong plants of Vallisneria have been weeded out of the glass receiver as being more than sufficient for the purpose required. — R.W.**

Warrington also added additional material in the *The Garden Companion, and Florists' Guide* a few years later that showed he was actively pursuing an interest in the marine aquarium as well (Warington, 1852):

At present I am attempting the same kind of arrangement with a confined portion of sea water, employing some of the green sea weeds as the vegetable members of the circle, and the common winkle or whelk to represent the water snails.

In addition to technical journals, Warington published his material in many of the popular periodicals of the day, especially those involved in gardening. However, when pressed to give to the world a little manual of instructions for amateurs, he always stated as a reason for non-compliance with the request, that the book market was overcrowded already with the **"worthless compilations of many scribblers on the subject."**

THE MARINE AQUARUM SANS FISHES

Although there was really never any disagreement that Warington was the first with regard to freshwater, the marine aquarium is quite a different case. Ward's name is also mentioned in this case: "As early as June, 1849, Mr. Ward stated, at a meeting of the British Association at Oxford, that he had succeeded, not only in growing sea-weeds in sea-water, but in sea-water artificially made. This must certainly be regarded as the first stop towards realizing the marine Aquavivarium. [Lankester, 1856, p. 10-11]." However, priority is established only by being published.

Another contender for the title of inventor of the marine aquarium is Félix Dujardin (1802-1860), a French biologist born in Tours. He is mostly remembered for his research on protozoans and other invertebrates. In 1840 he was appointed professor of geology and mineralogy at the University of Toulouse, and during the following year was a professor of zoology and botany at Rennes. Later in his career he became a member of the French Académie des sciences. Concerning his educational background, Dujardin was largely self-taught.

His studies of the microscopic animal life frequently found in decaying organic materials led him in 1834

Figure 5: Edwin Lankester (1814-1874)

to propose a new group of one-celled animals that he called Rhizopoda. He named the seemingly formless life substance that oozed outward through openings in certain shells *sarcode*; later it became known as protoplasm. This work led him in 1835 to argue against Christian Gottfried Ehrenberg's theory that microscopic organisms have the same organs as higher animals. Dujardin also studied jellyfish, corals, and sea stars; his study of flatworms laid the foundation for the later development of the study of parasites and parasitism.

In an article on the l'Aquarium du Jardin d'Acclimatation, the director, Etienne Rufz de Lavison, had this to say (Rufz de Lavison, 1863):

M. de Quatrefages m'a fait observer que j'avais fait tort à un savant français, Dujardin, à qui doit être rapportée l'application première du principe fondamental des aquariums; je reproduis textuellement la note de M. de Quatrefages:

Dès 1838, M. Dujardin faisait des voyages sur nos côtes dans l'intérêt de ses éludes zo-

Figure 6: Félix Dujardin (1802-1860)

ologiques. Il rapportait tous les ans à Paris de nombreux flacons contenant des animaux vivant dans l'eau de la mer, et pour entretenir la pureté de cette eau, il plaçait dans chaque flacon quelques frondes d'Ulva lactuca. Nommé professeur à Toulouse, il y transporta son musée ou son aquarium, qui s'accrut de nombreux flacons rapportés de Cette. Appelé plus tard à la chaire de zoologie de Rennes, il se fit suivre de sa collection, qui s'accrut encore d'une foule d'espèces recueillies sur les côtes de la Bretagne. C'est dans un de ces flacons qu'un des premiers, il constata l'organisation des Méduses. J'ai eu le plaisir d'observer moi-même chez mon ancien collègue une de ces Méduses développées en captivité.

The Jean Louis Armand de Quatrefages de Bréau (1810-1892) mentioned above was a well-known French naturalist. My translation is as follows:

M. de Quatrefages pointed out that I had wronged a French scientist, Dujardin, who must be credited with the first discovery of the fundamental principle of the aquarium; I reproduce verbatim, M. de Quatrefages's note:

'In 1838, Mr. Dujardin was traveling on our shores in the interest of his zoological studies. He brought back many jars of marine animals to Paris every year, and to maintain the purity of the water, he placed in each jar a few fronds of *Ulva lactuca*. Appointed professor at Toulouse, he moved his museum or aquarium, and his **collection grew. Later called to the chair of zoology at Rennes, his collection followed, which included even a greater variety of species collected on the coast of Brittany. Here, in one of these jars, is where he established his first collection of jellyfish. I had the pleasure of personally watching my former colleague growing one of these jellyfish in captivity.'**

The problem here - once again - is in priority of publication.

Anna Thynne (1806-1866) is frequently cited as the inventor of the marine aquarium. She was the wife of the Reverend Lord John Thynne, sub-dean of Westminster Abby and spent many years in the respecta-

ble surroundings of her London drawing room, studying the intricate forms and intimate sex lives of stony corals called "madrepores." Initially, she had supplies of seawater brought from the coast, which she - and later her maid - aerated by hand, pouring it repeatedly between vessels to stave off fouling of the water. In 1849, she tentatively tried adding some seaweed to her tanks, expecting them to help enrich the water with oxygen much like the captive atmosphere inside Nathaniel Ward's fern cases. In doing so, Thynne kept her corals alive for an unprecedented three years, along with clusters of other marine animals and plants.

In addition to what he had to say about his father and the freshwater aquarium, Stephen Ward (*loc. cit*) also had this to say about Anna Thynne and the marine aquarium:

The individual to whom is due the merit of having introduced marine vivaria into London is Mrs. Thynne. Having procured some living madrepores when at Torquay in the autumn of 1846, she placed them in some sea-water in a bottle covered with a bladder, and brought them safely to town. They were then transferred to two glass bowls, the sea-water being kept aerated by being daily poured backwards and forwards, and being, moreover, periodically renewed by a fresh supply from the coast. In the spring of 1847, Mrs. Thynne sent for some pieces of rock, shells, &c. to which living sea-weeds were attached, and subsequently depended upon the action of these for the purification of the water.

In addition to Stephen Ward, Thynne's biographer, Rebecca Stott (2003), also credits her as being the inventor of the marine aquarium. In addition to Dayell's experiments, Stott mentions those of Robert Grant (1793-1874), one of the foremost biologists of the early 19th century, Edward Forbes (1815-1854), a distinguished British naturalist and the young Charles Darwin (who had been a student of Grant's), all of whom had kept sundry marine creatures alive for several days at a time in the 1820s and 30s. However, as Stott points out:

But such experiments… depended upon either constant changing of the seawater or a tiring process of aeration. For these students of zoology the Firth of Förth was never more than half an hour's walk away. She (Thynne) was in London and, even with her riches and domestic servants, shipping seawater into the capital seemed a frivolous waste of money. So she had been forced to discover other means of establishing vitality in her glass tanks.

However, Stott overlooks the fact that Thynne did aerate her water. From Thynne's own account (Thynne, 1859):

"My next consideration was as to the possibility of keeping them alive, and this I accomplished in the following manner. I placed them in glass bowls, holding about three pints of water each, which I changed every other day; and as I could not have a continual supply sufficient for such a demand, I thought of having it aerated by pouring it backwards and forwards through a small watering-pot, before an open window, for half or three-quarters of an hour, between each time of using it. This was doubtless a fatiguing process; but I had a little maid, who, besides being anxious to oblige me, thought it rather an amusement; so that as the service was cheerfully performed, it was also done well; and the exer-

Figure 7: Anna Thynne (1806-1866) with her two children, Selina and Emily

Figure 8: George Johnston (1798-1855)

tion was diminished by her standing for only ten minutes or a quarter of an hour at one time.

From this time I regularly placed sea-weed in my glass bowls; but, as I was afraid I might not keep the exact balance required, I still had the water refreshed by aeration.

Stott also apparently was unfamiliar with the works of George Johnston (1798-1855), a Scottish medical doctor and naturalist. Amid his many arduous professional duties, he cultivated natural history with an enthusiasm and a success which rendered the place of his residence "one of the most classic localities in Great Britain." Apart from numerous papers contributed to the *Edinburgh Philosophical Journal* and other scientific periodicals, he published two works of first-rate importance: "History of British Zoophytes" (2d ed., 2 vols. 8vo, London, 1847) and "History of British Sponges and Lithophytes" (8vo, 1842). In 1850 his "Introduction to Conchology" appeared with an abundance of illustrations and later he published "The Natural History of the Eastern Borders" (vol. I., "Botany," 8vo, 1854). He was engaged at the time of his death upon a complete work on British annelids. He is considered one of the most accomplished contributors to the literature of natural history, and was one of the founders of the Ray society.

The following is taken from his "History of British Sponges and Lithophytes" (Johnston, 1842):

Was there a need of adding any additional proof of the vegetability of the Corallines, an experiment now in progress before me would seem to supply it. It is now eight weeks ago since I placed in a small glass jar, containing about six ounces of pure sea-water, a tuft of the living *Corallina officinalis*, to which were attached two or three minute confervae, and the very young frond of a green Ulva, while numerous Rissoae, several little mussels and annelids, and a star-fish, were crawling amid the branches. The jar was placed on a table, and was seldom disturbed, though occasionally looked at; and at the end of four weeks, the water was found to be still pure, the mollusea and other animals all alive and active, the confervae had grown perceptibly, and the coralline itself had thrown out some new shoots, and several additional articulations. Eight weeks have now elapsed since the experiment was begun,—the water has remained unchanged,—yet the coralline is growing, and apparently has lost none of its vitality, but the animals have sensibly decreased in numbers, though many of them continue to be active, and show no dislike to their situation. What can be more conclusive? I need not say that if any animal, or even a sponge, had been so confined, the water would long before this time have been deprived of its oxygen, would have become corrupt and ammoniacal, and poisonous to the life of every living thing.

It is interesting to note that Johnston used no aeration nor did he change the water during this time. One may argue that Johnston's experiment lasted only eight weeks whereas Thynne kept her madrepores for three years, but it is irrelevant here since precedence in publication once again is the deciding factor. Johnston, therefore, was the originator of the marine aquarium sans fishes. Note, however, that being first doesn't always mean being best or the

most important. Johnston's material was a short footnote consisting of 247 words; Thynne's was an article consisting of 12 pages. Her account was much more detailed and added significantly more to our knowledge of the marine aquarium of the times.

THE DRED STOTT DERISION

Stott writes: **Other individuals, however, made bolder claims for their work. And indeed Anna's description of her visitors as 'professed naturalists' may reveal a degree of suspicion or resentment on her part about their ethics. In a culture in which many naturalists saw a distinction between the-orists and mere collectors or experimenters, her visitors would have not have had any conscience about using her experiment for their own profits or to provide evidence for their own theories.**

I can certainly appreciate Thynne's situation and what she and other women of the time had to endure. Another woman for whom I have the greatest respect was Helen Beatrice Potter, best known for her children's books that featured animal characters such as Peter Rabbit. At the time, the only way to record microscopic images was by painting them, so Potter made numerous drawings of fungi, and as the result of her observations, she was widely respected throughout England as an expert mycologist. Potter was one of the first to suggest that lichens were a symbiotic relationship between fungi and algae. She studied the life cycles of fungi extensively and in 1897, her paper on the germination of spores was presented to the Linnean Society by her uncle as women were then barred from attending meetings. Similarly, the Royal Society also refused to publish at least one of her technical papers. In 1997, 100 years after she submitted her paper, the Linnean Society held a meeting in her honor and issued a posthumous official apology to Potter for the way she had been treated.

Two individuals Stott singles out as possible visitors with such ulterior motives are Robert Warington (which she misspells as "Warrington") and Philip Henry Gosse. In point of fact, however, there is no evidence whatsoever that either of these gentlemen ever visited Anna Thynne. She is particularly hard on the first:

The chemical operator of the Society of Apothecaries, Warrington began a series of experiments with the chem-ical properties of aquatic vitality in 1849. Why 1849? Was he one of the visitors to Anna's Westminster Abbey drawing-room that spring? Was this visit the motivation for his subsequent experiments?

This is, in my opinion, tantamount to a character assassination of this most distinguished gentleman. In her quest to "prove" that a woman was the inventor of the marine aquarium, some men got trampled.

THE MARINE AQUARUM WITH FISHES

In spite of Stott's attempt to show that it was Thynne rather than Warington who should get the credit for the first marine aquarium, Warington gets the credit here, also. The following is the paper that did the job (Warington, 1853):

In the published notices of my experiments of 1849, to maintain the balance between the animal and vegetable organisms in a confined and limited portion of water, the fact was demonstrated, that, in consequence of the natural decay of the vegetation, its subsequent decomposition and the mucus-growth to which it gave rise, this balance could only be sustained for a very short period, but, if another member were introduced, which would feed upon the decaying vegetation and thus prevent the accumu-

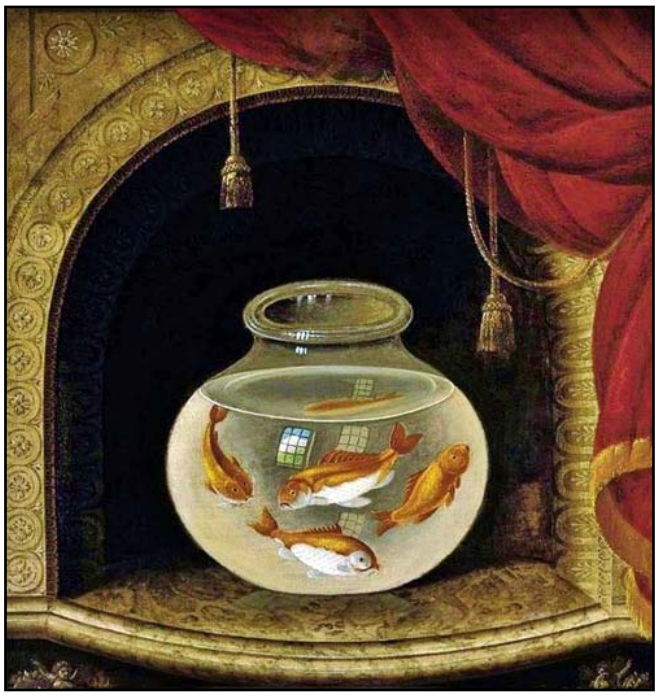
lation of these destructive products—a function most admirably performed by the various species of water-snail—such balance was capable of being continuously maintained without the slightest difficulty and I may add, that the experimental proof of this has now been carried on, in a small tank in the heart of London, for the last four years and a half, without any change or disturbance of the water; the loss which takes place by evaporation being made up with rain or distilled water, so as to avoid any great increase of the mineral ingredients originally present. It follows then, as a natural deduction, from the successful demonstration of these premises, that the same balance should be capable of being established, under analogous circumstances, in sea water. And in a paper published in January 1852 (*Gardeners' Botanical Magazine and Garden Companion*, Jan. 1852) I stated that I was, at that time, attempting the same kind of arrangement with a confined portion of sea water, employing some of the green sea-weeds for the vegetable member of the circle, and the common periwinkle as the representative of the water-snail.'

The sea water with which the experiments I am about to detail were conducted, was obtained through the medium of one of the oyster-boats at the Billingsgate fish-market, and was taken from the middle of the English Channel.

My first object was to ascertain the kind of sea-weed best fitted, under ordinary circumstances, for keeping the water clear and sweet, and in a sufficiently oxygenated state to sustain ani-mal life. And here opinions were at variance, for one naturalist friend whom I consulted, advised me to employ the Rhodosperms; another stated that it was impossible to make the red weeds answer the purpose, as he had tried them, and strongly recom-mended the olive or brown-coloured Algae; while, again, others thought that I should be more successful with those which had in theory first suggested themselves to my own mind, namely the Chlorosperms. After making numerous unsuccessful expe-riments with both the brown and the red varieties of Algae, I was fully convinced that, under ordinary circumstances, the green weeds were the best adapted for the purpose.

This point having been practically ascertained, and some good pieces of the *Enteromorpha* and *Ulva latissima* in a healthy state, attached to nodules of flint or chalk, having been procured from the shore near Broadstairs, several living animal subjects were introduced together with the periwinkle. Everything progressed satisfactorily, and these all continued in a healthy and lively condition.

My first trials were conducted in one of the small tanks which had been used for fresh water; but as it was necessary, during the unsuccessful experiments with the brown and red seaweeds, to agitate and aerate the water, which had been rendered foul from the quantity of mucus or gelatinous matter generated during the decay of their fronds, until the whole had become oxidized, and the water rendered clear and fitted for another experiment, it was, therefore, for greater convenience, removed into a shallow earthen pan and covered with a large glass shade to protect the surface of the water, as much as possible, from the dust and soot of the London atmosphere, and at the same time impede the evaporation. In this vessel then I had succeeded perfectly in keeping a large number



of beautiful living specimens in a healthy condition up to the close of 1852. I therefore gave instructions for the making of a small tank as a more permanent reservoir, and one more adapted for carrying on my observations and investigations on the economy and habits of the inhabitants.

From the experience I had obtained in my experiments with the freshwater tank, I was induced to modify slightly the construction of this vessel; thus, at the back, or part towards the light, the framing was filled with slate in the same way as the ends and bottom; for I had found that the glass, originally employed, very soon became covered with a confervoid growth which had an unpleasing appearance to the eye, and in consequence of which I had been obliged to paint the glass on the exterior to prevent this growth from increasing to too great an extent. It was also an unnatural mode of illumination, as all the light should pass through the surface of the water. The front towards the room and the observer was constructed of plate-glass, the whole being set in a stout framework of zinc, and cemented with what is known under the name of Scott's cement, and which I have found to answer for the purpose most admi-rably. Within this tank were arranged several large pieces of rock-work, thrown into an arched form, and other fragments were cemented in places against the slate at the back and ends, and at parts along the water-line, so that the creatures could hide themselves at pleasure; a short beach of pebbles was also constructed in order that shallow water could be resorted to if desired. The whole tank was covered with a light glass shade to keep out the dust and retard evaporation.

With the sea water obtained in January 1852, I have been working without cessation up to the present time, agitating and aerating when it became foul during the unsuccessful experiments on the sea-weeds, but since then it has been rarely ever disturbed; the loss which takes place from evaporation being made up, as before stated, with rain or distilled water.

For a considerable period, after commencing these experiments, I was much troubled to obtain living subjects in a healthy condition, but having alluded to this, and the success of my investigations, in a short notice appended to a paper published in the 'Annals of Natural History' for October 1852, my friend Mr. P. H. Gosse, who was then sojourning at Ilfracombe for his health, offered in the kindest manner possible to supply me with materials, and from that period he has always most heartily responded to my wants. It must not be imagined for a moment that the beautiful creatures I have thus received have been all preserved alive or always quite healthy. In experimental investi-gations this would be unreasonable to expect, as the very fact of experimenting implies a disturbance of the then state of things. Besides which, from want of a sufficient knowledge of natural history, from want of forethought and experience and other causes, I have lost many very fine specimens; and as the detail of these losses may prevent the occurrence of the like annoyances to others, I shall venture to occupy your time for a short period with their history.

My greatest loss arose from too great an anxiety to transfer the collection I had preserved in a healthy condition to the end of December 1852 into the new tank. As soon as it arrived from the maker's I lost no time in introducing my numerous family to their new abode, and dearly I paid for my precipitancy, for on the next morning I found many of my most beautiful spe-cimens dead; thus I lost two fine Holothurias (*H. Pentactes),* a small freckled Goby (*Gobius minutus*), a beautiful little Pipe-fish (*Syngnathus lumbriciformis*), and several others, and on opening the door of the case the cause of this mortality was at once evident,—an iridescent film of oily matter

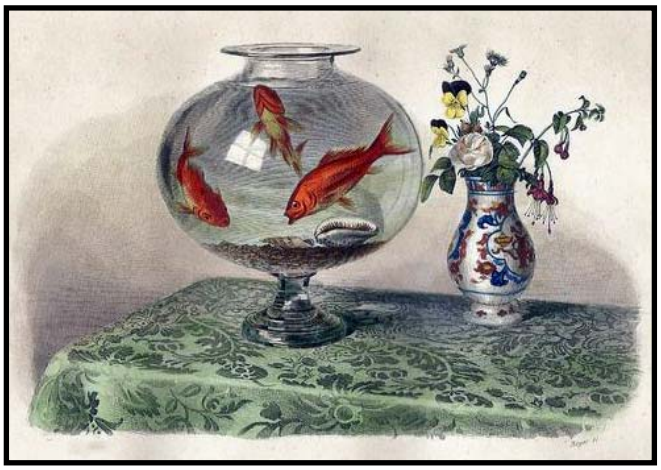
was floating on the surface of the water, arising from the paint with which the angular joints and edges of the small tank had been coloured not having become sufficiently hardened.

Another source of loss arises from the several creatures attacking and devouring each other, and it therefore becomes a point of great importance—and highly necessary to be carefully ob-served, where their preservation is an object—to ascertain what varieties may be safely associated in the same tank; as, for in-stance, I have found that the Shrimps and Prawns attack, and very soon devour, all the larger varieties of Corallines and Polyps, Sabellae, Serpulae, Rock-borers, Cirrhipeds, some of the Annelids, many Bivalve and Univalve Mollusks that are unprotected by an operculum, or have no power of closing their valves. The instances which have come under my own immediate observation have been the destruction of the *Pholas dactylus, Saxicava rugosa, Cypraea Europaea,* and several specimens of Sabellae, Serpulae, Coryne sessilis and many others.

The common Crab (*Cancer Maenas)* is likewise a most destructive agent; and the tribe of rock-fish, the Blennies, Gobies, &c. are also most voracious, devouring all the varieties of Cirrhipeds, Corallines, Polyps, Annelids, &c.; they will also attack the shrimps and prawns, and even seize upon the horns of the periwinkle, which they bite. If the mollusks do not keep a very firm hold of the rock or tank sides, they are rapidly turned over by these fish on their backs and lie helplessly exposed to their attacks. It is doubtless their seeking food of this kind which causes these little fish to be so generally found in the shallow rock-pools of the coast. In consequence of these ravenous propensities I have been obliged to establish several small tanks and imitation rock-pools, so as to separate these various depredators from each other : thus in one I have varieties of *Actiniae,* Shrimps, Nudibranchs, Holothurias, and some Annelids; in a second the rock-fish, as the Blennies, Gobies, Cottus, with Crabs and Actinia; in a third Corallines, Annelids, Polyps, Rock-borers, Sabellae, Serpulse, Holothurias, and *Actiniae.*

Another curious instance of loss I may detail which has quite recently occurred, and which may prove interesting; it was in a small rock-pool containing Blennies, Gobies, Crabs, &c. I had procured two live oysters for the purpose of feeding my numerous small fry in these vivaria, and one of these having proved ample for the purpose of one meal, the other was placed on the sandy bottom; on the second day after this the oyster was observed to have opened the valves of hid shell to a great extent, which were afterwards seen closed, but a small *Gobius niger,* in-habiting the pool, could nowhere be seen. The day after this the oyster was opened for the general feeding, when, lo! within the shell was found the unfortunate *Gobius*, quite dead. Whether this little gentleman had been attracted within the trap by curiosity or the ciliary motion of the oyster, it is impossible with certainty to say; but that he must have seized on some sensitive part of the oyster is more than probable, so as to have caused such a rapid closing of the valves of the shell as could entrap so active a burglar.

Another important point is the gravity of the sea water; this should be very carefully regulated, for it must be borne in mind that many of the marine creatures are supplied by a per-meation of water through their tissues or over their delicate and beautiful organs. The specific gravity should not rise above 1.026 at 60° Fahr., and a small hydrometer should be at short periods introduced to ascertain that this point is not exceeded, particularly during the hot months of summer. The reduction to this gravity can be readily effected by the addition of rain or distilled water. Many of the



creatures will of themselves afford indications of this increase of density; some of the *Actiniae* will remain closed and become coated with a white slimy covering within which they remain for a length of time, and if the specific gravity of the water be lowered this is very soon ruptured by their expansion, thrown off, and the tentacula become soon extended.

"All putrescent matter or excess of food or rejecta of the *Actiniae* should be carefully removed from the water, as the noxious gaseous compounds generated by the decay of such matters appear to diffuse themselves rapidly through the water, act as a virulent poison, and speedily destroy the vitality of the occupants. Thus many beautiful subjects were lost in a few hours from the introduction, into a small glass jar, of a large Pecten shell, encrusted with corallines, which had become loaded with putrescent matter by partial submersion in a foul muddy bottom.

"Great care should also be taken in moving the *Actiniae* that the foot or sucking disc with which it attaches itself to the rocks, stones, or mud, be not injured, as, when this occurs, they rarely survive, but roll about without attaching themselves, and gradually waste away and die.

"With these exceptions then, everything has gone on very satisfactorily, care being always taken not to overload the water with too large a proportion of animal life for the vegetation to balance, as, whenever this has been inadvertently attempted, the water has soon become foul, and the whole contents of the tank, both animal and vegetable, have rapidly suffered, and it has required some time before the water could be restored to its former healthy condition.

"In one of the numbers of the 'Zoologist' of last year, I stated that besides the *Ulvae, Enteromorpha* and *Cladophora,* I had found the *Zostera marina* a very useful plant for oxygenating the sea water; but this observation has reference only to the case of a tank supplied with a ground where its roots will find a sufficiency of food for its growth, as in a clear shingle or sand it soon de-cays ; and it should be associated with such animals as delight in a ground of this nature, as many of the Annelids, Crabs, burrowing Shrimps, &c. There are several interesting observations which have been made from time to time connected with this subject, which I hope to lay before the natural-history world as soon as I can find leisure time for the purpose.

"Since the reading of this paper at Hull I have received a Blenny of larger size, being about inches in length, and although it has become so tame that it will allow itself to be touched by the hand and takes its food from the fingers, yet its destructive propensities are so great, that it very soon killed four small Crabs; and to save three others, of rather a larger size, I have been obliged to remove the Blenny to a rock-pool in asso-ciation with his own species and a few *Actiniae.* The only refuge the poor Crabs had was to bury themselves in the sand, and whenever they attempted to move out of their refuge they were immediately pounced upon and only escaped by burrowing rapidly again."

It was a squeaker, however, since Gosse lost the competition by only a few months. The following is Gosse's book, "A Naturalist's Rambles on the Devonshire Coast" (Gosse, 1853):

"It is a curious circumstance that experiments exactly parallel to these, founded on the same

Figure 9: Philip Henry Gosse (1810-1888)

principles, have been simultaneously prosecuted with the same results by another gentleman, whose name is well known in the scientific world. Mr. Robert Warington of Apothecaries' Hall has now (Dec. 1852) at his residence in London a marine aquarium, with living Algae and Sea-anemones in a healthy condition. I find, on comparing notes, that Mr. Warington has precedence of me in instituting these experiments; but the particulars that I have above detailed of my own success were fully recorded before I had the slightest knowledge that the thought of such a project had ever crossed the mind of any person but myself."

Although briefly acknowledging Warington's experiments and priority, Gosse described in great detail his own marine aquarium experiments, even though they were unsuccessful and Warington's were. As time went on, Gosse believed that he should have been credited with the invention of the marine aquarium (Gosse, Edmund, 1890):

There was no sort of rivalry between these earnest and amiable investigators, but a little later on, when the aquarium had become a fashionable thing, Philip Gosse was accustomed to say that if it was needful to dispute about an invention which was virtually simultaneous, it might be said that Warington had invented the vivarium (*AJK: i.e., the freshwater aquarium*) and he the marine aquarium."

Nonetheless, the following, taken from Humphreys, 1857: pp. 27-28, pretty sums up who gets the credit for the "invention" of both the freshwater and marine aquarium:
"These successful experiments, both in freshwater and marine Aquaria, assign to Mr. Warington, beyond dispute, the credit of being the originator, or inventor, if the term may be so used, of these charming additions to our conservatories, corridors, and even living-rooms, to which they are certainly a much more attractive and instructive addition than the old globe of blank water, with its pair of goldfish swimming around and round in ceaseless gyrations, tiresome to behold, in the vain hope of escaping from their glaring and inconvenient prison; in which they would inevitably have perished very shortly but for the daily changes of water, which, previous to our knowledge of air-emitting plants and their use, was absolutely necessary."

MUSINGS ON "WHO INVENTED THE AQUARIUM?

Before one attempts to pin down a "first," one must devise a set of criteria. In Great Britain in the early 1850's the de facto definition of an aquarium in the sense of the whole concept, not just the container, was a vessel containing water and plants, plus aquatic animals (excluding, of course, mammals and water fowl) in which the water was not aerated nor changed. Note that fish were not necessarily included. Implicit in this definition was that basis for the aquarium be the relationship between plants and the animals, i.e., that plants absorbed the carbon dioxide that the aquatic animals generated whilst the animals absorbed the oxygen that the plants generated.

Another part of the requirement for "first" was priority of publication, a criterion required in the 1800's and also present-day. "Previous to the year 1850, many experiments had been made in London of keeping sticklebacks, gold fish, and other animals in jars containing Vallisneria. I find, from some of my

own notes, that I had sticklebacks in a jar containing Vallisneria and Water Starwort, in 1849 [Lankester, p. 11, 1856];" However, none of these would vie for "first" because they were not published.

To simplify the analysis, I have considered four categories for "firsts" in this monograph: freshwater aquarium sans fishes, freshwater aquarium with fishes, marine aquarium without fishes **and marine** aquarium with fishes. Using these criteria, Charles des Moulins - a man mostly overlooked in aquarium hobby history - comes in first (1830) for the freshwater aquarium sans fishes, Warington (1850) for the freshwater aquarium with fishes, Johnston (1842) for the marine aquarium sans fishes and Warington for the marine aquarium with fishes.

If, however, we add another criterion, that of the impact on the aquarium hobby in the Nineteenth Century, then Warington remains in the first place for the freshwater aquarium, with Gosse and Warington in a close tie for the marine aquarium title. It is difficult to break this tie, since Warington published first whereas Gosse had the greater impact.

In today's hobby, neither plants, aeration nor water changes are a part of our definition of the aquarium. Plastic plants abound, water is frequently changed and aeration (either directly or through filtration) is almost a given. The only criterion is that there is at least one fish in the container; thus a Betta in a jar qualifies as an aquarium today. Even in Great Britain in the 1870's the aeration criterion was modified or removed. Lloyd (1872), for example, relaxed the aeration requirement but maintained the necessity for plants: **The water must be kept not only in a pure and respirable condition by its absorption of atmospheric air at its surface, which absorption may or may not be increased by putting the water in motion in any convenient manner, but this purity must be assisted by the presence of vegetation growing in it…** Hughes (1876) relaxed the aeration criterion even more: **The word Aquarium is, therefore, in use popularly as signifying a collection of aquatic animals maintained in health by plants, or by artificial means supplying their place…**"

In 1846, Jean Jacques Marie Cyprien Victor Coste published his paper, "Nidification des épinoches et des épinochettes," i.e., "The nest building of sticklebacks" (Coste, 1846). (Coste, by the way, was never recognized in the literature with a forename, and he never gave the secret away! He was mostly referred to as M. Coste, the French abbreviation for Monsieur; in American publications he was frequently given the initial P, but sometimes B and C.)
Coste (1807-1873) studied medicine at the Faculty of Medicine of Montpellier and, after graduating, he taught anatomy at the Ecole Pratique de Paris from 1836 and embryology at the Collège de France from 1844. He devoted himself to the study of the natural sciences, notably of embryogeny. His work attracted the attention of learned men, and the Academy of Sciences awarded him a gold medal in 1834. He became a member of the Academy in 1851and later was a recipient of the Cross of the Legion of Honor.

During the later years of his life Coste was much occupied with the art of increasing fish populations via artificial insemination. The art of pisciculture, although discovered in Germany in the previous century, was not yet applied. In 1851 Coste designed

Figure 10:
Jean Jacques Marie Cyprien Victor Coste (1807-1873)

and built a model piscine establishment at Huningue that, in two years, supplied 600,000 salmon and trout for the seeding of the Rhone. In 1852, he was appointed by Napoleon III to head a mission to study the production of natural oyster beds and is generally accredited with saving the oyster fisheries of the country. Close to the Emperor and the Empress Eugenie, to whom he was her personal physician, he was appointed by the Emperor in 1862 as Inspector General of the rivers and coast fisheries of France. Using a circular tank a little over 6-1/2 feet in diameter and 13 inches high, Coste placed in it a large number of male and female sticklebacks. The tank contained plants, but were mostly intended as material for the nest-building. Because of its large size and physical configuration, it did not need aeration or a change of water. In this tank Coste observed the fish court, lay eggs, care for and rear their young. Clearly this satisfies the criteria for the first freshwater aquarium with fish.

Other than impact, (Coste's paper had non), what then is the difference between Warington's and Coste's experiments with regard to who is first? The difference is in intent. Coste was not concerned with showing that fish can survive without aeration of water changes by utilizing plants, i.e., the "balanced aquarium" principle; he was only interested in describing the breeding behavior of sticklebacks. Technically Coste had the priority, but not the spirit of the criteria. However, using today's relaxed criteria, Coste is inventor of the freshwater aquarium with fishes (and, by the way, because of his paper, the stickleback might therefore be considered as the first fish - excepting perhaps the goldfish - bred in an aquarium).

We are all familiar with the following discourse from "Alice in Wonderland":

ALICE: I don't know what you mean by "glory."
HUMPTY: Of course you don't — till I tell you. I meant "there's a nice knock-down argument for you!"
ALICE: But "glory" doesn't mean "a nice knock-down argument."
HUMPTY: When I use a word, it means just what I choose it to mean — neither more nor less.
ALICE: The question is, whether you can make words mean so many different things.
HUMPTY: The question is, "which is to be master" — that's all.

We consider this to be a bit of nonsense and smile, but if Humpty Dumpty had answered, **"…what are your criteria— that's all,"** it would have been regarded as a sage remark, indeed!

THE ARTIFICIAL SEAWATER CONTROVERSY

William H. Brock (Brock, 1991) published a paper involving a controversy over the composition of artificial seawater between two of the best knows aquarists of the day, Robert Warington and Philip H. Gosse (an abridged version can also be found in Klee, 2003).

Gosse had written a paper (Gosse, 1854b) describing his experiments with an artificial seawater formula based on analysis of seawater in the English Channel near Brighton by a chemist in Brighton who sold the salts of evaporated seawater for medicinal use (Schweitzer, 1839). Shortly afterwards, Warington wrote a paper (Warington, 1854a) pointing out a number of errors Gosse had made in converting Schweitzer's formula to his own. Although Brock thought that the differences between Warington's and Gosse's formulae "were not all that significant," I disagree. The table below is a comparison between the two and there are considerable differences.

Gosse admitted the errors but defended his formula, citing the omission of the three components as being unimportant and an attempt to simplify things for the average aquarist, a somewhat puzzling argument since he kept the potassium bromide but omitted the calcium sulfate which was twice as important. His main argument, however, was that it worked, citing his own experiments with his formula and those of William Alford Lloyd (Lloyd, 1855) who also had success with it. However, neither of these gentlemen had ever used fish in their experiments, so although it was certainly a success for the marine aquarium sans fishes, it was not a successful formula for the marine aquarium *in toto*. In discussing the use of Gosse's artificial sea-water, Humphreys [1857: p. 111] stated: "The artificial salt water has been found sufficient for Zoophytes, but not for fish and other of the higher class of marine animals, except for a certain given time."

However, it not the chemical side of this controversy that I wish to explore here, but the basic reason for the dissention between the once amiable friends. The following is Gosse's introduction to his paper (submitted on June 9, 1854):

The inconvenience, delay and expense attendant upon the procuring of sea-water, from the coast or from the ocean, I had long ago felt to be a great difficulty in the way of a general adoption of the Marine Aquarium. Even in London it is an awkward and precarious matter; how much more in inland towns and country places, where it must always prove not only a hindrance, but to the many an insuperable objection. The thought had occurred to me, that, as the constituents of sea-water are known, it might be practicable to manufacture it; since all that seemed necessary was to bring together the salts in proper proportion, and add pure water till the solution was of the proper specific gravity. *Several scientific friends to whom I mentioned my thoughts, expressed their doubts of the possibility of the manufacture; and one or two went so far as to say that it had been tried, but that it had been found not to answer; that though it looked like sea-water, tasted, smelt, like the right thing, yet it would not support animal life.* Still, I could not help saying, with the lawyers, 'If not, why not?' Experientia docet. I determined to try the matter for myself.

I have italicized the part that was the cause of the dissention between Warington and Gosse. There is no doubt that this was included in the introduction to assure readers that he, Gosse, had no assistance from any of the scientific community. This, however, is not true since Gosse visited Warington in 1854 on two occasions at Apothecaries Hall, on January 16th

TABLE I
THE SCHWEITZER, GOSSE AND LAURENS FORMULAS COMPARED
The numbers are lbs./ 100 lbs. of water (= 10 Imperial gallons).

COMPONENT	(1) SCHWEITZER	(2) GOSSE	% INCREASE (1) OVER (2)	(3) LAURENS
Sodium chloride	2.7060	2.1875	24%	2.722
Potassium chloride	0.0766	0.0563	36%	0.001
Magnesium chloride	0.3666	0.2813	30%	0.614
Magnesium bromide	0.0029	-	-	-
Calcium sulphate	0.1407	-	-	0.015
Magnesium sulphate	0.2296	0.1563	47%	0.702
Calcium carbonate	0.0030	-	-	0.009
Magnesium carbonate	-	-	-	0.011

and again on January 21st to discuss, among other things, the feasibility of using artificial seawater. One can imagine Warington's surprise when he read Gosse's introduction. Accordingly, he replied thusly (Warington, 1854a), submitted on November 1, 1854:

In the 'Annals and Magazine of Natural History' for July last, you published a short communication from Mr. Gosse, on the artificial formation of sea water, and having lately had my attention especially directed to this paper by a friend who wished to put the formula given into practice, I was surprised at the difference in the proportions of the ingredients as compared with what I had myself employed in the course of 1853, more par-ticularly from the circumstance, that when Mr. Gosse called upon me in January last, and consulted me on the feasibility of the plan, I told him that there could be no difficulty in the matter, as I had made and had then in use several small quantities artificially produced, and that all that was required was that a good analysis should be taken as the basis for deducing the proportions, and at the same time referred him to the source from which I myself had worked, namely Dr. E. Schweitzer's analysis of the water of the English Channel taken off Brighton. Now, as numerous parties have been inquiring respecting this subject, and the erroneous formula has been copied into other journals, it may prevent much annoyance as well as disappointment if this matter is set right.

Gosse's reply (Gosse, 1854c) submitted on December 20, 1854 was shorter:

If Mr. Warington supposes that I obtained from him one atom of information previously unknown to me, on the subject of making seawater from its constituent salts, he is most thoroughly mistaken. He is no less wrong in saying that I "consulted" him; since I merely mentioned what was on my mind in familiar conversation. With this, however, the public are of course not concerned, and I shall say no more on that head.

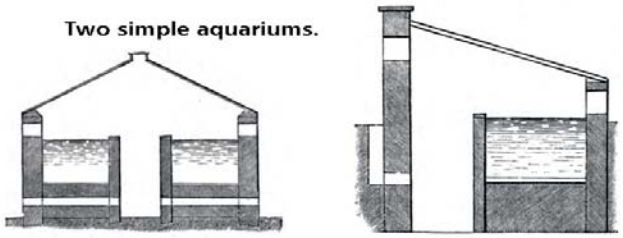
Not all believed him. The following appeared in the *Leisure Hour*, January 25, 1855:

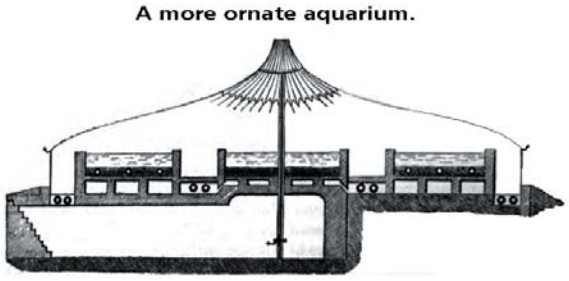
It is now some months ago that Mr. Gosse, the gentleman on whom the care of the marine vivarium belonging to the Zoological Society devolves, and to whom the public are indebted for some most interesting works on natural philosophy, published a formula for the generation of sea-water artificially, and having supplied some marine pets with the liquid, found that they thrived in it well. The analysis of sea-water chosen by Mr. Gosse was that made by Dr. Schweitzer, the formula of which it appears was suggested to that gentleman by Mr. Warington of Apothecaries Hall."

Brock may be putting the cart before the horse when he opines that the reason the relationship between the two men soured was because Warington was jealous of Gosse's success in which he had made the major scientific breakthrough. Since it was Gosse who precipitated the controversy, it was more likely because Gosse was jealous of Warington's standing in the scientific community in spite of his overwhelmingly popular successes with "A Naturalist's Rambles on the Devonshire Coast" and "The Aquarium: an unveiling of the wonders of the deep sea." Perhaps we can agree that both men were to blame.

In any event, Warington and Gosse never communicated again. However, the seawater contro-

versy was never mentioned in Edmund Gosse's biography of his father, so it was apparently not the sort of bitter rife that characterized the famous fossil-finding competition known as the "Bone Wars" between Edward Drinker Cope and Othniel Charles Marsh.





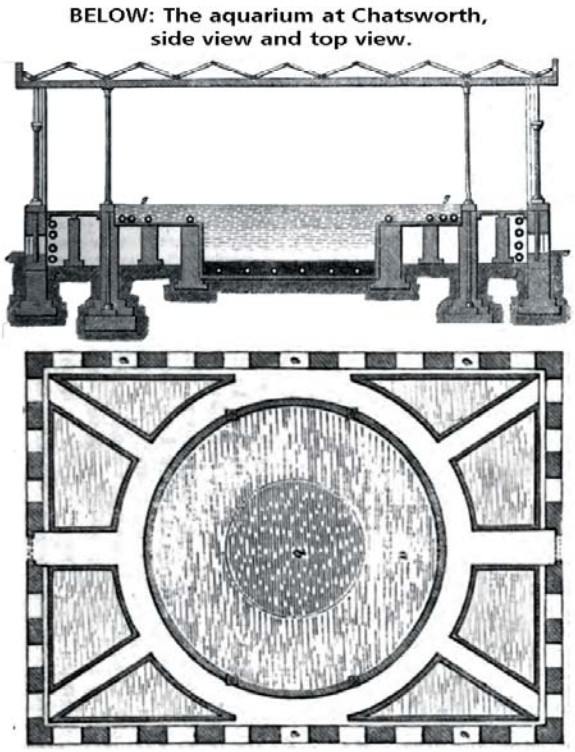


Figure 11: Examples of the gardeners "aquarium."

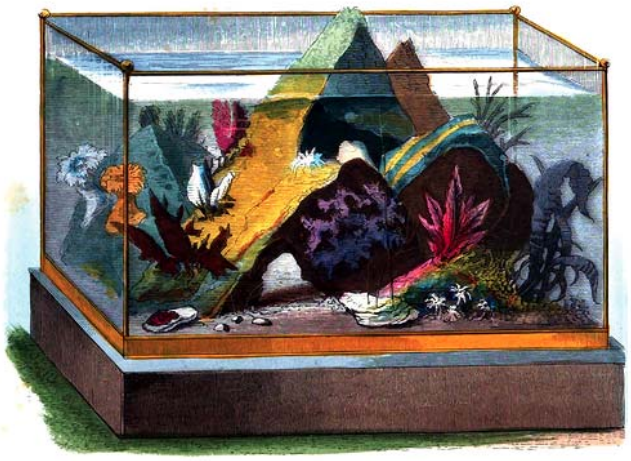
Finally ,it should be noted that Gosse's artificial sea water was not a success: from Hibberd, 1856: "But artificial water is quite unsuited for animal life of any kind, until it has been brought into condition by means of growing weeds for eight or ten days, and for Crustaceans, Starfishes, and Fishes proper, it is not suitable till it has been in use for many months, and even then some species lose their health in it, and at last perish, and from Hughes, 1874: "Much has been said about artificial sea-water, but my experience is not very favourable to it - I found it crude and harsh in its effects on the anemones, they refused to expand, and shrank up and died."

WHO WAS THE FIRST AQUARIST TO USE THE WORD "AQUARIUM"?

"Aquarium" existed in the Vulgar Latin but in Roman times it meant a watering place, in particular a drinking place for cattle. As the world entered into the Nineteenth Century, however, gardeners used the term as a place for growing aquatic plants. In essence they were greenhouses, either stand-alones or attached to a house, containing tanks (gardeners called them "cisterns") that held the water and plants. Some were simple structures but others were exceedingly complex and ornate as shown in Figure 11.

John Claudius Loudon (1783-1843) was born in Lanarkshire, Scotland to a respectable farmer and, as he was growing up, developed a practical knowledge of

Figure 12: John Claudius Loudon (1783-1843)



plants and farming. As a young man, Loudon studied chemistry, botany and agriculture at the University of Edinburgh and in 1815, he was elected a corresponding member of the Royal Swedish Academy of Sciences. Loudon was a prolific horticultural and landscape design writer and his first published work was An Encyclopædia of Gardening (Loudon, 1824), an immediate success. In his book Loudon suggested that fish might be added:

It is almost needless to add, that exotic aquatic fowls and fishes might be kept in such an aquarium, and either of the sea or fresh water rivers, according as salt water or fresh was used.

In a later gardening book (M'Intosh, 1853) the author quotes from the *Liverpool Chronicle* that chronicles the miniaturization and exportation of the aquarium to the home:

Few, perhaps, are aware of the great beauty which the tropical aquatic tribes present under good cultivation. They are not well adapted for small houses, but look best in houses having a vestibule, or circular centre. They may be made in various forms, according to the taste of the proprietor: if in a square or oblong vestibule, the aquarium should be of the same shape; if in a circular house, or part of the house, the form may be varied and much ornamented; a vase-shaped basin, circular cistern, or any other form suitable to the style of the building: a jet-de-eau in the centre is a great improvement. The interior must be of various depths, to suit the plants of various sizes, for which reason steps are usually formed from the circumference to the centre, the water being thus made shallower at the edge, to suit the smaller plants. Upon these steps or shelves pebbles and soil are laid, in which the roots are planted; and gold and silver fishes may be made to add to the interest of this group.

It is odd that M'Intosh made no mention of the "Parlour Aquarium," a term that entered the vocabulary of gardening magazines and other journals the previous year, but once again there is the suggestion that gardeners might combine fishes with the plants in their aquaria.

The earliest reference I have found to the word aquarium in the sense of a fish tank is in the article by Warington, "The Aquatic Plant Case, or Parlour Aquarium (*The Garden Companion, and Florists' Guide*, January, 1852). If we define the aquarium as a vessel consisting of at least one transparent side in which water-dwelling plants and animals are kept, then here is perhaps the first reference to the word "aquarium" in the literature. I say "perhaps" since one can never be sure that an earlier reference won't be discovered.

Although it is likely that either Arthur Henfrey, Thomas Moore or William P. Ayres (the regular authors of the publication) was responsible for the title of the article, on page 7 Warington himself uses the term, and since his submission to the journal preceded the use of the term in the title, Warington must be given credit for its first recorded use.

The Garden Companion, and Florists' Guide was preceded by *The Gardeners' Magazine of Botany, Horticulture, Floriculture, and Natural Science*, edited by Thomas Moore and William P. Ayres (Arthur Henley was listed as an Assistant). This magazine, however, was dedicated more to the professional than to the amateur gardener and so was experiencing subscription problems, hence the change of name and favoring of a different audience. I thought it wise, therefore, to examine *The Gardeners' Magazine of Botany, Horticulture, Floriculture, and Natural Science* for 1851 to see if the word aquarium had been used. Indeed it had, in an article by Mr. George

Lawson titled “Contributions to the Aquarium.” However, its use was in the traditional gardener’s sense, not in the sense of a fish tank.

In another article, this one titled “Visits to Remarkable Gardens,” the author (Thomas Moore) visited the suburban residence of Nathaniel Bagshaw Ward at Clapham. The Wardian case was mentioned in this article, and included quotes from Ward himself. The author ends with the following:

We have left ourselves but little space to notice the many interesting plants crowded into Mr. Ward's small house. Passion-flowers, Manettias, Aristolochias, and such like, cover the pillars and festoon the roof, from which also Orchids are suspended. The raised rocky mounds on either side give pasturage to various small Palms, Ferns, Bamboos, Musas, Cannas, Colocasias, Clerodendrons, Achimenes, and hosts of smaller plants. The Cuphea ignea here grew, and flowered from year's end to year's end, until it became too large for the space. Fuchsias, too, which grew luxuriantly and flowered profusely, became too large, and had to be rooted out. A tank at the end affords accommodation for gold fish, and some of the smaller aquatic plants. The whole forms a beautiful miniature tropical forest scene.

It seems safe, therefore, to conclude that Warington was the first to use the word “aquarium” in the sense of a vessel to hold fish.

In any event, the modifier “parlour” is easily understood. If gardeners are going to bring the aquarium into their homes, they need a new descriptor to distinguish it from the external greenhouse concept and what better one than “parlour,” since that is the best room in the house (indeed, the parlour was often colloquially called just that) and where parlour aquaria were usually sited (although if there was room, as mentioned previously, the entryway was also popular). In any event, it is during the remainder of the year 1852 that we find an increasing use of the term (Chambers, 1852):

An interesting companion to the Wardian Case has lately been presented in the Aquatic Plant Case, or Parlour Aquarium, due to the ingenuity of Mr. Warington, and which has for its object, as its name indicates, the cultivation of aquatic or water , plants. It may be described as a combination of the Wardian Case and the gold-fish globe, the object being to illustrate the mutual dependence of animal and vegetable life.
The Parlour Aquarium affords valuable, we might say invaluable, facilities to the naturalist in the prosecution of his researches. The botanist can now conveniently watch the development of aquatic plants under conditions not unnatural, throughout the entire period of their existence, from their germination to the production of flowers and the perfection of seeds; and we are in hopes that much of the obscurity that invests many aquatic vegetables will in consequence be cleared up. The zoologist is perhaps even more indebted to the invention. The habits, not only of the fishes, but of the mollusca, can be accurately studied under natural conditions, and many important facts of their history ascertained and illustrated. The water-beetles and other aquatic insects will also come in for a share of attention.

Figure 13: This is the replica in the Natural History Museum of Vienna of Warington’s early setup showing the globular bowl he first used.

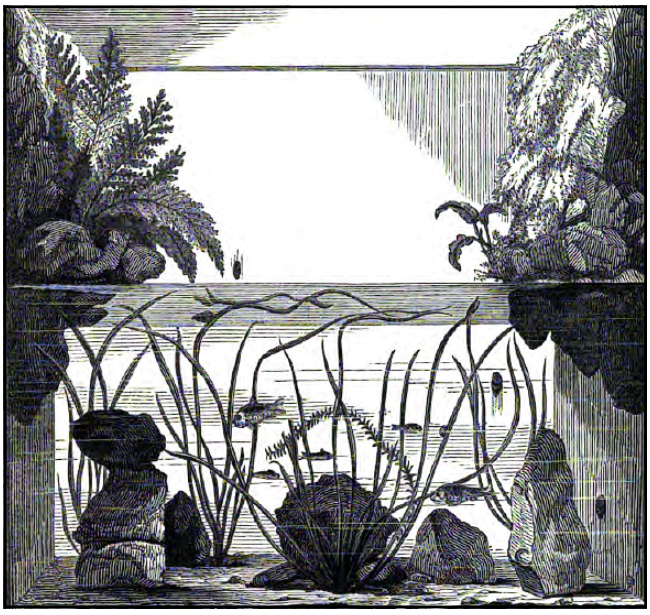


Figure 14: Warington's sketch of his idea of what became to be known as the "Warington Case" and later the "Warington Aquarium."

Warington uses the word "aquarium" with an interesting modifier (Warington, 1852, p.7):

Since the reading of my paper before the Chemical Society, on March 4, 1850, respecting the Miniature Aquarium (Quarterly Journal of the Chemical Society, iii 62), I have continued the investigations, introducing other water plants, and also three other varieties of water snail. But the principal alteration has been the construction of a better form of vessel for holding the water, as I found that the globular form of the glass receiver, produced a distortion in the vision of the fish, besides being very inconvenient for observation (see Figure 13). I have therefore adopted the form of vessel, of which a sketch is appended, having flat surfaces of plate-glass at the back and front, the bottom and ends being formed of slate, and supplied with a loose plate of glass at the top to keep out dust and soot (Figure 14 To render the whole more ornamental, as it was to stand in a sitting room, some pieces of tufa, or sandstone, were attached to the ends by means of Roman cement, so as to form ledges and slopes rising from the water line, on which mosses and ferns, such as luxuriate in an atmosphere loaded with moisture, could be grown. These materials are set in a stout angular zinc framework, and connected with a mixture of white-lead ground in oil, to which about an equal quantity of red-lead is added. This arrangement I have found to answer all my expectations, as it has been going on most flourishingly since January 1851. The plants consist chiefly of Hymenophyllum tunbridgense, and H. Wilsoni, Trichomanes speciosum, Blechnum boreale, Adiantum Capillus-Veneris, and several mosses. The whole of the interior can be viewed with the greatest ease, so that the natural habits of its living inhabitants can be watched and accurately noted in every particular.

Note that Warington was also one who needed to modify the gardener's "aquarium." Using the term "miniature aquarium" made sense since Warington was comparing the parlour aquarium to its forebears, in general rather large constructions. Warington followed the use of the word "aquarium" in print by using the plural in his 1854 article, "Memoranda of observations made in small aquaria..." (Warington, 1854b).

Although Warington provided the editors with a drawing showing the basic idea of his aquarium, in another article in this issue the editors show the result of a commission they gave to A. Aglio, a teacher of drawing and civic engineering:

We have already given a view of the parlour aquarium, contrived by Mr. Warington, and which may well bear his name; and have also explained in his own words the principles on which success depends. These principles, it must be obvious, admit of various modes of application so that our former illustration is to be regarded rather as an exemplification of the principle than as a model. We now subjoin another design for an aquarium, or Warington case, with the view to indicate, to some extent, the variety which may be attained, by combining this with the Wardian case. It will be obvious that this combination will afford scope for a much greater variety of form than would have been brought out by confining them chiefly to the growth of aquatic plants, and this amount of

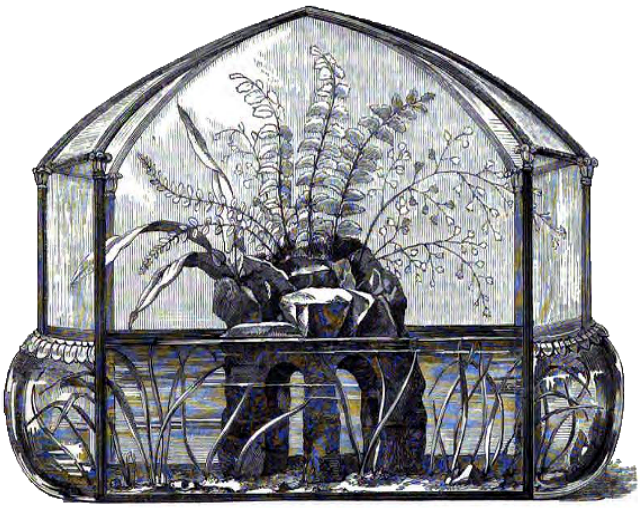


Figure 15: The "Warington's Plant Case" designed by A. Aglio

variety will afford opportunity for the display of a greater amount of ornamentation.

The design now submitted (Figure 15), from the pencil of A. Aglio, Esq., jun., is intended to consist of an ornamental zinc frame-work, a slate bottom, and the whole of the sides to consist of glass, used in plates, as large as the fittings will allow. The front and back will thus each consist of a single plate, and the absence of frame-work of every kind will admit of the whole interior being viewed without obstruction. The convex ends of the basin portion are also intended to be of glass formed into the exact shape and size required.

The mass of imitation rock in the centre must be formed expressly for the reception of the plants, good drainage being an essential feature, so that the soil may not become soddened. The whole is supposed to be supported by an appropriate and elegant stand.

It is interesting to mention that the Zoological Society intend to fit up a case on Mr. Warington's principle in their garden in the Regent's Park.

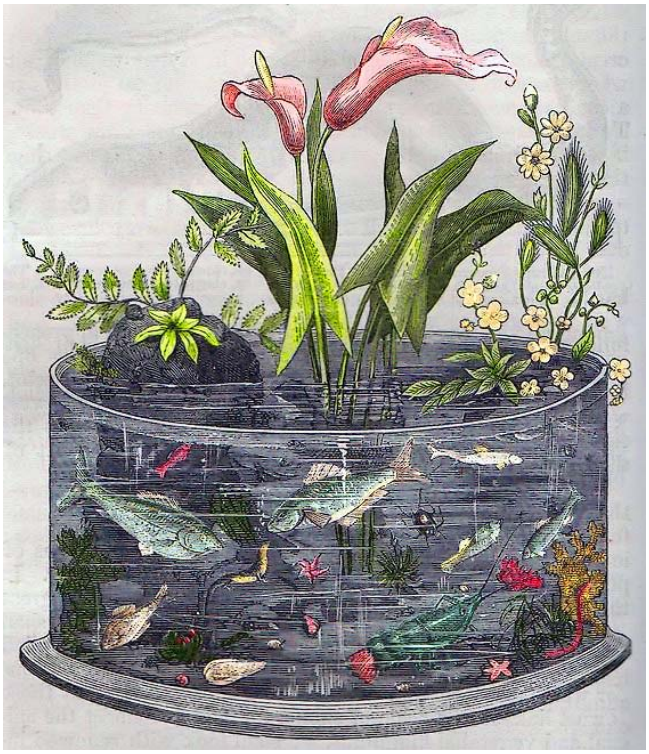
As I have shown, although the term aquarium was used for the vessel to hold aquatic animals before Gosse's book "The Aquarium" (Gosse, 1854a) appeared on the scene, there was no general agreement on the matter. The moment the book was published, however, it became the name that everyone used. Although Gosse had discussed the true origin of the term, the public thought he was its architect; thus it might be said that he invented it de facto. Indeed, it forced the Regent's Park Aquarium, established a year earlier, to discard aqua-vivarium in favor of aquarium. Many authors (but not the London Zoo itself) claim that the word aquarium originated there, but this clearly is not true.

It may seem strange that the origin of the word "aquarium" rests with the gardening community. However, gardeners needed a word that denoted a container for aquatic plants and if the Romans could use "aquarium" for a vessel to supply water to cattle, why not use it for a vessel to supply water to aquatic plants? As Gosse argued (Gosse, 1854a), "The term had already been in use among the botanists, to designate the tanks in which aquatic plants were reared; and the employment of the same term for our tanks is not forbidden by the character of the service to which they are put, since this is not an alteration, but only an extension. The growth of aquatic plants is still a most important and pleasing feature of our pursuit, and the addition of aquatic animals does not at all detract from the appropriateness of the appellation." Gosse had it right.

EPILOGUE

As David Allen writes in his *The Naturalist in Britain, a Social History* (1976),

Gosse was already well known for his immensely successful book, The Ocean, published in 1843. Ten years later he now repeated his success with A Naturalist's Rambles on the Devonshire Coast, in which he described the marine aquarium and forecast that it would soon be in mass-production for the parlour. A great rush of books promptly followed - and a general advance on the beaches by a large section of the British middle classes. The aquarium, almost overnight, turned into a national craze. Ladies of fashion, it is credibly recorded, had palatial plate-glass tanks erected in their drawing-rooms; the odd corners of most of the newspapers were



filled with notes for the would-be aquarist; a multitude of shops opened for the single purpose of supplying aquaria and their contents.

Then, at length, the enthusiasms faded. Nine out often aquaria were thrown out or abandoned; many of the shops folded up their shutters; 'to all appearances,' in the words of the Rev. J. G. Wood, 'the aquarium fever had run its course, never again to recur, like hundreds of similar epidemics.'

An amusing alternate explanation of the hobby's decline comes to us from France (Kete, 1995):

Although the introduction of tropical fish into fin-de-siécle Europe and American permanently reinvigorated interest in aquarium keeping - the aquarium still has a place in Western culture - its precipitous decline by around 1880 elicited comment. In France, *La Grande Encyclopédie* explained in 1886, medical warnings about pernicious miasmas accounted for this decline. It was '…above all after the doctors had suggested that effluvia released by evaporation could well produce intermittent fevers" that aquarium keeping fell into disfavor.'

The saltwater phase of the hobby laid dormant until the years after World War II when it was rescued by technology. The freshwater hobby, however, soldiered on and slowly grew over the next 175 years. I think that any one of the pioneers mentioned in this monograph would be absolutely astounded and amazed by the world-wide aquarium hobby as it exists today.

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Darwin, Jenyns, and the Chanchito

By Albert J. Klee, Ph.D.

(Buntbarsche Bulletin, No. 223, pp. 13-21, August 2004)

In the June 2004 issue of Modern Aquarium (Greater City Aquarium Society—New York), Claudia Dickinson wrote about the Chanchito. The Chanchito is probably the first of our aquarium hobby cichlids, having been imported into Germany in 1894 and into this country in 1895. In the course of preparing the material, Claudia and I had an exchange of e-mails concerning the author of the species, Leonard Jenyns. The Jenyns name is fairly well known to those aquarists interested in species authorship since he also described Corydoras paleatus, the ten-spotted livebearer (Cnesterodon decemmaculatus), and Galaxia maculatus (the spotted Galaxia, one of the rainbowfishes). In addition, the genus, Jenynsia (Anablepidae), was named after him.

So, who was Leonard Jenyns? A little research uncovered some absorbing facts and provoked some fascinating questions about Charles Darwin and what might have been, all because of an article about a cichlid!

Leonard Jenyns (1800-1893) was the youngest son of the Rev. George Leonard Jenyns of Bottisham Hall, Cambridgeshire. Jenyns was related through his mother's family to Dr. William Wollaston, a famous English chemist and physicist who, among other things, discovered two new metals, palladium and rhodium. (Another link to well-known names was that Jenyns' mother had her portrait painted by Gainsborough.)

By 1812, encouraged by his great uncle, the Rev. Leonard Chappelow, he took up the study of natural history and in 1813 he departed for Eton. There he read Gilbert White's "Natural History of Selborne," copying it out and memorizing most of it by heart. White's lifestyle and methods Jenyns later took for his own. In those days the only model to whom field naturalists could turn for inspiration was Gilbert White and those who are familiar with Lynn Barber's "The Heyday of Natural History" or David Elliston Allen's "The Naturalist in Britain, A Social History," will appreciate White's importance in the early decades of the nineteenth century.

In 1818 Jenyns entered St. John's College, Cambridge and during his second year his interest in natural history came to the attention of John Stevens Henslow (1796-1861), later to become a famous botanist of the nineteenth century, as well as a distinguished teacher. Henslow and Jenyns worked together on various natural history pursuits until Henslow's death. The two were extremely close, Henslow marrying Jenyns' sister Harriet in 1823. Henslow's relevance to this story will be made clear a bit later.

Jenyns took his degree in 1822, became a Fellow of the Linnaean Society and of the Cambridge Philosophical Society and, with Henslow, set up the latter's Museum. In May 1823 he was ordained a Deacon and in 1824 he was ordained a Priest. In this same year he published a "Scientific Journal Book" for the making of Meteorological and other observations, and in 1825 he proceeded to his M.A. degree and read his first paper on the "Ornithology of Cambridgeshire" to the Cambridge Philosophical Society.

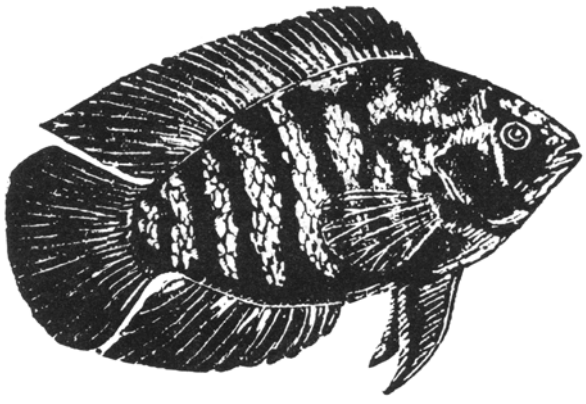


Figure 1: The image of the Chanchito that appeared in the April 1895 issue of Mulertt's *The Aquarium*.

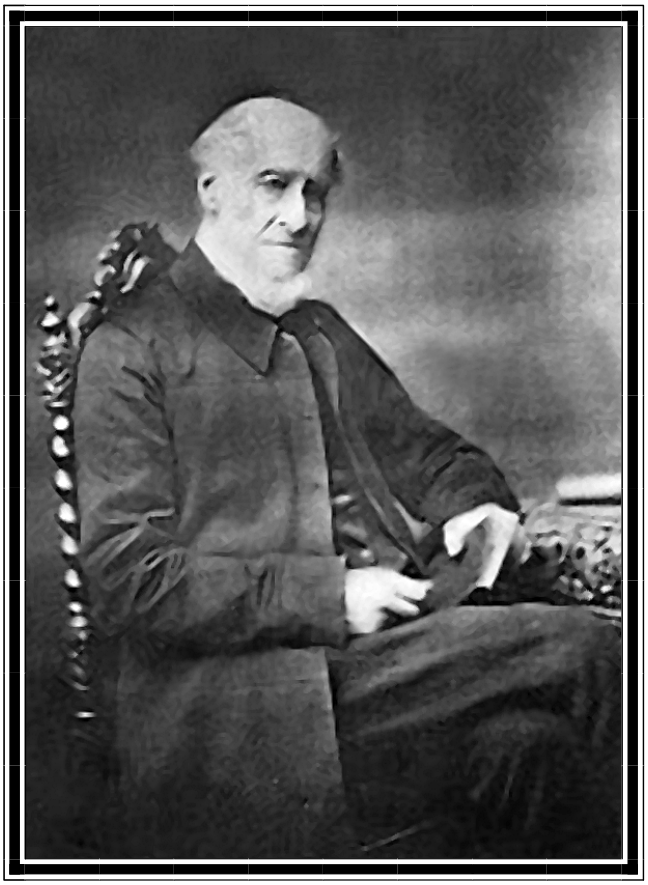


Figure 2: The Rev. Leonard Jenyns (1800-1893), British naturalist and author of the fish volumes of "The zoology of the voyage of H. M. S. Beagle, under the command of Captain Fitzroy, R. N., during the years 1832 to 1836."

In December 1827 he became the Vicar of Swaffham Bulbeck. However, this did not slow down his scientific output. In 1828 he read a paper to the Linnaean Society on "Two British Species of Plecotus" and a year later declined a Zoological Professorship being contemplated at Cambridge. In 1829 his publications included "The Common Bat of Pennant," and "On Incisor Teeth of Rodenta." In 1831 he published "On a Peculiar Parasitical Mite found on Slugs," and a paper on squids, i.e., "On the British Species of Cyclas and Pisidium." He also found time that year to read a series of lectures on Ornithology to the Cambridge Philosophical Society. It is clear, therefore that, although a clergyman, Jenyns was also a widely respected naturalist by the time the HMS Beagle was set to sail at the end of 1831.

For the next forty years Jenyns published widely in the scientific literature. Jenyns, by the way, was a supporter of Darwin's "Origin of Species" (published in 1859) and, for a clergyman at the time, this was both courageous and risky. (In 186o Darwin wrote to Asa Gray, "Several clergymen go far with me. Rev. L. Jenyns, a very good naturalist. Henslow will go a very little way with me, and is not shocked with me.")

In July 1871 Jenyns was left the property of a cousin of his father, Francis Blomefield, but to inherit he had to assume the name of Blomefield. At the time the estate was worth more than £7000 (big bucks in those days!) and it came with 140 acres in Norfolk. Jenyns continued to publish scientific papers under the Blomefield name up until a year before his death. By 1891 he had suffered bronchial attacks and gout but was able to rally enough to give two lectures, "Records of a Rookery" and "Remarks on the Distribution and Movements of British Animals and Plants." He remarked at the time, "Perhaps I am the only scientific man in England who ever gave lectures in his ninety-second year!"

Although this answers the question of who was the mysterious "Jenyns, L." noted as the describer of some of our best-known aquarium fishes, this is only part of the story. In Jenyns' diary entry for 1831 he writes, "This year I had the offer of accompanying Capt. Fitzroy, as Naturalist, in the Beagle, on his voyage to survey the coasts of S. America, afterwards going round the globe:—declined the appointment which was afterwards given to Charles Darwin Esq. of Xts' College Cambridge."

In July of 1831, Fitzroy had proposed to Captain Francis Beaufort the idea of a naturalist accompanying him on his expedition. If the name sounds familiar, Beaufort was the one who developed the "Beaufort Scale," a means by

which one could judge the speed of the wind visually, and Fitzroy made wide use of it during the Beagle's second survey. Beaufort was at a loss as to who to suggest, so he sought the advice of his old Cambridge friend, George Peacock. The following is taken from Jenyns' "Chapters in My Life" (then known as Leonard Blomefield):

The appointment arose in this way. Dean Peacock, at that time Fellow of Trinity College, was intimate with Captain Fitzroy, and was applied to by the latter, as to whether he could not find some one among the Cambridge men, who would be fit and willing to accompany him in his voyage in the capacity of Naturalist. Peacock immediately thought of Henslow and myself Henslow, however, being a married man with a family, was not disposed to go under his then circumstances,—(though earlier in life no doubt he would have caught at such an offer gladly)—and he tried to persuade me to go instead. I hesitated; and, after a full day taken to consider my decision, I also declined, as well on account of my being engaged in parish work—as Vicar of Swafham Bulbeck—which I did not think it quite right to quit for a purpose of that kind, as on account of my judging that I was not exactly the right person, either in point of health or other qualifications,—to offer myself for the situation. We then agreed (Henslow and self) that Darwin, in all respects, would be a fit man to go, and on his assenting, his name was at once sent up to Capt. Fitzroy, and the appointment was confirmed.

It may come as a surprise to some, therefore, to learn that Darwin was the third choice to accompany the Beagle, not the first. That Jenyns and Henslow recommended Darwin should come as no surprise. Darwin and Jenyns had met when Darwin was an undergraduate at Cambridge, and the two of them collected insects together, especially beetles. Some years later Darwin wrote of Jenyns, "At first I disliked him from his somewhat grim and sarcastic expression; and it is not often that a first impression is lost; but I was completely mistaken and found him very kindhearted, pleasant and with a good stock of humor. I visited him at his parsonage on the borders of the Fens, and had many a good walk and talk with him about Natural History."

Jenyns also wrote later of Darwin, "He was my junior at College by ten years; but from the similarity of our pursuits, we soon became intimate after the first introduction. He was at that time a most zealous Entomologist, and attended but little—as far as I remember—to any other branch of Natural History. He occasionally visited me at my Vicarage, at Swaffham Bulbeck, and we made Entomological excursions together, sometimes in the Fens, that rich district yielding so many rare species of insects and plants—at other times in the woods and plantations of Bottisham Hall. He mostly used a sweeping net, with

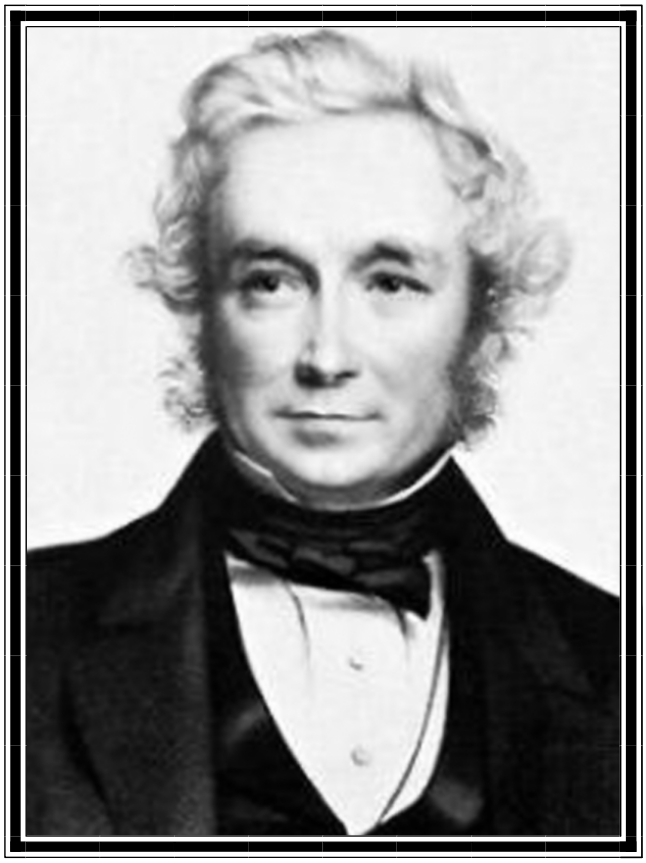


Figure 3: John Stevens Henslow (1796-1861), friend of both Leonard Jenyns and Charles Darwin. Along with Jenyns, he was instrumental in obtaining Darwin's appointment as Naturalist on the HMS Beagle.

Figure 4: The route of the HMS Beagle, showing its route to Brazil where the Chanchito was collected.

which he made a number of successful captures I had never made myself, though a constant resident in the neighborhood."

Charles Darwin (1809-1882), like many people of genius, did not at first appear to have extraordinary talents. From a young age Darwin disliked school and preferred observing birds and collecting insects to study. He was sent to medical school in Scotland when he was 16 but young Darwin found medicine "intolerably dull," and he was much more interested in attending natural history lectures. (The sight of blood made him squeamish and it is interesting to note that even before Darwin left for sea there were signs that he had a weak stomach!)

Seeing that Darwin lacked enthusiasm for becoming a doctor, his father suggested he study for the clergy. Darwin was agreeable to the idea and enrolled in the university at Cambridge, England, in 1827. Here again, Darwin admitted, "My time was wasted, as far as the academic studies were concerned." However, Darwin found that his friendship with John S. Henslow, then professor of botany at the university, made life in Cambridge extremely worthwhile. Through long talks with Henslow, Darwin's knowledge of the natural world increased and Henslow encouraged Darwin in his studies of natural history. Henslow was also a pastor, so Darwin made plans to pursue a life in the clergy.

His heart really wasn't in it, however, but since he had a summer to think about it he went on vacation. When he returned home he found two letters waiting for him: one, an offer to work as a naturalist aboard the HMS Beagle, and the other, a letter from Professor Henslow encouraging him to do so. However, like many young men and women still living at home, Darwin had to consider what his father, Dr. Robert Darwin, might think about such a trip. Darwin ultimately won his father over (Dr. Darwin even put up 30 pounds a year for Charles' food and paid to equip him for the voyage) and was soon signed on as ship's naturalist. At the end of the voyage and at the earnest request of Charles Darwin, Jenyns undertook to edit the monograph on the fishes for the trip (Jenyns, L., "The zoology of

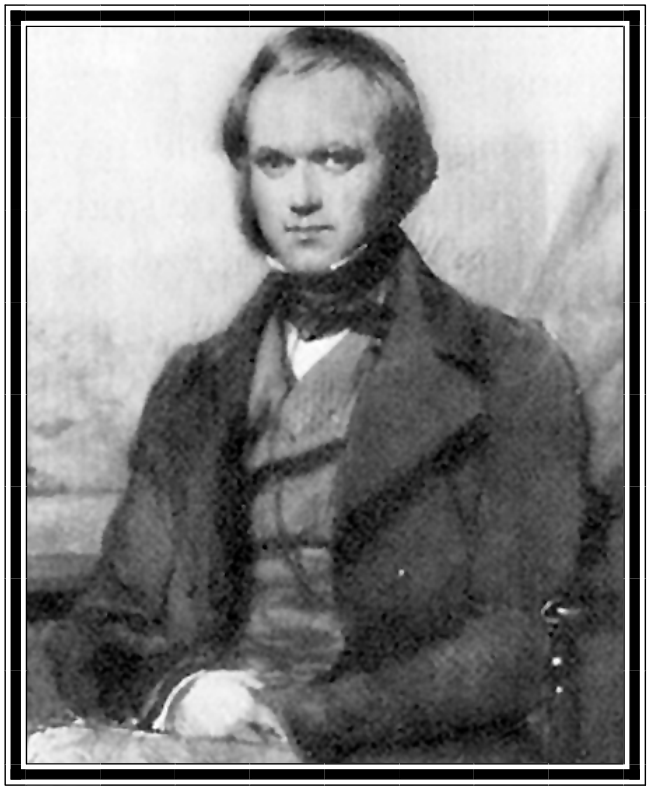


Figure 5: Charles Darwin (1809-1882).

the voyage of H. M. S. Beagle, under the command of Captain Fitzroy, R. N., during the years 1832 to 1836," London: Smith, Elder, and Co. Issued in 4 parts, Fish, 1840-42.), and the rest is, as they say, aquarium history.

We now arrive at three interesting questions, all arising from an aquarium article on the Chanchito. Assuming that Leonard Jenyns had gone on the voyage of the Beagle instead of Charles Darwin:

(1) Would Jenyns rather than Darwin have developed the origin of species concept?

Even though Jenyns was interested in species variation (he read a paper on "The Variation of Species" to the Cheltenham meeting of the British Association for the Advancement of Science in 1856, a paper that Darwin asked Jenyns to send him), I think it unlikely. In addition to his religious background, Jenyns was essentially a field naturalist and lacked the breadth of vision needed to develop such a theory.

Oddly enough, though, Jenyns was a far better field naturalist than Darwin. Henslow's letter to Darwin re the Beagle appointment read: "I have stated that I consider you to be the best qualified person I know of who is likely to undertake such a situation—I state this not on the supposition of your being a finished Naturalist, but as amply qualified for collecting, observing and noting anything worthy to be noted in Natural History. ... Captain F. wants a man ... more as a companion than as a mere collector and would not take anyone however good a Naturalist who was not recommended to him likewise as a gentleman." Far from being an enthusiastic endorsement of Darwin's scientific abilities, the letter reads as nothing more than an assurance that Darwin had the social status needed to qualify him as Fitzroy's companion and enough knowledge of natural history to qualify him as a general menial collecting samples and making general observations.

A good example of Darwin's weakness as a field collector is that in spite of the importance of "Darwin's finches" in evolutionary theory, the original type specimens from the Beagle voyage have long been a source of puzzlement to ornithologists. The localities recorded on the specimens, for example, do not seem to coincide with the various species and subspecies distributions observed today. The explanation for these anomalous specimens lies in part in Darwin's own collecting procedures while in the Galapagos. His specimens, which were largely unlabelled by island, later acquired a number of erroneous localities as a result of Darwin's own incorrect guesses, as well as the efforts of later ornithologists to make Darwin's specimens agree with his published localities.

(2) Would Darwin have developed the origin of species concept in any case?

Well, perhaps not. During the voyage of the Beagle, Darwin found fossils in South America of extinct animals that were similar to modern species, and on the Galapagos Islands he noticed many variations among plants and animals of the

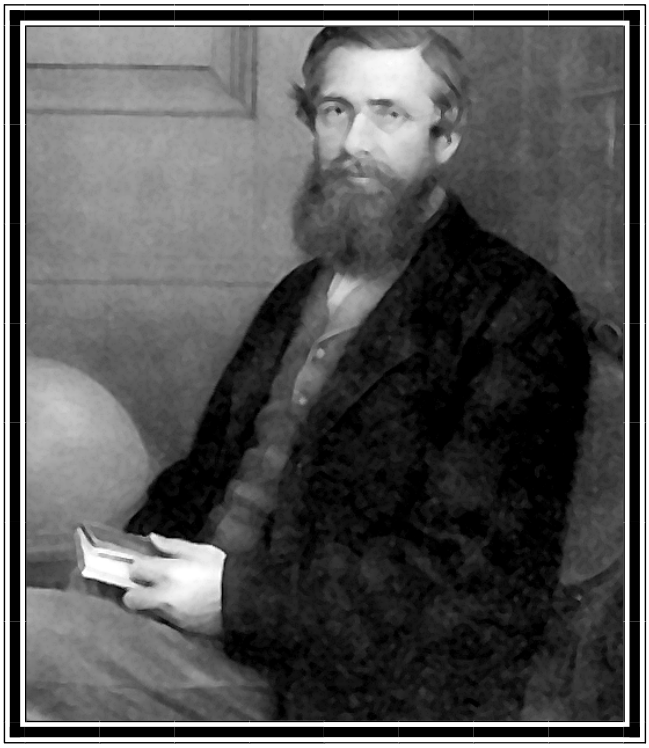


Figure 6: Alfred Russel Wallace (1823-1913).

same general type as those in South America, thus sowing the seeds of his ideas on natural selection. Darwin himself wrote in 1838 to have been "... greatly struck from about the previous March on the character of South American fossils, and species on Galapagos Archipelago. These facts, especially the latter, origin of all my views." If the Beagle voyage was the origin of all his views, then it would seem unlikely that he would have developed the origin of species concept had he not made the trip.

(3) Would Darwin have developed the origin of species theory in time to establish priority over Wallace?

In 1854, Alfred Russel Wallace (1823-1913) traveled to the Malay Archipelago to collect for various museums and private collectors. He was looking specifically for evidence that related forms were found in both the Amazon Basin and on the Archipelago. If he could find evidence that closely related species were found in widely dispersed regions of the world, this might bring into question the idea that each species was created independently.

In 1855 he published a cryptic note in guarded language entitled "On the Law Which Has Regulated the Introduction of New Species," in the Annals and Magazine of Natural History. Here he maintained that new species arose from related, pre-existing species. Darwin did not fully comprehend what Wallace was saying and considered him to be a "creationist."

In February of 1858, while on an island in the Moluccas (Indonesia), Wallace was bed-ridden and suffering from an attack of malaria. Ill and fevered, he suddenly realized the importance of Malthus' classic observations on populations and drafted his ideas on "the survival of the fittest" during a single evening. He worked over the draft the next two evenings with the idea of sending it to Darwin with whom he had prior correspondence. On March 9, 1858 he mailed his letter by mail-boat from the island of Ternate, asking if Darwin thought the ideas worthy.

Upon seeing Wallace's paper Darwin realized he was about to be scooped, and decided to end the 20-year delay in publishing his own theory. Wallace's paper and Darwin's various notes and correspondence on the subject were subsequently read at the same Linnaean Society meeting in London on July 1, 1858. The next year, Darwin published "On the Origin of Species." Although Wallace independently reached the same conclusion, it has usually been Darwin's name alone associated with the theory. In light of the close call in dates, I think a good case could be made that Wallace would have been first and therefore the one credited with the origin of species concept had Jenyns and not Darwin been on the Beagle voyage.

Perhaps you have your own answers to these questions, but whatever stance you take, it constantly amazes me that the aquarium hobby can open up so many interesting doors when one least expects it! Chalk one up for the Chanchito!

Our First Aquarium Cichlid

By Albert J. Klee, Ph.D.

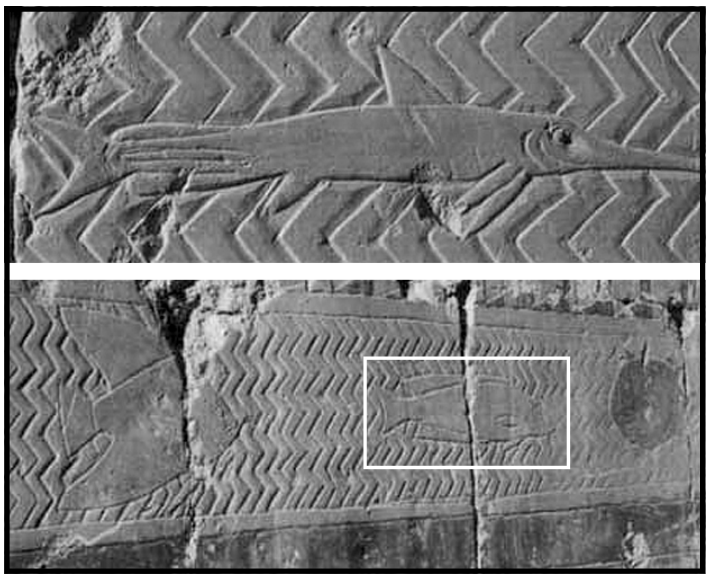
(Buntbarsche Bulletin, No. 231, pp. 32-34, December 2005)

When I first became interested in tracing the roots of the aquarium hobby I was faced with the Gordian knot of defining terms. One of the most difficult was in pinning down the meaning of "hobby" in the aquarium context and, although it might not seem as if it would, even the definition of "aquarium" posed a problem. Indeed, the definition of "aquarium" was the subject of detailed analyses through the years by such renowned and respected figures as William Alford Lloyd (1876), Philip F. Rehbock (1980), and Stephen Jay Gould (1998). Trying to pin down a concise explanation of the meaning of a word or a term sometimes is sometimes akin to attempting to estimate the number of angels that can dance on the head of a pin!

One way out of this dilemma is to avoid definitions and examine the major stages in the development of the aquarium hobby instead. Consequently, I was able to distinguish four such distinct events. STAGE I started when people began to keep fish for their ornamental and entertainment value in ponds and in indoor containers, e.g., the piscina (from *piscis,* a fish, fish-pond, pool or basin – the term later took on different meanings) of the Romans, and the goldfish ponds of the Chinese a thousand years ago. Although the owner of any respectable Roman villa could look down on the animals in his fishpond, they could only be viewed from above through the opacity of rippled water. The same held for the indoor containers of the time since they also were opaque-sided.

STAGE II involved any container of glass or other transparent medium that afforded the viewing of a fish in a more direct, edge-on, eye-to-eye orientation, i.e., what we know as the "fish bowl," although the shape of the container varied widely. The first Stage II fish keeper of record was Jeanne Rondelet, who kept a fish alive in a glass of water for three years sometime in the late 1530's or early 1540's. In the mid to late 1700's, the keeping of fish in glass containers became fashionable in Great Britain and included such illustrious personages as Horace Walpole, the 4th Earl of Oxford.

The aquarium craze of the mid 1850's in Britain brought on STAGE III of the aquarium hobby, characterized by the interpretation of the aquarium as a mini-representation of a small portion of some natural aquatic environment (the marine aquaria of the time, for example, were frequently referred to as "parlour" oceans), an availability of books on the subject, and the existence of commercial establishments supplying fish and equipment. Finally, towards the end of the Twentieth Century STAGE IV appeared, i.e., the notion of



RIGHT: FISH HEIROGLYPHICS FROM ANCIENT EGYPT.
A Tilapia is shown at the right within the white frame in the lowermost image.

aquarium societies, exhibitions, and competitions, all strengthened by improved communication through the appearance for the first time of aquarium magazines, advances in travel, and the changing nature of cities.

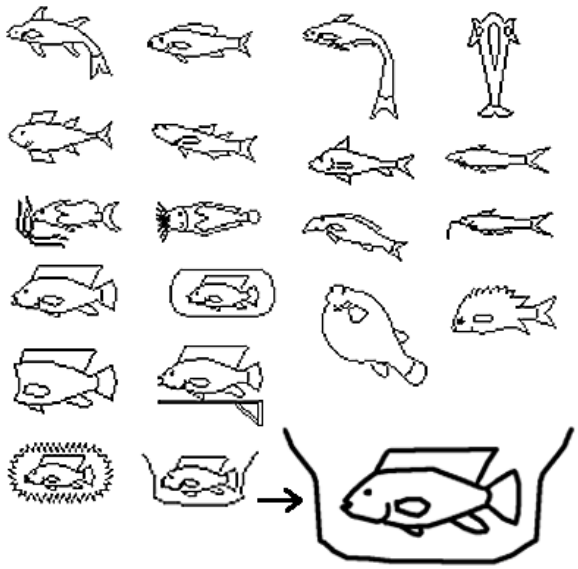
Although Jeanne Rondelet kept a fish alive in a glass of water for three years in the Sixteenth Century, I doubt that most readers would agree that this established the aquarium hobby in France at that time. When one talks about the aquarium hobby, therefore, it makes sense to think in terms of Stage IV of the hobby. An interesting case in point, therefore, is in determining the first aquarium cichlid. If we restrict ourselves to the aquarium hobby (*sensu* Stage IV) then it is clearly the Chanchito, *Cichlasoma facetum*. If, on the other hand, we are seeking the first cichlid kept in an aquarium then the field is wide open. Some writers (e.g., Geerts, 2005) erroneously assign it to the Orange Chromide, *Etroplus maculatus*, but they are thousands of years off, as well as missing the correct fish!

It is well documented that the Egyptians kept fish in aquaria, and hieroglyphics in the tombs of the Pharaohs very clearly describe the farming of tilapia in ancient Egypt. In the mid 1970's I traveled extensively in Egypt and observed and photographed many of the hieroglyphics depicting fishes. The accompanying figure shows line drawings taken from some of them. The six in the lower left corner are drawings of a tilapia, the last showing it in a vessel of some sort, i.e., an aquarium.

The ancient Egyptians kept fish for food, to be sure. However, large quantities of fish bones have been found at various archeological sites in Egypt and, given the fact that the bones were found in accordance with the real animal shape, it is certain that the animals were deposited while still in the flesh and therefore played a religious role.

Oddly enough, the Egyptians had opposing views regarding fishes. They were often considered as unclean animals and were forbidden as offerings and food to kings, gods, and the priesthood. When the cult of Osiris became popular, fish were identified with his evil brother Seth, the god of chaos and confusion, since (according to Plutarch) people believed that the Nile Carp (*Lepidotus*) had eaten the phallus of the dismembered Osiris. Therefore, on certain feast days fishes were burned and trampled underfoot as an offering.

On the other hand, despite the belief of those just cited, fishes were often regarded as sacred animals. The elephant fish, *Sternarchorhynchus oxyrhynchus*, for example, was considered to have been created out of Osiris' wounds. This fish was also connected to the important goddess Hathor and also acted as a pilot fish for the solar bark of the sun god, Ra, warning of the approach of the snake Apophis during the sun's voyage through the underworld. The tilapia also seems to have been a



A Sample of Fish Hieroglyphics Taken From Egyptian tombs.
The six in the lower left corner depict Tilapia, and the last (magnified to the right) shows it in a vessel of some sort.

manifestation of Ra. As aquarists well know, a mouth brooder, it keeps its fertilized eggs in its mouth until they are fry and then spits them out. It therefore appears to be swallowing and then "giving birth" to them and, as such, is therefore a symbol of rebirth. Furthermore, this fish was associated with fertility and had a strong erotic connotation. To offer a tilapia, for example, was considered as an invitation to love.

Arthur E. P. B. Weigall (2005) writes that three thousand years ago, an Egyptian man wrote this poem about his home: "Its fields are full of good things and it has provision for every day. Its granaries overflow... they reach the sky. Its ponds are full of fishes and its lakes of birds. Its fields are green with grass and its banks bear dates. He who lives there is happy and the poor man is like the great elsewhere." These ponds certainly contained tilapia, but which tilapia?

The accompanying table lists the fish species documented from excavations in Egypt. The table is based on archeological investigations related to cultural studies that, in contrast to the antiquarianism of classical archaeology, are concerned with the explanation of cultural processes such as foods eaten and animals domesticated or farmed. The table is interesting in that it contains some very familiar aquarium fishes, e.g., elephant fishes, the bichir, labeos, a barb, and a host of well-known aquarium catfishes. Included are two species of tilapia - *Tilapia nilotica* and *Tilapia galilaea*. It is often assumed that the tilapia shown in Egyptian hieroglyphics is *Tilapia nilotica*, but as it is not possible to distinguish between the two species by looking at the hieroglyphs, it is therefore not certain which of the two is our first aquarium cichlid. As the reader can appreciate, nailing down these "firsts" is not an easy task nor is it always possible.

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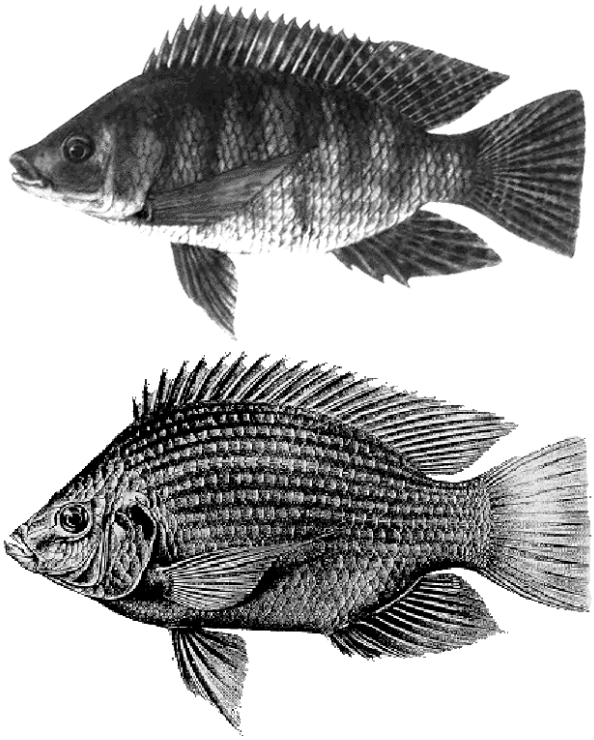

ABOVE: ***TILAPIA NILOTICA.***
BELOW: ***TILAPIA GALILAEA.***

A List of all Fish Documented from Excavations in Egypt (after Boessneck, 1988).

1	Bichir, Polypterus bichir	23	Schilbe mystus
2	Mormyrus caschive	24	Nile Catfish or Hog catfish, Bagrus docmac
3	Mormyrus kannume	25	Bagrus bayad
4	Mormyrops anguilloides	26	Auchenoglanis occidentalis
5	Gnathonemus cyprinoides	27	Chrysichthys auratus
6	Hyperopisus bebe	28	Chrysichthys rueppelli
7	Hydrocyon forskali (= Hydrocinus forskali)	29	Synodontis schall
8	Alestes dentex	30	Synodontis batensoda
9	Alestes baremose	31	Synodontis membranaceus
10	Disticodus niloticus	32	Synodontis serratus
11	Citharinus citharus	33	Synodontis frontosus
12	Citharinus latus	34	Synodontis sorex
13	barbus bynni	35	Malapterurus electricus
14	Labeo niloticus	36	Mugil capito (= Liza ramada)
15	Labeo horie	37	Mugil cephalus
16	Labeo coubie	38	Nile perch, Lates niloticus
17	Labeo forskalii	39	Tilapia nilotica (= Oreochromis niloticus)
18	Clarias lazera (= Clarias gairepinus)	40	Tilapia galilaea (= Sarotherodon)
19	Clarias anguillaris	41	Tetrodon fahaka
20	Heterobranchus longifilis	42	Sparus aurata
21	Heterobranchus bidorsalis	43	Morone punctatus (= Dicentrarchus punctatus)
22	Eutropius niloticus	44	Johnius hololepidotus (= Argyrosomus regius = Sciaena aquila)

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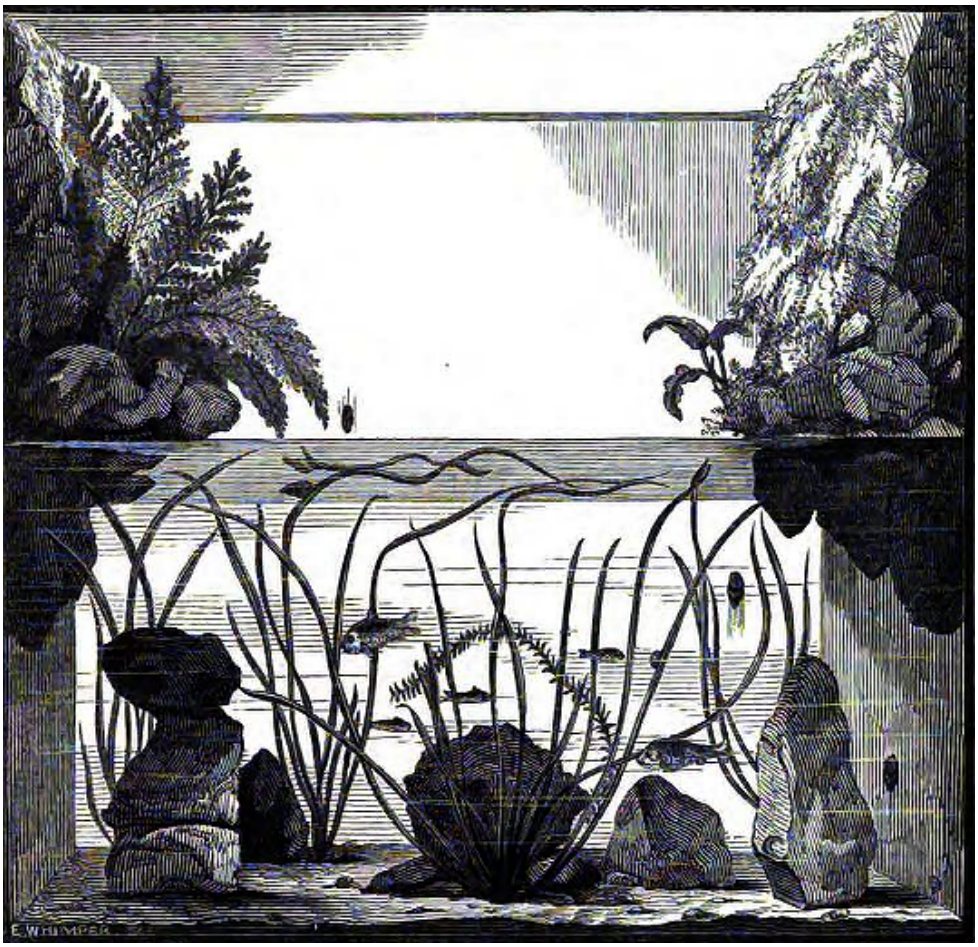


THE STORY of PANCHAX and KILLIFISH

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, March 26, 2011)

THE STORY OF PANCHAX

When an ichthyologist describes a new genus, it is necessary to specify a particular species as the type for the genus. This is referred to as the "type species." The rules of nomenclature that ichthyologists must follow state that, regardless of the other member species of the genus, the generic name goes with the type species like Damon with Pythias of Greek mythology. In the early days of ichthyology, however, it was not considered necessary by many ichthyologists to name a type species for a new genus. It was later realized that this was going to lead to quite a bit of nomenclatural confusion and it became necessary to designate type species for genera which had none.

Our story starts when the genus *Aplocheilus* was established in 1839 by the ichthyologist, John McClelland. However, be forewarned that what follows is a convoluted comedy of errors! McClelland placed three fishes in the genus at that time, two of which were newly-described by him. These fishes were: *Aplocheilus chrysostigmus, A. melastigmus* and *A. panchax*. The last-named species was first described as *Esox panchax* in 1822 by the Scottish ichthyologist, Francis Buchanan-Hamilton, and did not really belong in that genus or anywhere near it for that matter. McClelland, however, failed to name a type species for his new genus and since it later turned out to be composite (i.e., actually comprising two distinct genera), his oversight paved the way for considerable confusion, a bit of which has been shared with killifish fanciers.

Chronologically, the next action was taken by the French zoologist, Valenciennes when in 1846, ignoring McClelland's *Aplocheilus*, he established the genus *Panchax* containing four species: *Panchax lineatus, Panchax kuhlii, Panchax buchanani* and *Panchax pictum*. However, *Panchax kuhlii* was a synonym for *Panchax panchax, Panchax buchanani* was a synonym for Hamilton's *Esox panchax* (Valenciennes renamed it), and *Panchax pictum* really belonged in the genus *Betta*. This left *Panchax panchax* and *Panchax lineatus* and the genus *Panchax* appeared as such in early aquarium literature and widely used by aquarists.

The Dutch ichthyologist, Pieter Bleeker, was the first one to designate a type species for McClelland's *Aplocheilus*, and in 1863 in his synopsis of the genera of killifishes, named *Aplocheilus chrysostigmus* as the type species. In so doing, Bleeker committed a bit of a booboo as this was actually directly opposite to what he had intended to do for *A. chrysostigmus* is a synonym of *A. panchax* and Bleeker, in the same synopsis, placed *A. panchax* in the genus *Panchax*. There is good reason to believe that he had intended to name *melastigmus* as the type species but under the mistaken impression that *melastigmus* was a synonym of *chrysostigmus*, he used the latter name instead. Confusing, isn't it? But, the damage was done and the genus *Aplocheilus* henceforth had to be associated with the species *panchax* (= *chrysostigmus*).

Since *Aplocheilus* predates *Panchax* by seven years, the correct genus for *panchax* and related species such as *lineatus* has to be *Aplocheilus* by the Law of Priority, one of the formal rules that taxonomic ichthyologists are expected to follow.

In 1906, the eminent American ichthyologist, David Starr Jordan and his colleague, John Otterbein Snyder, established the genus *Oryzias* for the Japanese cyprinodont then known as *Poecilia latipes*. This genus was snubbed by other ichthyologists for many years, for they considered *Oryzias* to be merely a synonym for *Aplocheilus*. Later, however, it was accepted as a valid genus (in which we

now place the medaka and related fishes). Since McClelland's *melastigmus* was really related to *latipes*, it was ultimately transferred to *Oryzias*.

Therefore, when all the evidence was in, species in *Panchax* were transferred to *Aplocheilus*, species in *Aplocheilus* were transferred to *Oryzias*, and *Panchax* was discarded, the whole business resembling an ichthyological version of musical chairs!

As hobbyists, it is interesting to note what the situation now would be had Bleeker named *melastigmus* as the type species for *Aplocheilus* as it is thought he had intended. If he had done this, all fishes now called *Oryzias* would be placed in *Aplocheilus*, leaving *Panchax* open to accommodate *panchax* et al., and leaving *Oryzias*, the newcomer, vacant.

At the beginning of the 1900's, American killifish fanciers were strongly influenced by their German counterparts and by German immigrants to this country who brought their interest in killifishes along with them. In Germany, the name given to killifishes was "eiergelegende zahnkarpfen," translated as "egg-laying toothcarps." Killies at the time were placed in the family Cyprinodontidae, a name meaning "toothcarps," and the Germans merely translated it into their language. However, "egg-laying toothcarps" is a real mouthful, so in due time Americans resorted to calling them panchax since that name had yet to be discarded in the aquarium literature and "killifish" was not yet in vogue.

Up to the mid-1950's and early 1960s, if one walked into fish store and asked to see some killies, all you would have received would have been a blank stare. Ask for "panchax," however, and you would immediately be taken to the killifish section, including species that never had any association with the name "panchax," such as African, South and Central American and North American killifishes. The objection to the use of "Panchax" as a general term for killifishes is not only based upon the fact that it is a scientific name no longer used, but, more importantly, that it applied originally to only a few species of killifishes from a small part of the world.

THE STORY OF KILLIFISH

Kill is a common Germanic word. The Old Norse form meant "bay" or "gulf" and gave its name to Kiel Fjord on the German Baltic coast and thence to Kiel, the port city founded there in 1240. In Middle Dutch the word is "kille" (the modern Dutch term is "kil" since nowadays no Dutch word ends in two consonants), meaning "riverbed" or "water channel," although the primary meaning is a deep trench between steep banks.

The term was used in areas of Dutch influence in the Delaware and Hudson Valleys and other areas of the former New Netherland colony of Dutch America to describe anything from a stream or creek to a strait, river or arm of the sea. These waters were home to fish that were new to the Dutch, who probably called them "killvis" ("fish from the kill"), but it is also possible that the name "killfish" originated in American English, after the locals had adopted the Dutch word to these bodies of water.

Although there is no connection, some people did and still do associate "kill" with "to kill," as was apparent from a controversy about the name of Fishkill, a small town in the southwest part of Dutchess County, New York. In 1996, the animal rights organization, PETA (People for the Ethical Treatment of Animals), had proposed to change Fishkill into Fishsave, claiming that Fishkill suggested cruelty to fish!

In the 1980's, I was spending my spare time at the University of Cincinnati, poring over copies of the *Bulletin of the United States National Museum*. The University had a rather complete copy of the early issues, but as hardly anyone ever looked at these books, I was covered with dust

and grime every time I made a library visit. Nonetheless, in this I have been fortunate since today, these tomes are located away from the University library in storage, and it takes three days for them to be brought up to the library for patrons to examine.

One day, I came across a reference to "*Cobitis killifish*," a scientific name given by Johann Walbaum in 1792 on the basis of a paper written by Johann Schoepff in 1788 wherein the latter described a fish he called "killfish" (note the absence of the "i") that we now know as *Fundulus heteroclitus macrolepidotus*. "Killfish," of course, literally means "fish of the kill." This was exciting since it provided new information as to the origin of the name, which up to this time had been thought only to have been a common name not a scientific one. However, I had some unanswered questions and to answer them, I was on my own.

For one thing, Schoepff had previously published the term in a scientific journal, the *Berlinische Gesellschaft Naturforschender Freunde*, so why wasn't he given the credit for being the first one to describe it scientifically? For another, Walbaum's description was published in an edition of Peter Artedi's *Ichthyologia* that he, Walbaum, edited; how did this description get into something he was just supposed to edit? Artedi, it should be noted, is credited with being the founder of modern ichthyology, and his posthumously published *Ichthyologia* was fundamental in establishing modern ichthyological methods.

Figure 1: Johann Julius Walbaum (1724-1799).

Johann Julius Walbaum (1724-1799), a native of Lübeck, was a physician, naturalist and taxonomist. He was the first to describe many previously unknown species from remote parts of the globe, such as the Great Barracuda (*Sphyraena barracuda*), the Chum salmon (*Oncorhynchus keta*) from the Kamchatka River in Siberia, and the curimatá -pacú (*Prochilodus marggravii*) from the São Francisco River in Brazil. He was also the first to observe gloves as a preventative against infection in medical surgery. In 1758, the gloves he observed were made from the cecum of the sheep, rather than rubber, which had not yet been discovered. The Naturhistorische Museum in Lübeck, opened in 1893, was based on Walbaum's extensive scientific collections.

As were most of the scientific books of the day, the Walbaum-edited book was written in Latin, its title being: "*Petri Artedi sueci genera piscium in quibus systema totum ichthyologiae proponitur cum classibus, ordinibus, generum characteribus, specierum differentiis, observationibus plurimis: Redactis speciebus 242 ad genera 52.*" The last part translates to "242 species and 52 genera added by the editor." Walbaum described the fish scientifically - within the lenient standards of the time - in six lines, using Schoepff's account for location information, i.e., "Habitat ibidem tam in aquis dulcibus, quam salsis" ("Habitat in fresh as well as salt water"). He also made clear in the title of the book that he had added material to Artedi's monumental work.

Well, that answered one question, but what about Schoepff's contribution? Schoepff was a German

botanist, zoologist and physician. He was born in Bayreuth and traveled to New York in 1777 as the chief surgeon for the Ansbach regiment of Hessian troops fighting for King George III of the United Kingdom. During the war Schoepff was stationed in Rhode Island. Determined to study the Americas as a scientist once the war ended, he travelled for two years in the United States, British East Florida and the Bahamas. Schoepff returned to Europe in 1784, where he worked for a time at the United Medical Colleges of Ansbach and Bayreuth. He is well known among present-day herpetologists for his 1792 "Historia testvdinvm iconibvs illvstrata" (Illustrated History of the Iconic Turtles, "iconic" in this sense meaning the British definition, i.e., "well-known").

Tracking him down was not easy since his name can be spelled Schoepff, Schoepf or Schöpf. Also, the literature citations I came across were fraught with errors. *The Northeastern Naturalist*, published by the Humboldt Field Research Institute, for example, cited Schoepff's paper as "Beschriebung einiger nordamerikanishen fische vorzuglick aus den neu yorkischen seewasser," not only misspelling Beschreibung but stating "seewasser" instead of the correct "Gewässern" and other minor errors as well. The correct citation is "Beschreibung einiger Nord-Amerikanisher Fische, vorzüglich aus den Neu-yorkischen Gewässern."

Incidentally, the English translation of "vorzüglich" gave me an additional problem as well. If one goes to the standard dictionaries, hard copy or on-line, one usually gets two basic meanings for the word: (1) ideal, excellent, exquisite or first-rate, and, to a less frequent extent, (2) those associated with food and cooking, such as delicious and cordon bleu, none of which makes any sense when you try inserting any of these definitions into the brackets in "A description of some North American fishes, [vorzüglich] from New York waters."

In such cases, one needs to go to a reference work that presents a list of all synonyms for the word, both past and present. The disadvantage is that these are usually wholly in the language under consideration. The one I used listed 14 different basic meanings and over 339 synonyms. I picked the basic meaning of "besonders," which gave me synonyms that included "notably," "primarily" and "chiefly," which solved the problem, my translation being: "A description of some North American fishes, mostly from New York Waters."

From the Bielefeld University Library (Universitätsbibliothek Bielefeld) site I found Schoepff's article in digitized form. The text was digitized as an image and this difficulty was compounded by the fact that this was in a 1788 German publication and printed in Fraktur, a Gothic font. Furthermore, Schoepff's killfish description pages were especially blurry as Figure 3 shows.
I have outlined the excerpt "Diese beyde Fische, der Yellow bellied Cobler und Killfish, halten sich um Neuyork, in Kriken und Teichen von sowohl gesalzenem als frischen Wasser auf,"

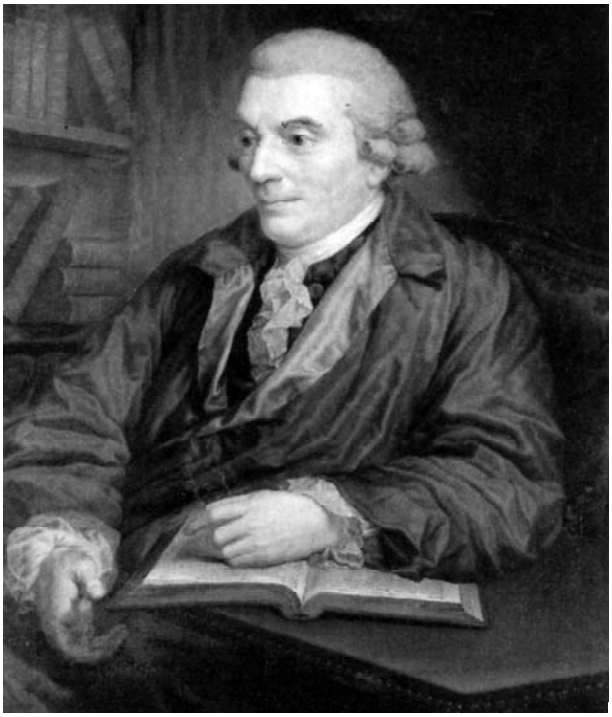
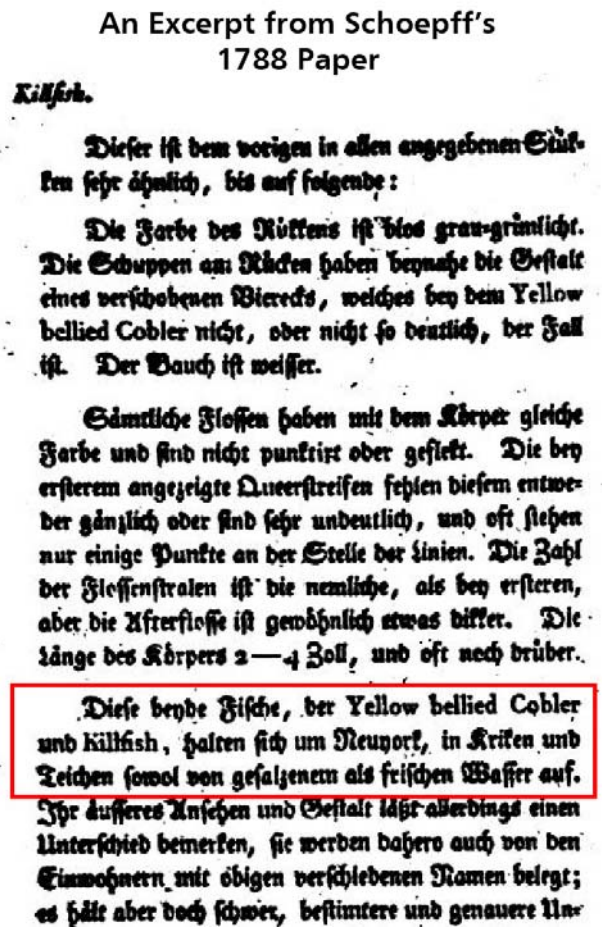


Figure 2: Johann David Schoepff (1752-1800).


An Excerpt from Schoepff's 1788 Paper

Killfish.

Dieser ist dem vorigen in allen angegebenen Stücken sehr ähnlich, bis auf folgende:

Die Farbe des Rückens ist blos grau-grünlicht. Die Schuppen am Rücken haben beynahe die Gestalt eines verschobenen Vierecks, welches bey dem Yellow bellied Cobler nicht, oder nicht so deutlich, der Fall ist. Der Bauch ist weisser.

Sämtliche Flossen haben mit dem Körper gleiche Farbe und sind nicht punktirt oder gefleckt. Die bey ersterem angezeigte Queerstreifen fehlen diesem entweder gänzlich oder sind sehr undeutlich, und oft stehen nur einige Punkte an der Stelle der Linien. Die Zahl der Flossenstralen ist die nemliche, als bey ersteren, aber die Afterflosse ist gewöhnlich etwas dicker. Die Länge des Körpers 2—4 Zoll, und oft noch drüber.

Diese beyde Fische, der Yellow bellied Cobler und Killfish, halten sich um Neuyork, in Kriken und Teichen sowol von gesalzenem als frischen Wasser auf. Ihr äusseres Ansehen und Gestalt läßt allerdings einen Unterschied bemerken, sie werden dahero auch von den Einwohnern mit obigen verschiedenen Namen belegt; es hält aber doch schwer, bestimtere und genauere Un-

Figure 3: An excerpt from Schoepff's 1788 paper.

which I have translated as "Both these fishes, the Yellow-bellied Cobbler and Killfish, are found in creeks and ponds in both brackish and fresh waters about New York." Figure 3 shows that Schoepff did not provide a binomial name for his "Killfish" and so it was not, even for the times, scientifically described. In other parts of his paper fish were provided with a binomial name, and so his "Labrus Burgall" is referred to in today's scientific literature as "*Labrus burgall* Schöpff 1788." Since his "Yellow bellied Cobler" and "Killfish" were not named scientifically, it remained for Walbaum to do so four years later.

One of the earliest references to killifish is Samuel Latham Mitchill's "The Fishes of New York" (Mitchill, 1815), but he refers to "killifishes" as names only, sans descriptions. One of the earliest descriptions of killifish, on the other hand, can be found in Samuel Akerly's "Economical history of the Fishes sold in the markets of the City of New York" (Akerly, 1818). Akerly (1785-1845) was a surgeon, naturalist, geologist, founder of the New York Institution for the Instruction of the Deaf and Dumb and author of many articles and books on medical and scientific subjects (one of the books he wrote was "An essay on the Geology of the Hudson river, and the adjacent regions illustrated by a geological section of the country, from the neighbourhood of Sandy-Hook, in New-Jersey, northward, through the highlands in New-York, towards the Catskill mountains: read before the Lyceum in August, l8l9"). American Ichthyology is dated from the feeble beginnings of Rafinesque and from Samuel Latham Mitchill (1764-1831) so it is interesting to note here that Akerly was Mitchill's brother-in-law. The following is from Akerly's 1818 paper:

"The killifish frequent the shallows of the bays and the small streams of salt water, following the recess of the tides and advancing with the flood. There are several species of them, and they afford sport to children during the summer months, and they fish for them with worms on a pin hook. In the winter they do not bite, but collect in great numbers and reside in the deep holes of creeks and bays. At such limes they are taken by sweeping their haunts with a small scap-net (Author's Note: A scap-net is a dip net), and though they are not larger than the finger, they are brought to market for sale, and are esteemed an excellent little pan fish. They are sold tor twelve cents a quart. They are put into blood-warm water, which causes them to vomit the contents of their stomachs, and thus they are prepared for cooking. The white-bellied killifish is the one under consideration, and is the *Esox pisculentus* of Mitchill's memoir. [Author's Note: the "memoir" mentioned here is Mitchill, 1815). Killifish is a provincial word for all small fish in New-York, and appears to be derived from the Dutch word kill, applied to all small streams by the original settlers of New-York.]

It has always been assumed that the "kill" in both of these descriptions refers to the Dutch word. However, due to the fact that killifish - and especially *Fundulus heteroclitus* - were often used as bait fish, an alternate derivation of this term was suggested by Ken Lazara in an article (now removed) that appeared on the first AKA web site titled, "On the Origin of the Term Killifish."

There is documented usage that in angling publications from at least 1676 until 1885, a very successful bait was referred to as a "killing bait," as in **"Now, the cadis, or cod-bait, which is a sure killing bait…"** (Walton and Cotton, 1676), **"As killing a Bait as any whatever."** (Chetham, 1681) and **"Fishing with the young frog is a very killing method of fishing for chub"** (Francis, 1867). In these examples, "killing" is used as an adjective, not as a verb or a noun.

Lazara contended that the transitions from "killing bait" > "killing fish" > "killfish" > "killifish" were perhaps how the term "killifish" was derived. However, although the last two transitions are certainly plausible, the transition "killing bait" > "killing fish" is a jump for which there is no documentation in the literature whatsoever. For another, during this period, anglers used the terms "killing" and "catching" interchangeably, so "killing bait" means "catching bait," and so the transition to "killing fish" makes no sense whatsoever.

Furthermore, the derivation relies on references to British publications, namely the Oxford English Dictionary and the Chetham and Francis books. The idea that "killifish" was derived from "killing fish" first appeared in the Oxford dictionaries. For example, under "Killifish" in my copy of the Oxford Universal Dictionary of 1933, updated to 1955, there is the following: **"1836 [? f. KILL + FISH; but cf. (i.e., a standard dictionary abbreviation meaning confer or compare) KILLING]." Under "Killing" appears: "of bait: sure to kill 1681."** The "killing bait" term originated in 1681 in England, over a century before the term "killifish" ever appeared in print.

However, in the current on-line Oxford Dictionary site of the Oxford University Press, it is now stated for the origin of killifish, "early 19th century: apparently from KILL and FISH." Oxford has thus abandoned the idea of "killing fish" as a possible origin of the word. (Although I myself would have cited 1792 as the date of origin, I have no real problems with "early 19th century"; I am thinking here of Mitchill, 1815 and Akerly, 1818.)

The question also arises as to whether any of these British references have any relevance to the name "killifish," since British usage is one thing and American usage quite another. To this end, I have consulted three of the earliest books on American Angling (Forester, 1850; Norris, 1864; Scott, 1869).

One of the most obvious differences between the British and American references cited in this monograph is the infrequent use of the terms "killing" and "kill" in the latter. American anglers favored "catch" and "take" over "kill" and on page 129 of his book, Norris states that "Pickering (Ellis, 1835) in his Piscatorial Reminiscences, speaks of a Pike killed (caught) in Loch Spey that weighed one hundred and forty-six pounds." Norris used the American equivalent in the parentheses, thus making sure that the reader was not confused by the term "killed." Kill, by the way, is mentioned frequently throughout the Forester, Norris and Scott books in place names, such as Kill van Kull, Bashe's Kill and Fishkill Landing.

With regard to bait, although "killing bait" and related terms do occur with some frequency in the American literature, they do not appear in connection with killifish. The reason is simple. Early on, not only were killifish referred to as "minnows," but "minnows" referred to killifish and killifish alone, as the following (with its ar-

chaic spellings preserved) confirms (Forester, pg. 176-177):

"MINNOWS
***Hydrargyra*; Auctorum**

[Author's note: "Minnow" has its roots in Old English menow and Anglo-Saxon myne, meaning a very small freshwater fish, perhaps influenced by Old French, menuise meaning small fish. Hydrargyra is an old synonym for Fundulus. Auctorum (abbreviated auct. or auctt.) in zoology is a term used to indicate that a name is used in the sense of a number of subsequent authors and not in its (different) sense as established by the original author.]

"The minnow proper of Europe, *Cyprinus, Leuciscus, Phoxinus*, is unknown to the waters of North America, but as their equivalents, and analogous to them, we have innumerable species of the *Hydrargyra*, or American Minnow; which, in general appearance, habits and haunts, are very nearly assimilated to the European fish.

"Its food consists of aquatic plants, small worms, and minute portions of any animal substances. It bites boldly and readily at small red worms, gentles, or the larvae of any of the *Phryganea*, known as caddis-baits, stick-baits, and the like, on the least Limerick hooks, number twelve; and is constantly taken by boys with a worm alone tied to a fine string, which the little fish swallows so greedily that he is pulled out before he has time to disgorge it.

"Under many local names this beautiful little *Cyprinus* is found in every swift-running stream with a gravelly bottom, and in the shallows of every pond or lakelet throughout the country. They are generally known as Killy-fish, and are an excellent bait for fish of almost every kind that prey on other fish.

"As live bait for Pike, Pearch or Catfish, they are not to be equalled; and in spinning or trolling they are excellent for the noble Striped Bass, the Pike, the Salmon, the Lake Trout in all its varieties, and for the Brook Trout - especially those which are found in the tide-creeks, where they are less willing than in other waters to take the fly. A more particular description of so common and well-known a fish would take up space needlessly, which is more required for other parts of my subject; and the species are, I was almost about to say, innumerable. Three of the commoner varieties, and those most useful as bait, are represented on the preceding page."

Among the other bait fish mentioned by Forester were dace, shiners and other small cyprinids (especially of the subfamily Leuciscinae), and in later years the term "minnow" included these fish as well, as evidenced in the Norris and Scott books. Webster's Revised Unabridged Dictionary (1913) includes among its three definitions for "minnow" the following: "Any of numerous small American cyprinodont fishes of the genus Fundulus, and related genera. They live both in fresh and in salt water. Called also killifish, minny, and mummichog." Therefore, even when the bait in question was a killifish, the name originally used by American anglers was "minnow," not "Killy-fish," "killfish" or "killifish." There never was a need to use the lethal meaning of "kill" to modify "bait" when the object in consideration was a killifish.

When I first became interested in the origin of the term "killifish" (over half a century ago!), I posit-

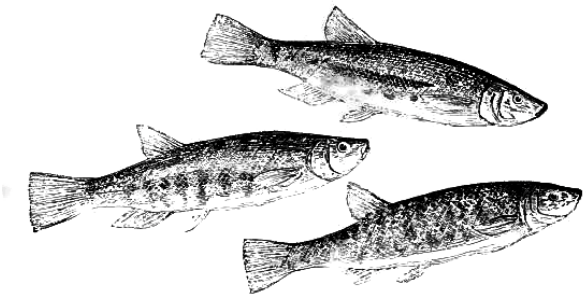


Figure 4: Figures from Forester's "Fish and Fishing of the United States," 1850.

ed that it could have come from only three possible communities: science, angling and aquarium. With regard to the science community, there are two hypotheses, i.e., that Schoepff and Walbaum had location on their minds or fishing. Throughout ichthyological history, location, patrimony and physical attributes have been the source of almost all names, and fishing is not included in any of them. Occam's razor (Ariew, 1976), often expressed in Latin as the *lex parsimoniae* or the law of parsimony, is a principle that generally recommends selecting the competing hypothesis that makes the fewest new assumptions when the hypotheses are equal in other respects. Clearly, location wins on this count and I have documented here one of the earliest (i.e., 1818) usages of "killifish" in a scientific reference appearing after Schoepff and Walbaum descriptions in the prior century.

The American angling community was never a contender since their word for killifish was "minnow," a term that originally only referred to *Fundulus* although later, anglers included dace, shiners and other small cyprinids under the rubric of "minnow" as well. Thus the origin of the term "killifish" could not have come from the angling community since it was a term they never used until a century after its use in the scientific community.

With regard to the aquarium community, in 1955 in *Tropical Fish Magazine*, published by a consortium of New England aquarium societies, Dr. George S. Myers (Myers, 1955) proposed two new popular names: "killifish" for the egglayers (and he based this on its long-term usage in the ichthyological community) and "gambusino" for the livebearers. However, the publication was largely unknown to any but those living in the New England area and so neither term caught on with aquarists at the time, panchax remaining in common use among killifish fanciers. However, I had read the article and it prompted me to use "killifish" in my own writings, all this quite a few years before the founding of the AKA. The establishment of the American Killifish Association in 1961, of course, made "killifish" the pro forma term used by most aquarists on both sides of the Atlantic.

Although it can be argued that, just like "Panchax," "Killifish" is based upon a no longer-used scientific name that applied to just a few killifishes (i.e., the fishes of the New York/New Jersey area), the latter is not actually based upon a scientific name but on a common name. Furthermore, it seems appropriate and desirable that an American organization should base its name on fishes found in this country, rather than in foreign ones.

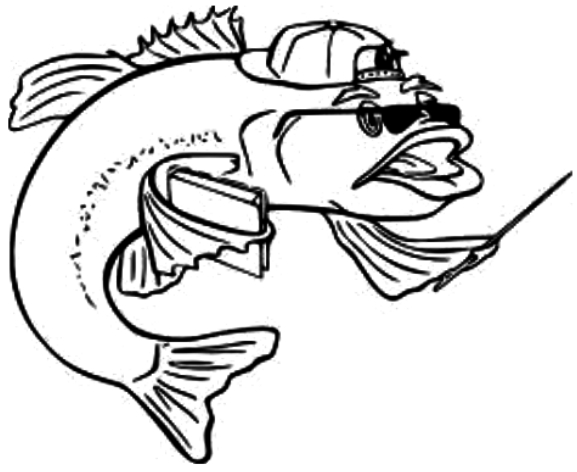
Finally, there seems to be some confusion about the correct spelling of killies in the singular, i.e., is it "killie" or "killy"? In the December 1969 issue of KILLIE NOTES in the "Letters to the Editor" column, Editor Joseph F. Ricco reported on a letter he had received:

"And finally an item from Dr. George Myers of Stanford University. Dr. Myers informed me that the name KILLIE NOTES is incorrect and the correct name should be KILLY NOTES. The reason being that KILLY is singular and KILLIES is plural."

In English, adjectives are always singular and thus whatever preceded "Notes" had to be singular. However, contrary to Dr. Myers' opinion, "killie" is singular and had been known as such for many, many years in both the scientific and lay literature. A good example is Henry Fowler's report on the fishes of New Jersey (Fowler, 1905) in which the following common names (all singular as common names are) were included in the list for *Fundulus heteroclitus macrolepidotus*: "Killy," "Killie" and "Killy Fish." The following were included for two other killifish species, "Killie Fish" and "Killi Fish," making a grand total of five different names for the singular of killifish!

In any case, usage out-trumps any grammarian and that which is "correct" changes with the times, as is shown clearly by Fowler's report. Maugham, in his 1938 book, "The Summing Up," wrote: **"It is necessary to know grammar, and it is better to write grammatically than not, but it is well to remember that grammar is common speech formulated. Usage is the only test."** Therefore, KILLIE NOTES is correct, and either "killie" or "killy" can be used safely for the singular.

Incidentally, when the AKA was founded in 1961, my own preference for the shortened singular of killifish was "killy," since it was consistent orthographically with the ending of other well-established aquarium names, such as "molly" and "platy." However, Jorgen Scheel had used "killie" prior to this and, as it was accepted among many well-known killifish fanciers, I decided against my better judgment to use it.



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HOW CLADISTS WORK

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, October 21, 2007)

THE IDEA BEHIND CLADISTICS

It is generally understood that classifications ought to reflect the phylogeny of organisms, where each taxon (a genus, for example, is a taxon) should originate from a single ancestral form. The emergence of “cladism” or “cladistic taxonomy” in the 1960’s, therefore, is expected to supplant Linnaean classification in the future since, in classifying species, cladists place a priority in achieving coherence with the Darwinian principle of common descent.

In grouping species, cladists look for “derived similarities,” meaning those aspects that species can be expected to share by virtue of a common evolutionary ancestry. This approach differs from that of phenetics, which associates species based on overall similarity and does not address ancestry. This was the way aquarium species were classified in the old days. It also differs also from classification based on ad hoc “key characters,” a device known to aquarists looking up identification in a book based on such keys. Cladists, on the other hand, avail themselves of all the types of evidence available, including DNA sequences and hybridization studies, biochemistry, and traditional morphology.

They often make use of computerized algorithms to identify the most likely phylogeny or “family tree” that relates the species they are considering. A cladistic analysis therefore is applied to a certain set of information. To organize this information a distinction is made between characters, and character states. Consider the color of fish scales; this may be blue in one species but red in another. Thus, “red fish scales" and “blue fish scales” are two character states of the character “scale-color.” The researcher decides which character states were present before the last common ancestor of the species group and which were present in the last common ancestor by considering one or more outgroups. An outgroup is an organism that is considered not to be part of the group in question, but is closely related to the group. This makes the choice of an outgroup an important task, since this choice can profoundly change the topology of a tree. Note that only character states present in the last common ancestor are of use in characterizing clades.

CLADOGRAMS

Cladistics provides systematists with one very handy feature. Due to its bipolar character states (a species has a given character or it doesn't — there's no in-between), cladistics lends itself very readily to computer analysis. Computers can analyze hundreds or thousands of characters in a fraction of the time that a human systematist could. Computers then use the results to generate branching diagrams — called "cladograms" — which graphically represent how the included species are interrelated. The example on the following page is an example of a cladogram:

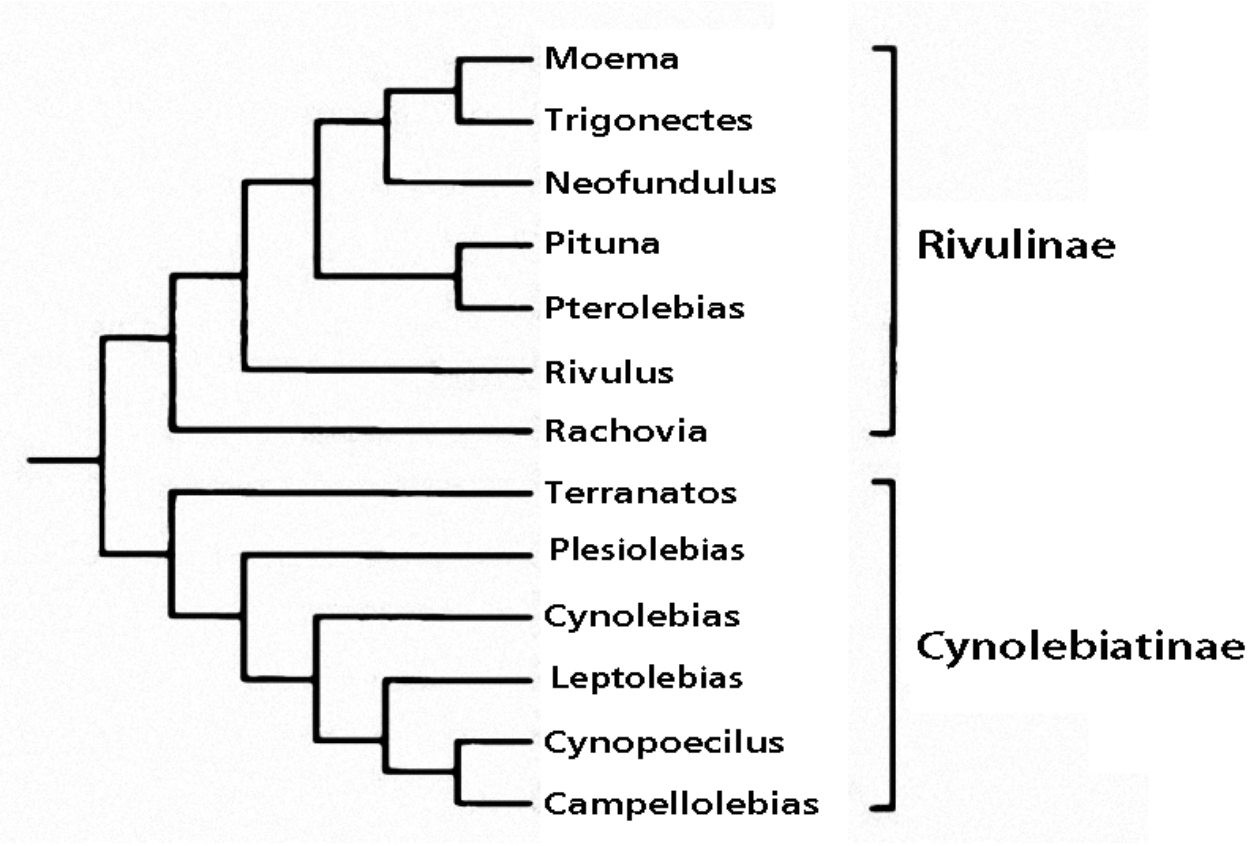
Clades ideally have many “agreeing” character states present in the last common ancestor. Ideally there are a sufficient number of them to overwhelm characters caused by convergent evolution (i.e. characters that resemble each other because of environmental conditions or function, not because of common ancestry). A well-known example due to convergent evolution would be a character “presence of wings”. Though the wings of birds and insects serve the same function, each evolved independently, as can be seen by their anatomy. If a bird and a winged insect were scored for the character “presence

of wings", this would confound the analysis, possibly resulting in a false picture of evolution.

HOW CLADOGRAMS ARE OBTAINED

Many cladograms are possible for any given set of taxa, but one is chosen based on the principle of parsimony, i.e., the most compact arrangement, that is, with the fewest character state changes. Though at one time this analysis was done by hand, computers are now used to evaluate much larger data sets. Sophisticated software packages allow the statistical evaluation of the confidence we might expect, these methods are difficult to explain to those not versed in statistics or mathematics but I'll give it a try.

The maximum likelihood method is based on a model and on a distribution. The model is the probability of an event dependent on a model parameter, p. The likelihood of the parameter given the data is the probability of observing X given p. The maximum likelihood method consists in optimizing the likelihood function. The goal is to estimate the parameters p which make it most likely to observe the data X. In this example I'll use the



can put in the veracity of the nodes of a cladogram. Using a parsimony criterion is only one of several methods to infer a phylogeny from molecular data: maximum likelihood and Bayesian inference, which incorporate explicit models of sequence evolution, are also ways to evaluate sequence data. As you

binomial distribution, often used to calculate the probability of the outcome of coin tossing. Suppose we throw a coin three times where the probability of observing a head (1) is p=1/4 and the probability of observing a tail (0) is p=3/4. We can compute the proba-

bility of each possible data set (X) of three tosses in Table I.

TABLE I				
X			Computation	
0	0	0	(3/4)*(3/4)*(3/4)	.4218
0	0	1	(3/4)*(3/4)*(1/4)	.1406
0	1	0	(3/4)*(1/4)*(3/4)	.1406
0	1	1	(3/4)*(1/4)*(1/4)	.0468
1	0	0	(1/4)*(3/4)*(3/4)	.1406
1	0	1	(1/4)*(3/4)*(1/4)	.0468
1	1	0	(1/4)*(1/4)*(3/4)	.0468
1	1	1	(1/4)*(1/4)*(1/4)	.0156

Now in a toss of coins three times, the probability of obtaining a head followed by two tails (the fifth entry in the table) clearly is: 1/4*3/4*3/4 = 0.1406. Inversely, if we observe the outcome of three throws as “1 0 1” we can compute the likelihood, L, of the probability that produced this outcome in Table II.

For example, in a toss of coins three times, if the probability of obtaining a head is 0.8, the probability of obtaining a head, then a tail, and then a head is (the eighth entry in the table) is: 0.8*0.2*0.8 = 0.128.

We can see from the table that the result “1 0 1” is most likely for p = 0.7. Substitute a set of observations on a group of fishes rather than a set of observations on a group of coin tosses, and substitute a postulated clade for the probability in the last table, and you have the basic idea of one way cladists form their cladograms using the maximum likelihood principle.

TABLE II		
p	Computation	L
0	0*1*0	0
0.1	0.1*0.9*0.1	0.009
0.2	0.2*0.8*0.2	0.032
0.3	0.3*0.7*0.3	0.063
0.4	0.4*0.6*0.4	0.096
0.5	0.5*0.5*0.5	0.125
0.6	0.6*0.4*0.6	0.144
0.7	0.7*0.3*0.7	0.147
0.8	0.8*0.2*0.8	0.128
0.9	0.9*0.1*0.9	0.081
1.0	1*0*1	0

POINT OF VIEW

THE NAME GAME

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, April 16, 2009)

I give you now Professor Twist,
A conscientious scientist,
Trustees exclaimed, " He never bungles!"
And sent him off to distant jungles.
Camped on a tropic riverside,
One day he missed his loving bride.
She had, the guide informed him later,
Been eaten by an alligator.
Professor Twist could not but smile.
"You mean," he said, a crocodile."
Ogden Nash

One change that stands out markedly to me in the aquarium writing that has evolved between the close of World War II and the present– and I refer here to magazine articles and even more particularly to the journals of specialist associations – is the plethora of changes of, and additions to, aquarium genera. One often has to wade through a nomenclatural mini-dissertation before one gets to what is of real importance to the reader, i.e., the fish's origin, description, behavior, requirements and (hopefully) its breeding.

Since it removes all doubt as to what fish is being referred to, aquarists have always been legitimately interested in pairing a common name for a fish with a scientific one. If one knows the species name it is a simple task to include it in an article without miring down the text in matters more of interest to a professional than to an aquarist.

Historically, one usually acquired the name of a species in three ways: (1) finding a match using aquarium references, (2) attempting to identify it oneself, or (3) sending a specimen to an ichthyologist for identification.

The first method was really hit-or-miss, since the pre-World War II aquarium literature available at the time was based upon illustrations, many of which were of doubtful accuracy or lacking in detail. The second method was mainly the province of specialist associations like the American Killifish and American Cichlid Associations whose members took the time and trouble to obtain the original descriptions and who had access to the equipment needed – such as a good microscope, preferable a binocular type – to count scales and fin rays and to calculate certain distance ratios. Since pre-World War II descriptions were often based mainly on these variables, some of these efforts were successful. However, amateurs are not professionals so the results were tentative at best. Furthermore, the examination of bone structure was fast becoming an additional and important tool with which to describe a fish, so the DYI approach to fish identification became untenable even for the specialist associations.

Although most ichthyologists were cooperative, the third method was not always successful either since one really needed to contact a professional whose primary interest was in the group the specimen was related to, and this was not always an easy search. When the first wave of African importations that included *Distochodus* species arrived in this country shortly after World War II, for example, it made more sense to contact a British ichthyologist such as Peter Humphrey Greenwood than an American ichthyologist such as Robert Rush Miller since the latter was not that familiar with these species nor was he interested in them.

By whatever means the names were supplied, however, if a mistake had been made then sooner or later it would be corrected. Although most of the changes during the immediate Post-World War II period involved species names, there were some changes in genera as well, e.g., *Haplochromis multicolor* to *Hemihaplochromis multicolor* and *Aplocheilichthys macrophthalmus* to *Micropanchax macrophthalmus* to cite a cichlid and killifish example, respectively. Aquarists found no fault in accommodating these changes either, since they were few and far between and it took very little effort to be "correct."

In any event, a change in generic name had no real effect upon the hobby since it provided little or no new information about a fish's origin, description, behavior, requirements or breeding that was not known previously. In short, except for being part of the species name, the genus was – and still is - of no appreciable value in the aquarium hobby. Indeed, I will shortly suggest that even for Science it is becoming as obsolete as the classical Linnaean system of classification it is part of.

THE INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE

During these early years some aquarists, especially those in the specialty groups, became familiar with the International Code of Zoological nomenclature (ICZN or the "Code"). This is a comprehensive document consisting of 18 Chapters, broken down further into Articles and sub-Articles. Its aim is to stabilize and provide uniformity in the scientific naming of animals. In spite of its apparent complexity, the Code can be summarized in two words: bookkeeping and priority.

The bookkeeping part of the Code deals with rules for naming. The Code, for example, requires that a generic name should be treated formally as if it were a Latin noun with a definite gender, and specifically rules that generic names formed from words included in the standard Greek or Latin dictionaries take the genders of those words. For example, if a species name is Latinized, the gender of its ending must agree with its generic name. An example is the old killifish name, *Fundulus bivittatus*. *Fundulus*, since it ends in –us, is masculine so the species name also ends in –us. However, when the fish was deemed later to be in the genus *Aphyosemion*, which is neuter since it ends in –um, the name had to be changed to *bivittatum*. It is not mandatory, however, for the author of a new genus to specify its gender; I could, for example, propose a new generic name, *Zwibac*, and have the ichthyological community guessing as how to assign the endings of the names of new species to the genus.

The Code expressly states that, with a few exceptions, a difference of a single letter is sufficient to make two species or generic names different; *londonensis* and *londinensis,* for example, could be accepted as names for different species of the same genus. The botanical code, on the other hand, rules that what is called "orthographic variants of the same name" are to be treated as homonyms. Here the botanists show greater respect for tradition and common sense.

The Code has no restrictions as to the number of letters in a name nor does it have any mandatory provisions for the combination of letters in names. Thus, *Xqnal* would be perfectly acceptable although no one would be able to pronounce it. There are, of course, procedures whereby one can petition the Commission for an exception. An example of where common sense prevailed was when Dybowski proposed the name *Gammaracanthuskytodermogammarus loricatobaicalensis* for a type of shrimp-like crustacean in 1927. It would have been the world's longest scientific name, but was rejected by the International Commission for Zoological Nomenclature on the grounds that it was unpronounceable, although I suspect that its

length had more to do with it. In actuality, if one breaks the name down into its components it is no more unpronounceable than the average scientific name. The honor, by the way, of having the longest scientific name approved by the ICZN actually goes to a species of soldier fly - *Parastratiosphecomyia stratiosphecomyioides*, while the shortest appears to be that of a carnivorous bat - *Ia io*, although there is a thrip with a single-letter species name - *Plesiothrips o*.

In passing I note that the official language of the Code is English but with preference for British written conventions. Therefore, words such as "parasitise" are often found in written opinions, rather than their American counterparts, i.e., "parasitize."

These are trivial examples of bookkeeping; a more consequential one is the designation of what is known as a "holotype." Suppose an ichthyologist receives a batch of fishes and finds it to be a new species. A **holotype*** is the single specimen upon which the original author of the species designated as such, if he bothered to do so that is, since it was not a requirement under the Code until 1999. The remaining specimens are designated as **paratypes**. Now the naming of a holotype can be important. Suppose, for example, that the batch of fishes actually contained two new species and a holotype was not designated. Which one then has the new name? There are sections of the Code that deal with such matters.

The current rules make type designation the all-important act as far as nomenclature is concerned. We have, for example, types for species as I have just explained, plus those for genera and families. The type for the species we have seen is the holotype, the type for a genus is a species, and a type for a family is a genus. Note that with the exception of the species, for which the type is an actual museum specimen, all the other types are just names and note that names change.

This system places a tremendous legal weight on the holotypes, the theory being that a single specimen can only belong to one species, whereas it always remains possible that a group of specimens might prove to contain more than one species. Although one cannot argue with this logic, a single specimen does not by itself provide a sufficient criterion to define a species. Yet, a whole family of fishes is, in effect, defined by a single specimen.

A further objection to this exclusive reliance on the type system is that holotypes are all too perishable, and if they receive the frequent and intensive study which the present system demands, their useful life will not be very long. In practice, the use of holotypes is restricted because in most groups they are scattered widely throughout the museums of the world, which as a rule are very reluctant to send them outside their own doors for study.

The founders of modern zoological nomenclature did not specify types for genera and it is doubtful whether the majority of genera had types specified for them before 1910. The citation of a type species for a new genus did not become legally obligatory until 1931, and during the last fifty years various taxonomists have taken it upon themselves to propose types wholesale for old genera which seemed to lack them. Such designations have only too often been made in a casual manner with no serious study of the issues involved; hence spring many of our present nomenclatorial troubles.

The problem is that the current code incorporates provisions to the effect that the original specifier of a species name as the type for a genus is assumed to have used that name correctly. This means, in effect, that the type for a genus is the name itself rather than an actual species; if later discoveries or rulings of the ICZN lead to a change in the application of the species name, this means that a different species

*Although I am not a big fan of professional jargon, admittedly it does simplify writing so I will define useful technical terms and boldface them as they first appear in this document.

becomes the type of the genus. I bring all this up because in addition to introducing problems for the professional, these problems in nomenclature are ultimately passed down to aquarists as well.

The original purpose of the priority principle in the code was to adjudicate instances where two zoologists, ignorant of reach other's activities, had described the same species under two different names. However, over time it included other categories as well. The principle of priority in the Code, and it should be noted that the principle is responsible for most of the name changes at the species level in the aquarium hobby, states that "…the valid name is the oldest available name…," an "available" name being one that meets certain criteria in the Code or does not fall entirely out of the province of science.

An interesting example of the latter criterion is the genus *Echidna.* In ancient Greek mythology, Echidna (Greek for "she viper") was called the "Mother of All Monsters," being described as a female monster spawned in a cave who mothered with her mate every major horrible fiend in the Greek myths. If one attempted to give a scientific name to this creature it would not be considered "available" under the Code since it clearly falls outside the realm of science.

In 1797 Georges Cuvier proposed the genus *Echidna* for the spiny anteater, basing the name on the Greek myth since the spiny anteater on a small scale admittedly did resemble some creature out of Hell, although it is actually quite a docile creature. Since this was an actual animal the name was deemed available and the spiny anteater became not only *Echidna* scientifically but Echidna commonly as well. However, Johann Reinhold Forster had published the name *Echidna* in 1777 for a genus of moray eels and therefore it had priority. It is ironic to note that although today everyone uses Echidna as a common name for the spiny anteater, the scientific name, *Echidna*, still belongs to the moray eels!

CLASSIFICATION, SYSTEMATICS AND TAXONOMY

The words classification, systematics and taxonomy unfortunately are now commonly treated as synonyms. Originally and properly, classification would have denoted the activity of placing things in classificatory groups, whereas systematics would be the body of general theory underlying this activity. The word taxonomy, though proposed long ago, has come into general use recently and has become a vaguer synonym of classification and systematics. Thus a taxonomist is generally thought of as an ichthyologist (in our case) who specializes in the classification of fishes into groups on the basis of their structure, origin or behavior. The groups are called **taxa** (from the Greek taxis meaning order or arrangement) and the singular is a **taxon**; a species, for example, is a taxon as is a genus, family, etc. **Genus**, by the way, is derived from the Latin word meaning race, stock or kind.

Systematics, on the other hand, is the study of the diversification of life on the planet Earth, both past and present, and the relationships among living things through time. These relationships are visualized as evolutionary trees, referred to as phylogenetic trees or simply phylogenies. The word **phylogeny** has its roots in the Greek words, phyle or phylon meaning tribe or race and genesis or genetikos meaning relative to birth.

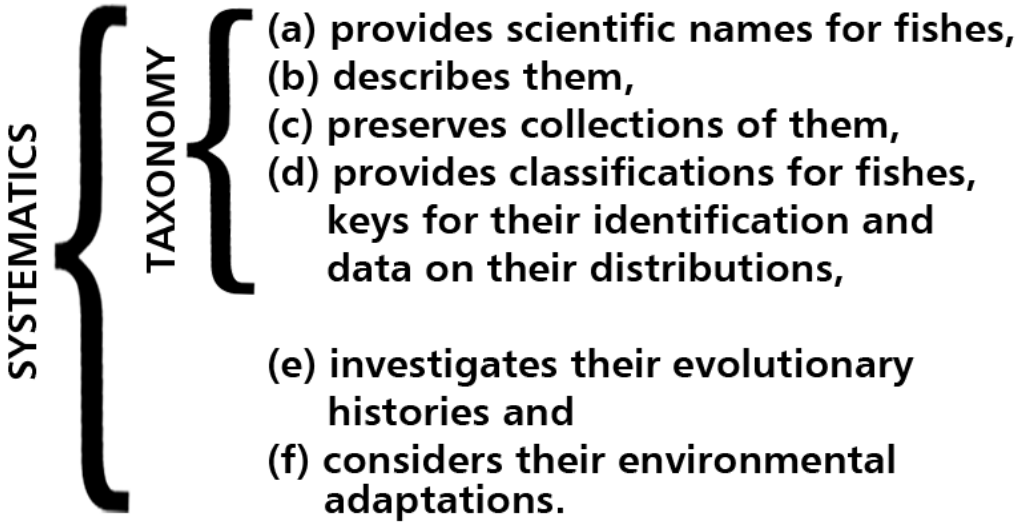
Phylogenies have two components: (1) a branching order showing group relationships, and (2) branch length showing the amount of evolution. Phylogenetic trees (sometimes called **cladograms** from the Greek word klados meaning branch) of species and higher taxa such as genera are used to study the evolution of traits, which can be anatomical like scale counts or molecular like DNA, and the distribution of organisms which we term biogeography. Systematics, in other words, is used to understand the evolutionary history of life on Earth. Figure 1 summarizes the relationship between systematics and taxonomy.

As mentioned previously, systematics and taxonomy are terms that are often confused and used interchangeably. Figure 2 shows how these two terms are related. On the plane denoted as "Current Time," the circles represent current existing species. The tree in the diagram is a phylogenetic tree, and has implied ancestries and a relative time axis. Our interest here, however, is in genera and so in the Current Time plane three are represented by the colored rectangles (counting the large gray one; if you are viewing this in black and white, the green would be the smallest rectangle and the red the next largest) that represent species grouped into genera based upon two measurements in each species, some common possibilities being fin count, height-to-length ratios or even behavioral information. Thus, species 1, 2 and 3 are in the genus denoted by the red color, species 4 and 5 are in the genus denoted by the green color, and species 6 is the only one in its genus.

The taxonomist historically based his groups on measurements made on existing species and not on information based on the evolutionary path hypothesized for these species. This approach is called **phenetics** (from the Greek, pheno, meaning display), i.e., the classification of organisms based on overall similarity, usually in morphology or other observable traits, regardless of their phylogeny or evolutionary relation. There are no hard and fast rules that a taxonomist has to follow in deciding what does and what does not belong in a particular taxon. The ICZN, for example, does not require any criteria for defining a genus - except for specifying a type species - because the Code is concerned with the nomenclatural rules, not with taxonomy.

Typically, a phylogenist - or cladist since cladistics is by far the most common method for determining phylogenetic trees - begins by collecting information on certain features of all the species in question, and then deciding which versions were present in their common ancestor and which have been derived since then. Usually the latter is done by considering some outgroup of fishes known not to be too closely related to any of the species in question. Certain characters are useless for showing common ancestry relationships because they evolved independently. For example, many fishes with sucker-like mouths originate from fast-moving waters where the sucker allows the fish to "stick" itself down without too much difficulty.

FIGURE 1



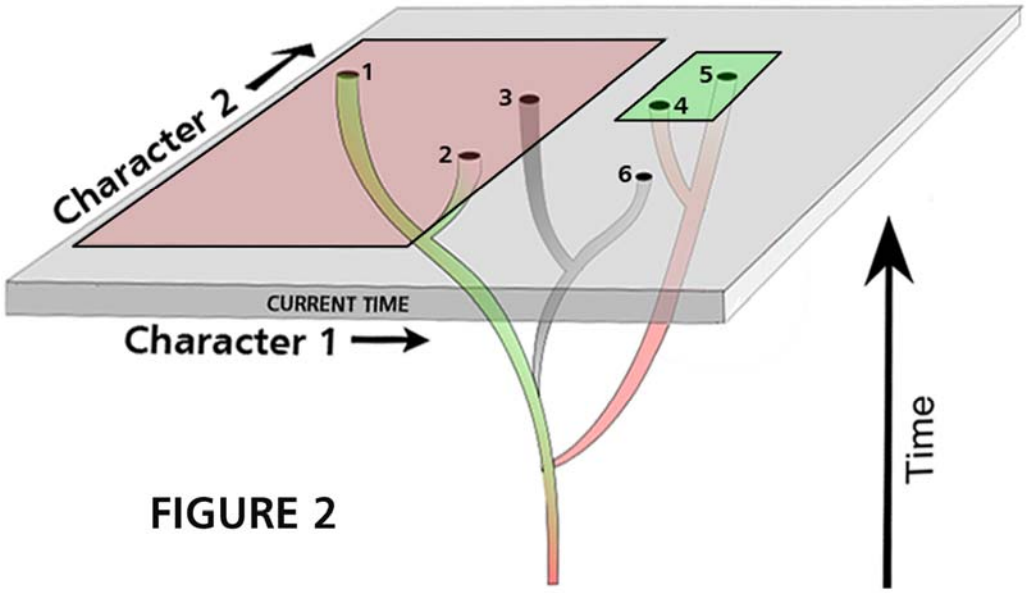


FIGURE 2

Despite their superficial similarity, this type of mouth can be found in fishes that are far from having a common ancestry, e.g., catfishes and Cypriniformes.

As a real world aquarium-related example of a phylogenic analysis, consider the Central Anatolian species of *Aphanius*. Since there a limited number of distinct morphological and phenotypical characteristics in Turkish *Aphanius* species, there are therefore few diagnostic morphological differences among the species. The classification of the genus *Aphanius* is based mainly on scalation, the number and shape of cross-bars and the characteristics of teeth, all of which are regarded as morphologically unstable. Therefore molecular data are likely to be much better suited for the determination of phylogenetic relationships of *Aphanius* species.

In 2004 the Turkish ichthyologists, Bardakci, Tatar and Hrbek studied the genetic relationships between Central Anatolian species and subspecies of *Aphanius* where they used a type of DNA analysis to classify *Aphanius asquamatus, A. fasciatus, A. danfordii, A. anatoliae anatoliae, A. anatoliae transgrediens, A. villwocki* and *A. mento*. Two populations of *A. danfordii*, one from Kayseri Lake and the other from Kocabey Lake, were included, indicated by (1) and (2) after their names.

A cladistic analysis was conducted using a well-known computer program called PAUP (Phylogenetic Analysis Using Parsimony; at this writing the program costs $85). Parsimony is one of the two main methods in cladistic analysis, the other being maximum likelihood. As I have already explained the latter elsewhere on this Forum (see “How Cladistics Works” in the Files Section), I’ll briefly talk about the parsimony method.

Most simply, parsimony is a principle that states that the simplest explanation that explains the greatest number of observations is preferred to more complex explanations. More specifically, it is defined as “a scientific rule that states that if there exists two answers to a problem or a question, and if, for one answer to be true, well-established laws of logic and science must be re-written, ignored, or suspended in order to allow it to be true, and for the other answer to be true no such accommodation need be made, then the simpler of the two answers is much more likely to be correct.”

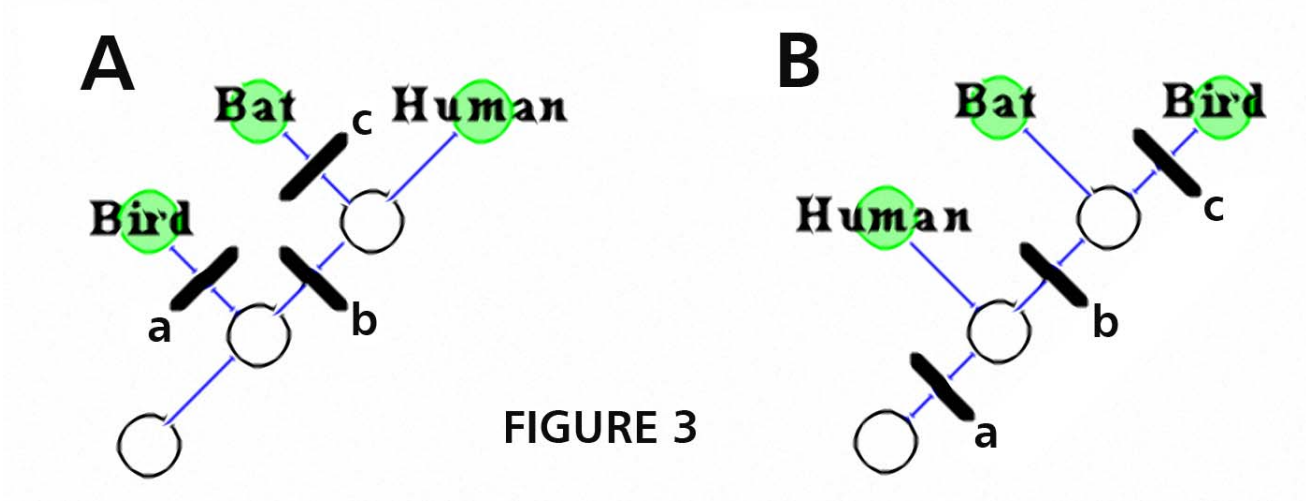


FIGURE 3

For example, consider two cladograms of birds, bats and humans shown in Figure 3:

In cladogram A, the following evolutionary steps occur:

1. At **a:** wing structures
2. feathers

At **b:**

3. hair
4. mammary glands

At **c:**

5. wing structures

In cladogram B, the following evolutionary steps occur:

1. At **a:** hair
2. mammary glands

At **b:**

3. wing structures

At **c:**

4. loss of hair
5. loss of mammary glands
6. feathers

However, cladogram A requires five evolutionary steps while cladogram B requires six. Because cladogram A requires fewer evolutionary steps it is the simplest, and parsimony dictates that this is the preferred cladogram. Further, one could legitimately argue that the combination of the loss of hair and mammary glands and the evolution of feathers would require that the well-established laws of logic and science must be re-written, ignored, or suspended in order to allow cladogram B to be "true." No such accommodation need be made for cladogram A, thus, again, making it the most parsimonious and preferred cladogram.

Using the parsimony method, the results of this investigation showed that (see Figure 4 and move down vertically from *A. asquamatus* to *A. mento)*:

(1) The Central Anatolian species of *A. anatoliae, A. danfordii* and *A. villwocki* forms a sister clade to *A. asquamatus* from Eastern Turkey (the two taxa on either side of a split in the tree are called **sister clades**). The authors point out that based on other research, the timing of the diversification of this clade is concordant with the geological history of Turkey.
(2) *A. fasciatus* (found a little East of the above species) forms a sister clade to all the Central Anatolian species of *Aphanius* including *A. asquamatus*.
(3) *A. mento* from Southern Turkey is only distantly related to the other Turkish species.

Returning now to Figure 2, a cladist would describe the red genus as **polyphyletic**, i.e., having more than one source or origin. The

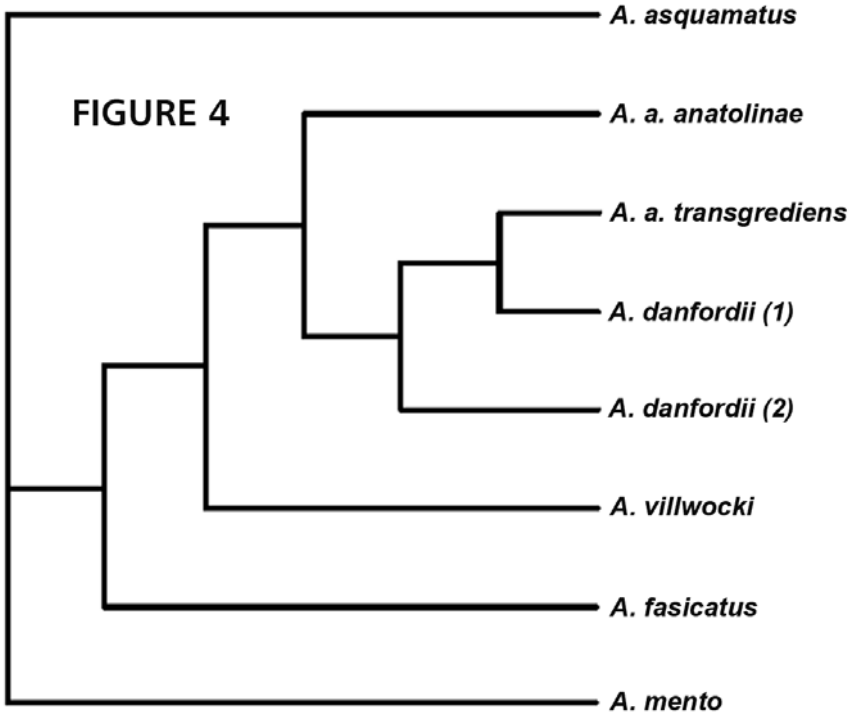


FIGURE 4

have valuable medicinal properties. Because the species is rare and difficult to propagate, attempts are made to locate the compound in other species. The search naturally centers on the genus to which the fish belongs, based on the widespread – but not always reliable - assumption that generic classifications will be predictive. If the genus is polyphyletic, however, it will obscure the fact that the compound can also be predicted to occur in species that have been excluded from the genus because of their marked divergence in some more obvious character or characters.

green genus, on the other hand, is **monophyletic**, i.e., having only one source or origin, and this is what cladists strive for. Finally, a cladist would consider species 3 and 6 to constitute what nomenclaturally we might call a genus (actually, cladists do not use the term; they would refer to it as a "**clade**"). The two classifications, therefore, are not entirely in agreement in this example.

Which of these two classifications is to be preferred? Some strongly oppose cladistic classification as a dangerous challenge to the traditional taxonomic system arguing that "readily recognizable" genera would have to be abandoned, destroying the taxonomic system without producing anything useful to replace it. My own view is that a system of classification should accurately reflect common ancestry, even if it means abandoning traditional genera. Cladists point out that systems that reflect cladistic relationships help users to avoid mistakes, such as analyzing character evolution and historical biogeography, and in making predictions.

Suppose, for example, that a compound in the mucus from a certain fish has been discovered to

In 1978 McAllister and Coad constructed a test between relationships based on phenetic and cladistic taxonomic methods, based upon the axiom that hybridizing taxa are, on the average, more closely related than non-hybridizing taxa. They used data on North American cyprinids and the study concerned 304 pairs of genera that live in the same area but which do not successfully reproduce, but 50 of which hybridize. For each pair they calculated similarity or matching coefficients for both the hybridizing and non-hybridizing genera for both methods.

With regard to the coefficients, as a simple example suppose that among our group of friends we wish to see who is similar to each other with regard to hair color, eye color and height. If two of our friends both had brown hair, blue eyes and were very tall, then the three characters match and the matching coefficient would be is 100%. If one of them had brown eyes, however, then only two of the three characters would match and the matching coefficient would be 68%. If the only matching character was that they were both tall, then the matching coefficient would be 33%.

TABLE I: PROPOSED CLASSIFICATION OF LIVING TELEOST FISHES ACCORDING TO REPRODUCTIVE BEHAVIOR (Balon, 1975)		
NON-GUARDER	GUARDER	BEARER
Open Substrate Spawner	Substrate Chooser	External
Brood Hider	Nest Spawner	Internal
No Parental Care	Some Parental Care	Intensive Parental Care
High Fecundity		Low Fecundity
Indirect Development	Direct Development	
High Number of Eggs		Low Number of Eggs
Investment at Low Cost		Investment at High Cost

For the phenetic method McAllister and Coad found that the proportion of matching coefficients for hybridizing genera above the mean coefficient, 62%, was not significantly higher than for non-hybridizing genera, 54%. On the other hand, for the cladistic method the proportion of values for hybridizing genera above the mean coefficient, 72%, was significantly higher than for non-hybridizing genera, 32%. The cladistic method, therefore, provided a better measure of phylogenetic relationships than did the phenetic method.

One goal of taxonomy is reasonable compactness, i.e., a genus should not be expanded needlessly nor have too many species. In an attempt to reduce the number of species in *Cichlasoma*, ichthyologists have increased the number of new genera significantly since World War II, and although understandable from the taxonomist's point of view, from the aquarist's perspective it often becomes an annoyance. The average aquarist was quite happy with most of the South and Central American cichlids residing in the genus *Cichlasoma*; the need to memorize the names of a slew of tongue-tying new replacement genera was about as appreciated as a root canal sans an anesthetic.

Taxonomists sometimes claim that knowledge of genera is an aid in identification but in fishes, as with birds, real-world identification is rarely made with keys. Species are usually identified directly by comparison with pictures or reference collections and aquarists never learn to attach any particular significance to the generic names.

This is not to say that there is no value in classification to aquarists or in using the genus as shorthand to refer to more than one species. Aquarists can put to good use classifications such as the very general one shown in Table I where genera are not mentioned all, and the more specific one shown applied to African fishes in Table II where a mixture of generic and species names are used. The genera in Table II, it should be pointed out, are simply convenient groupings for this classification and does not necessarily have anything to do with taxonomy or phylogeny. In this respect the generic name does have practical use for the aquarist.

SPLITTERS AND LUMPERS

Historically, lumpers are those who take two or more genera (or any other taxa) and lump them as one because they feel there is not enough variation to justify the extra names and divisions. The opposite of this is splitting - pulling apart one genus to make two or more. From one perspective, splitters recognize more

TABLE II: SIMPLIFIED CLASSIFICATION OF REPRODUCTIVE TYPES IN AFRICAN FISHES (Balon, 1984, Bruton & Merron, 1990)
NON-GUARDERS
Open Substratum Spawners
Pelagic Spawners: *Stolothrissa, Limnothrissa, Lates, Ctenopoma muriei, Alestes*
Rock and Gravel Spawners: *Opsaridriam microlepis*
Brood Hiders
Annual Fishes: *Nothobranchius*
GUARDERS
Clutch Tenders
Plant Tenders: *Polypterus*
Nesters
Froth Nesters: *Hepsetus odoe, Ctenopoma ansorgei*
Hole Nesters: *Protopterus*, many Tanganyika cichlids
Sand Nesters: *Tilapia zilli* and other cichlids
Plant Material Nesters: *Pollimyrus, Gymnarchus, Heterotis*
BEARERS
External Brooders
Mouth Brooders: *Oreochromis* and *Sarotherodon* spp., *Haplochromis, Arius*
Pouch Brooders: *Syngnathus*

genera than really exist, and lumpers go around fixing the resulting damage. From another perspective, lumpers are indiscriminating bunglers incapable of appreciating the subtleties of nature.

Each approach has its well known problems. Lumping tends to create more and more unwieldy definitions with members having less and less mutually in common. Splitting often leads to "distinctions without difference," ornate and fussy categories, and failure to see underlying similarities. While it may or may not be a factor in any individual case, it is also to be observed that there is more glory in "discovering" a new genus than there is in discovering a new species, despite the fact that the former can be done in one's own living room whereas the latter requires one to get his feet wet.

> *"Say what's the rest but empty boast*
> *The pedant's idle claim,*
> *Who* having *all the substance lost*
> *Attempts to grasp a name."*
>
> (From *Solomon*, an oratorio by George Frideric Handel.)

The practicality of the binomial system has, in any event, been seriously undermined by the changes that have occurred since Linnaeus. Enormous numbers of species have been added to those recognized by Linnaeus; we are now approaching a million species of animals, compared with a few thousand in Linnaeus's time. The binomial system could have absorbed this enormous increase without serious loss of utility if most of the additional species had been incorporated in already established genera so that the number of the latter did not rise very greatly. In practice, however, the multiplication of species since Linnaeus's time has gone hand in hand with the splitting of his genera, and the average number of species per genus has actually declined - a figure of about five would probably be a reasonable estimate today.

In some groups (e.g. birds) generic splitting has gone to such lengths that the average number of valid species per genus is down to something between two and three, and among present-day ornithologists there is serious question whether the generic names serve a practically useful purpose at all. One effect of this has been the discrediting of the genus as a practical category among ornithologists, some of whom have even proposed that the generic names should be dropped from practical use altogether. Although I don't favor this drastic discarding of the baby with the bathwater approach for fishes (where the situation is fast approaching that in birds), I wish that ichthyologists would make more use of the subgenus. Botanists, by the way, have a

easier time of it in that they have five categories of taxa between genus and species – i.e., subgenus, sectio, subsectio, series and subseries – than the zoologist's only one.

For example, on the basis of behavior and reproduction, the *Nothobranchius* species can be separated biologically into the subgenera as follows (the subgenus *Zononothobranchius* was based on the color patterns of the males rather than on biological grounds as in the other subgenera):

Genus *Nothobranchius* Peters, 1868.
Subgenus *Nothobranchius* s.s. Peters, 1868.
Subgenus *Adiniops* Myers, 1924
Subgenus *Zononothobranchius* Radda, 1969
Subgenus *Aphyobranchius* Wildekamp, 1977
Subgenus *Paranothobranchius* Seegers, 1985

Aquarists are at leisure then, to use the single generic name *Nothobranchius* for all of the species. If, for some reason, such as discussing the reproductive aspects of these fishes, recourse to the subgenera is helpful, then the aquarist is free to use them.

In conclusion, I do suggest placing less importance upon the "genus du jour" in aquarium writing. To dwell upon this taxon is often taxing, and we all know what happened in 1763 when King George imposed taxonation without representation!

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NOMINOPHILIA*

Consider the volatile splitter,
Excited and all of a twitter.
At the fun in the game
Of adding a name
For each little variant critter.

If you make up a different name,
For forms that just might be the same;
You can use the confusion,
To support the illusion
That the effort will add to your fame.

But it's not always praxis that leads
To the multiplication of breeds;
Nor the glory of God,
But the conceit of the clod
With his ego-aggrandizing needs.

Now, a lumper's a different kind;
He thinks the world is designed,
Of similar bits
That won't addle the wits
In the limited scope of his mind.

Specify! somebody flutters;
Simplify! one of them mutters;
The lumpers and the splitters
Will never be quitters,
So the field is a patchwork of splutters.

As names blossom forth anew,
There's much to be said for the view
That puts its store
In "less is more,"
And errs on the side of the few!

**by "I. Doolittle Wright" (C. Loring Brace).*

CURRENT TRENDS IN TAXONOMY

by Albert K. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, January 26, 2006)

INTRODUCTION

Binomial nomenclature is a standard convention used for naming species. As the word "binomial" suggests, the scientific name of each species is the combination of two names: the genus name and the species or trivial name. The name of the genus (generic name) is always capitalized, while the specific or trivial name is not, and both are usually typeset in italics, e.g. *Homo sapiens*.

The names used are usually derived from Latin. Although Latin derivation is not universal (names sometimes come from Ancient Greek, sometimes from local languages, and often from the name of the person who first described a species), the names are always treated grammatically as if they were Latin words. For this reason the binomial name of a species is sometimes called its "Latin name," though this usage is frowned on by biologists. The term "Scientific name" is more acceptable. For a name to be scientifically complete, an author label and publication details have to be added.

The Linnaean system made it easy to identify unambiguously any given species of plant or animal. Linnaeus proceeded further to introduce into his system a series of groups: genus, order, class. The system works by placing each organism into a layered hierarchy of groups. Each group at a given layer is composed of a set of groups from the layer directly below. Simply knowing the two-part scientific name makes it possible to determine the other six layers.

The groupings (taxa) of taxonomy from most general to most specific are:

* Kingdom
* Phylum (animals) or Division (plants)
* Class
* Order
* Family
* Genus
* Species

An amusing note is that several acronym mnemonics have been made for these groupings, e.g., "King Phillip called out for good soup," or "Kings Play Chess On Funny Green Squares."

Intermediate ranks may be created by adding prefixes, for instance:

* Superorder
* Order
* Suborder
* Infraorder

In addition, species are often subdivided into subspecies and other infraspecific categories (subspecies, variety, subvariety and form). When a species in further subdivided, a trinomial nomenclature is used, e.g. *Astrophytum myriostigma* subvar. *glabrum*.

CLADISTICS

Cladistics (or **phylogenetic systematics**) is a branch of biology that determines the evolutionary relationships between living things based on derived similarity. Cladistics differs from phenetics, which groups organisms based on overall similarity, and from more traditional approaches based on "key characters."

Based on a wide variety of information, which includes genetic analysis, biochemical analysis, and analysis of morphology, rela-

tionship trees called "**cladograms**" are drawn up to show different possibilities. A cladogram showing the relationship between various insect groups using horizontal parallel lines joined by vertical lines. In some cladograms of this type, the length of the horizontal lines indicates the amount of time that has passed since the last common ancestor between two groups or species.

In a cladogram, all organisms lie at the endpoints, and each split is ideally binary (two-way). Each branch, whether it only contains one item or a hundred thousand, is called a **clade**. A correct cladogram should have all the organisms contained in any one clade share a unique ancestor for that clade, one which they do not share with any other organisms on the diagram. Each clade should be set off by a series of characteristics that appear in its members but not in the other forms it diverged from. These identifying characteristics of a clade are called **synapomorphies** (shared, derived characters). For instance, hardened front wings are a synapomorphy of beetles, while circinate vernation, or the unrolling of new fronds, is a synapomorphy of ferns.

CLADISTIC METHODS

Typically, an analysis begins by collecting information on certain features of all the organisms in question, and then deciding which versions were present in their common ancestor (**plesiomorphies**) and which have been derived since (**apomorphies**). Usually this is done by considering some outgroup of organisms we know are not too closely related to any of the organisms in question. Only apomorphies are of any use in characterizing cladistic divisions.

Next, different possible cladograms are drawn up and evaluated. Clades are typically drawn so that they can have as many synapomorphies as possible. The idea is that a sufficiently large number of characteristics should be large enough to overwhelm any examples of convergent evolution. In other words, there are many ways in which plants and animals, etc., may evolve features that resemble each other because of environmental conditions. A well-known type of convergent evolution is insect mimicry, in which some insects that are edible come to superficially resemble other insects that are inedible, and so escape being eaten.

In practice, neutral features like **exact ultrastructure** (a term for extremely fine structure, microscopic or molecular composition of cellular structure) tend to do just that, to provide evidence for real relationships even when the appearance of organisms makes it otherwise difficult. When equivalent possibilities turn up, one is usually chosen based on the **principle of parsimony**: the most compact arrangement is likely the best (a variation of Occam's razor). Another approach, particularly useful in molecular evolution, is **maximum likelihood**, which selects the optimal cladogram that has the highest likelihood based on a specific probability model of changes.

Cladistics has taken a while to settle in, and there is some questioning over in just what sort of circumstances cladistics is applicable. In particular, apomorphies are not always easy to distinguish and data are often unavailable due to a sparsity of available forms or a lack of knowledge of characters, and these may invalidate cladograms. There is also concern that use of widely different data sets, for instance structural versus genetic characteristics, may produce widely different trees. However, by and large cladistics has proven a useful and coherent extension of other methods and has gained general support.

MODERN APPROACHES

The approach Linnaeus took to classifying species and the majority of his taxonomic groupings remained the standard in biology for at least two centuries. Over time, however, our understanding of the relationships of living things has changed. The greatest change was the widespread acceptance of evolution as the mechanism of biological diversity and species formation. After this, it became generally understood that classifications ought to reflect the phylogeny of organisms, where each taxon should originate from a single ancestral form. The emergence of "cladism" or "cladistic taxonomy" in the 1960's, therefore, is expected to supplant Linnaean classification in the future since, in classifying species, cladists place a priority in achieving coherence with the Darwinian principle of common descent.

In grouping species, cladists look for "**derived similarities**," meaning those aspects that species can be expected to share by virtue of a common evolutionary ancestry. This approach differs from that of phenetics, which associates species based on overall similarity and does not address ancestry. It also differs also from classification based on ad hoc "**key characters**." Cladists avail themselves of all the types of evidence available, including DNA sequences and hybridization studies, biochemistry, and traditional morphology. They often make use of computerized algorithms to identify the most likely phylogeny or "family tree" that relates the species they are considering.

A group in a biological taxonomy is **monophyletic** (greek: of one stem) if all organisms in that group are known to have developed from a common ancestral form, and all descendants of that form are included in the group. Taxonomic groups that contain organisms but not their common ancestor are called **polyphyletic.**

For an example of monophyly versus polyphyly, all organisms in the genus *Homo* are believed to have come from the same ancestral form in the family *Hominidae*, and no other descendants are known. Thus the genus *Homo* is monophyletic. If, on the other hand, it were discovered that *Homo habilis* had developed from a different ancestor than *Homo sapiens*, and this ancestor was not included in the genus, then the genus would be polyphyletic. Since biologists by and large prefer groups to be monophyletic, in this case they would likely either split the genus or broaden it to include the additional forms.

We've met!

Groups that contain some but not all descendants of a given form are called **paraphyletic**. A paraphylic group is similar to a monophylic group, but excludes some of the descendants that have undergone significant changes. For instance, the traditional class Reptilia excludes birds even though they developed from the ancestral reptile.

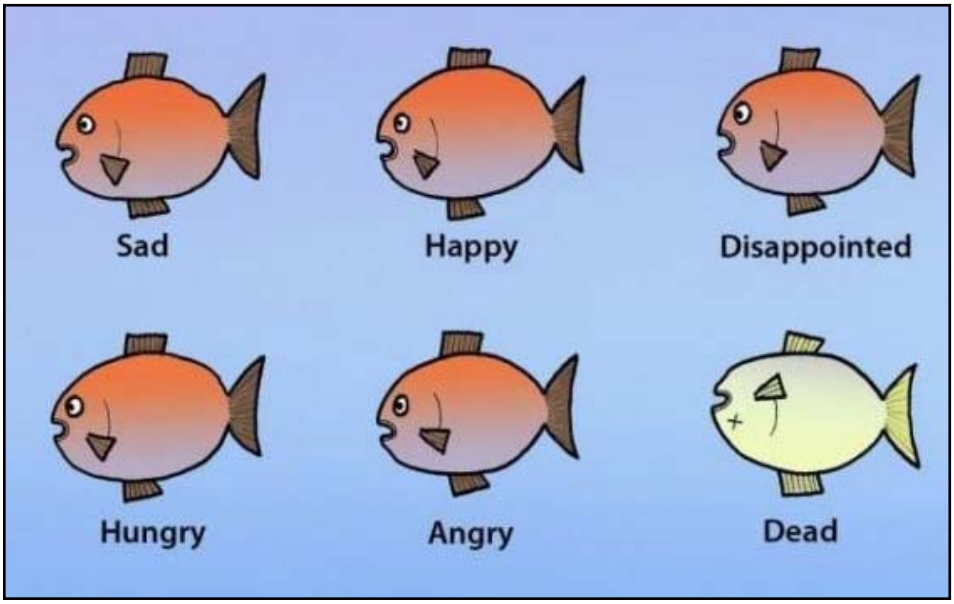
In biology, **phenetics**, also known as **numerical taxonomy**, is an attempt to classify organisms based on overall similarity, usually in morphology or other observable traits, regardless of their phylogeny or evolutionary relation. Phenetics has largely been superseded by cladistics. However, some biologists continue to use certain phenetic methods, such as neighbor-joining, as a reasonable approximation of phylogeny when cladistic methods are too computationally expensive.

As DNA sequencing has become easier, phylogenies are increasingly often constructed with the aid of molecular data. Computational systematics allows the use of these large data sets to construct objective phylogenies. These can more accurately filter out true synapomorphy from parallel evolution.

Cladistics does not assume any particular theory of evolution, only the background knowledge of descent with modification. Thus, cladistic methods can be, and recently have been, usefully applied to non-biological systems, including determining language families in historical linguistics and the filiation of manuscripts in textual criticism.

Cladists argue the classification system should be reformed to eliminate all non-clades (paraphyletic and polyphyletic groups). In fact, some cladists have argued for entirely abandoning the Linnaean system of ranked taxa in favor of clades. To this end, a formal code of phylogenetic nomenclature, the **Phylocode**, is currently under development for a cladistic taxonomy that abandons the Linnaean structure.

The denial of recognition to paraphyletic groups has been very controversial in biology and remains so among a number of more traditional evolutionary taxonomists. They feel that abandonment of paraphyly leads to loss of information in the classification system about significant changes in organisms' morphology, ecology, or life history. Accordingly, they argue that the notions of clade and taxon should be kept distinct, and that paraphyletic taxa are necessary if every group is going to be broken down completely into subgroups. Cladists counter that "significant changes" recognized by evolutionary taxonomists are often too subjective to be a basis for classification.



Understand your fish.

TILAPIA - AN ARCHAEOZOOLOGICAL MYSTERY

By Albert Klee, Ph.D.

(Buntbarsche Bulletin, No. 239, pp. 14-20, April 2007)

Fish were important in ancient Egypt both in religion and in aquaculture (Klee 2005). In the latter, tilapia (notably *Oreochromis* and possibly *Sarotherodon*) reigned supreme. In the Ti Saqqara wall paintings, for example, although clearly meant to present a wide range of different Nile fish, virtually all of the fish being processed for consumption in the illustrations seem to be tilapia. It is also the most mentioned fish in Old Kingdom texts (von den Driesch, 1983).

My interest in this subject was prompted by an attempt to identify those species associated with early ornamental fishkeeping that were also kept by later-day aquarists, and tilapia certainly fills the bill. There is an ornamental fish pond at the Temple of Amon in Luxor (see Figure 1) in which embedded in its walls were ceramic vessels to shade the fish and to provide refuge. It is evident, therefore, that the Egyptians not only knew how to build fishponds but were knowledgeable about the requirements for keeping fish as well. However, since there is no evidence that tilapia were kept in this pond, this is pretty much a dead end in the quest as far as Egypt goes. Like the Egyptians, the Romans also kept fish for religious purposes. Fish sacred to Zeus were kept in the Jovis fountain, fish functioned as oracles at the Apollinis and Limyrae fountains, and at other temple ponds fish were kept for decoration. In addition to aquaculture, the Romans also kept fish for ornamental reasons. The question now is did they keep tilapia for this purpose?

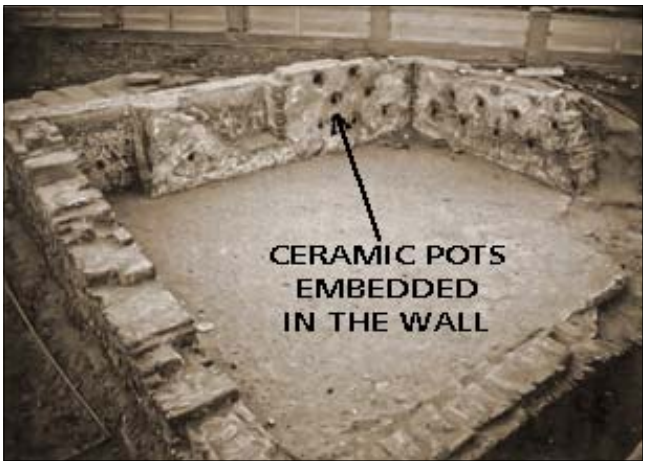


Figure 1: A sketch by the author (after Higginbotham) of the fish pond at the Temple of Amon in Luxor, showing the ceramic vessels embedded in the walls to provide shade and refuge for the fish.

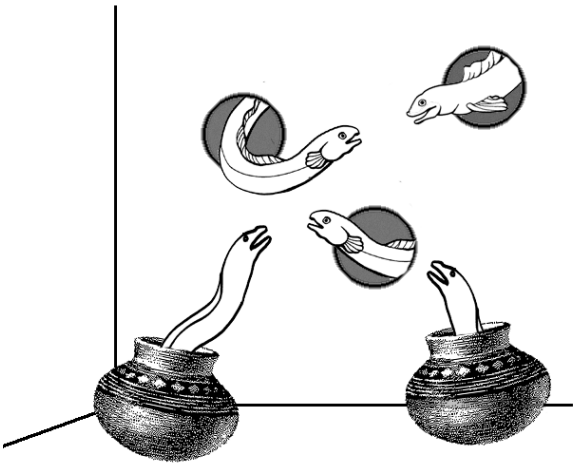


Figure 2: A sketch by the author showing how ceramic vessels were used in Roman fishponds for shade and refuge. These were placed both on the bottom of the pond and also incorporated into the walls.

It is easy to show that the Romans were true experts in fishkeeping. Lucius Iunius Columella (4 -70 AD), a Roman writer, discussed the importance of constructing a "natural environment" within a fishpond and went on at some length about the diets for various fish (e.g., decaying fish parts, salted fish, milk curds, dried figs, as well as small fish). The Romans also included ceramic vessels in the design of their fish tanks, placing them in the walls or on the bottom of the ponds (see Figure 2). These provided both

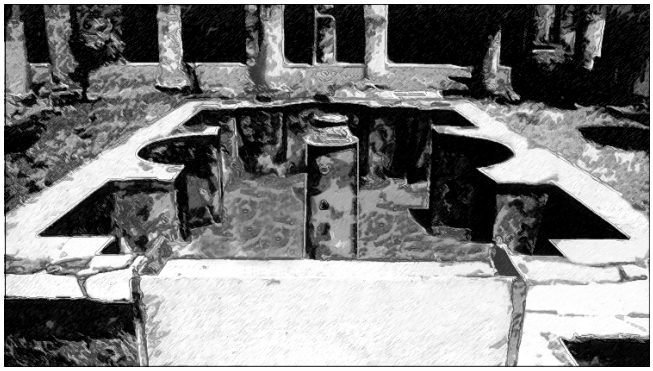


Figure 3: A sketch by the author (after Higginbotham) of the freshwater fishpond at the Casa di Meleagro in Pompeii showing the niches built into the walls for shading the fish and for refuge.

shade and hiding places for the fish. They also incorporated niches in the walls for the same purpose (see Figure 3). Columella also wrote, "Many people think that, in ponds of this type, deep recesses and winding hollows should be made in the sides for the fishes where there may be shadier refuges from the heat. However, similar recesses, like cells, ought to be excavated in the sides so that they may protect the fish, seeking refuge from the heat of the sun, and let the water, which they have received, flow out easily."

The importance of water changes also were recognized by the Romans, and provisions were made for water circulation in both their freshwater and marine tanks. They also recognized that certain fish could exist peacefully side by side but that others had to be kept strictly with their own species. Publius Nigidius Figulus (c. 98-45 BC), a savant of ancient Rome and friend of Cicero, is quoted as saying that the lupus (a member of the Labridae family) and the mullet do get along on occasion but when they do not, the lupus would eat the mullet's tail. Nigidius adds that there is no need for concern because the mullet can live without its tail! Thus, what the Romans knew about fishkeeping could easily form the basis for any beginner's aquarium book today.

As to whether the Romans kept tilapia, this is a difficult question to answer for a number of reasons. For one thing, since the Roman aristocracy preferred saltwater to freshwater fish, the historical record deals almost exclusively with the former. Because of their many excesses, the aristocracy presented a clear target for the critics of the day. Pliny the Elder (23-79 BC), for example, tells a story where a man bought an extra large mullet and remarks that the price of the fish was equal to that of nine horses!

In point of fact, fish and meat were high-status foods and not a significant part of the Roman diet. Cereals, along with beans and legumes, formed the basis for their diet, to which supplements such as meat, fish, vegetables, and fruits were added. Fish were not dependable sources of food, however. Although saltwater fish were plentiful, the supply was unpredictable and could not be guaranteed at expected times and large single fish were difficult to catch and expensive. The latter was especially true of freshwater fish which were generally caught singly. Freshwater fish also had another strike against them. To quote from the Roman physician Galen (129-200 AD): "And some of them that dwell in rivers running through a large town, eating human dung and certain other bad foods, are worst of all, as I said. So that even if they remain for a very short time after death, they straightaway become putrid and smell most unpleasantly. They are all unpleasant to eat and concoct and contain little nutriment but much residue. Accordingly it is not surprising if they produce an accumulation of unhealthy humors in the body of those who eat them on a daily basis."

Nevertheless, based on Diocletian's "Edict of Maximum Prices" issued in 301 AD, we do know that the Romans ate both fresh and salt water fish, and that it was more expensive than simpler meat types. The price of freshwater fish was 12 denarii for first quality and 8 denarii for second quality (by way of comparison, a clerk made 25 denarii a day). Saltwater fish were even

more expensive, i.e., 25 denarii for first quality and 16 denarii for second quality. The Edict, by the way, was an attempt to control runaway inflation and poverty in the Empire. The penalty for exceeding the prices of the Edict or refusing to sell the goods at the stated price was severe, i.e., death. Not satisfied to execute just the seller, Diocletian also decreed that the buyer was to be executed as well!

A recent approach to ancient nutrition is the analysis of skeletons from ancient cemeteries. Such chemistry enables us to construct a picture of prehistoric diet and lifestyles. Recent research (Nicholls, 2005) has shown that the low analyses of carbon-14 in the human remains of this period can only be explained if the Romans ate a lot of freshwater fish, which is particularly low in this material. The verdict is not just in, therefore, regarding how much freshwater fish the Romans actually ate.

Although we know that the Romans farmed brackish water species, such as eels, mugils, labrids, porgy and flatfish, and also predominately marine species such as parrot fish and mullets, we do not know whether they farmed freshwater fish or, if they did, what species were involved. Dumont (1988), in his "Cultural criteria of the choice of the fishes in antique Greek nutrition," showed that both the Greeks and Romans admired and prized tilapia (identified via mitochondrial DNA) as one of the better food fishes of the Mediterranean. Detailed archaeozoological studies (Arndt and others, 2003) of fish bones recovered from the Roman and Byzantine strata in Pisidia, located in present-day Southwestern Turkey about 66 miles north of the capital city of Antalya, have also revealed the presence of tilapia. Tilapia bones have also been found at Mons Claudianus, a quarrying settlement in the mountains of the present-day Egyptian Eastern desert about midway between the Red Sea and the Nile.

This, however, does not prove that tilapia were actually farmed in these areas. Arndt, for example, suggests that the tilapia bones might have come from salt fish (i.e., fish preserved in salt) regularly imported from the Nile Valley. Another explanation involves the discovery of the bones of the African catfish (*Clarias gariepinus*) in the same sites containing the bones of the tilapia (see Figure 4). In fact, the bones of *Clarias gariepinus* seem to crop up all over ancient Roman sites, including Rome itself, an oddity in that the Romans expressed disdain for most species of catfish. (Actually, salted catfish seems to be mentioned most often in relation to its medicinal use, as it apparently was used to recover from childbirth.[1]) Taken together, this evidence provides us with an argument for tilapia cultivation in ancient Rome.

Kron argues that the most plausible solution to the riddle of the prominence of the African catfish in these sites can be found in its highly productive symbiosis with the much more valuable

[1]Oddly enough, the spines of *Clarias* were also used for removing spines, much like we use a needle today to remove splinters.

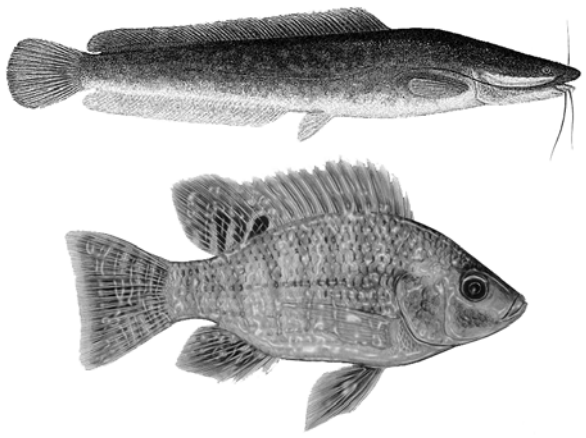


Figure 4: *Clarias gariepinus* (TOP), a police-fish for tilapia (BOTTOM) polyculture. In a polyculture, the catfish consist of about 4% of the fishes.

tilapia (Kron 2005). Both in its natural environment and in modern aquaculture, the African catfish has proven one of the most popular and effective species for use as a police-fish. A police-fish is a natural predator used to restrain the otherwise explosive reproduction of most tilapia species, particularly the mouthbrooders such as the highly prized Nile tilapia (*Oreochromis niloticus*).

The tilapia is an extremely prolific fish that reaches sexual maturity relatively young. The females have a short reproductive cycle and are able to reproduce many times over their life. Most importantly, adult tilapia protect their fry extremely carefully. As a consequence, tilapia tend to become stunted and fail to reach marketable size if raised in monoculture. If allowed to breed freely in the absence of predators, 28-70% of the total biomass of tilapia consists of fingerlings. The resultant intense competition for food between adults and their ever-burgeoning numbers of young prevent the tilapia from reaching their natural optimal size of up to almost 24 inches.

Studies in the Ivory Coast (Moehl, 1999) have shown that yields of 4 to 5 tons per acre per year of tilapia can be boosted to 9-11 tons per acre per year when the tilapia are combined with *Clarias gariepinus*. Not all of this boosted production consists of the more valuable tilapia, of course, but the vast majority generally does and the catfish are also suitable for human consumption, albeit at a lower price. Although a number of other species can also be used effectively as a police-fish, the African catfish and the Nile perch (*Lates niloticus*) are far more common. Lazard (1980), however, reported higher yields with *Clarias gariepinus*. This fish is able to control tilapia development with a stocking rate of only one catfish for every 27 tilapia, higher than the 1:37 ratio for the Nile perch but with less danger of the destruction of the tilapia if the balance is miscalculated.

The most plausible explanation then for these striking finds of African catfish all over the Roman Empire is that Roman fish farmers imported it in order to facilitate the more efficient cultivation of tilapia, which would have been a very prolific and delicious food fish for them. The African catfish was clearly an important fish in the normal habitat of the Nile tilapia, so it is very likely that Egyptian fish farmers would have quickly recognized the natural symbiosis between this species in the wild and realized the value of maintaining this relationship in tilapia fishponds. When trying to understand the culture of unfamiliar and exotic species such as tilapia, it is logical that Roman fish farmers would have drawn upon the experience of the Egyptians and imported both the tilapia itself as well as the most suitable local fish, i.e., *Clarias gariepinus*, for its polyculture. If this is the case, then it is not much of a leap to suppose that the Romans also kept tilapia for ornamental purposes as well.

One could argue that the African catfish bones found in ancient Roman sites were salt fish and not a result of fish farming. However, one would then have to explain why they were imported when much more attractive species, such as tilapia and the Nile perch, were available for salting. Large fish such as the African catfish would generally have their head, vertebrae and dorsal spines removed before being salted; yet the dorsal spines of *Clarias gariepinus* are commonly found at the sites. Indeed, if *Clarias* were used as police-fish then this would be a supply of fish that could be marketed to Romans disinclined to eat catfish in general, thus explaining the prevalence of *Clarias* bones throughout the Roman Empire.

There is one problem, however, and it is not trivial. Although tilapia species are far more common and more important than the African catfish, tilapia bones are found on fewer sites and in smaller quantities. Kron hypothesizes that there may be some taphonomic (i.e., the conditions and processes of fossilization) peculiarity

about the tilapia, or about its preparation, which tends to cause the disproportionate destruction or loss of the more readily identifiable bones of this species. Von den Driesch also noted these oddities in Egypt where we know tilapia were farmed extensively.

In any event, the question of whether the Romans farmed and perhaps kept tilapia as ornamentals is a fascinating mystery that has piqued the curiosity of classical archaeologists and archaeozoologists, and now aquarists as well.

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Did You Know???
In early 1965, Albert J. Klee initiated the idea of establishing a national cichlid association. Taking on the responsibilities as Publisher and Editor of the new magazine, AQUARIUM ILLUSTRATED, the first issue appearing in January 1966, Dr. Klee was unable to devote the necessary time to the project, and Dick Stratton enthusiastically and efficiently took over. To our great fortune, the insight of these two gentlemen was the motivation behind what is now the American Cichlid Association.

AN AQUARIUM PATENT PRIMER

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, December 8, 2007)

The aquarium historian traditionally has had recourse to two major sources of information: (1) interviews, oral or written (and this includes the historian if he or she has information relevant to the subject at hand), and (2) printed material such as books and magazines, whether as hard copy or in electronic form as might be gathered from the Internet. However, because equipment is such an important part of the aquarium hobby, there is a third major source, i.e., patents.

Fortunately for the historian, the United States Patent and Trademark Office (www.uspto.gov) maintains a database of patents available for examination on-line to any and all free of charge (the database also includes information regarding copyrights). Patents issued from 1790 through 1975 are generally searchable only by the three field codes of patent number, issue date, and Patent Office classifications (the Patent Office refers to these as "Full-Page" images). Patents issued after 1975 are in a full-text database and are searchable by all 31 different field codes as well as by keywords or phrases in Boolean combinations (the Patent Office refers to these as "Full-Text" images). A full-text database, for example, allows one to search field codes for such things as title, abstract, and inventor, or on keywords or phrases such as "aquarium heater." The latter can be of a Boolean nature such as "aquarium heater" AND "aquarium thermostat" or "aquarium heater" OR "aquarium heating."

EXAMPLE 1, FOR PATENTS ISSUED BEFORE 1975: ISD/1/$/1950->12/$/1974 and CCL/119/257.

This will retrieve all wall aquarium patents awarded between January 1, 1950 and December 31, 1970. The ISD and CCL are Field codes for issue date and classification, respectively. For patents issued before 1975, only the Field codes ISD, CCL and PN (patent number) can be used. Note that searches are not case-sensitive. You can, for example, use ccl rather than CCL. Also note that the $ symbol is a "wild card," i.e., the date field is month, day, and year so I used $ to indicate any day in January through December.

The retrieval for this search is shown in Figure 1. In the actual retrieval, the terms "Full-Text" and "Full-Page Image" are indicated by the icons after the patent number. The first patent turns out to have been issued in 1973 but the Patent Office has converted it to full-text as indicated by the title which is in text. The other three patents are available only as Full-Page images their titles being replaced by relevant classification codes. Consequently their titles are available only when one clicks on the patent number and examines the patent. As will be seen later, this causes a problem when the classification codes used involves other than aquarium-related patents.

EXAMPLE 2, FOR PATENTS ISSUED AFTER 1975: ISD/1/$/1975->12/$/2004 and IN/Danner-Eugene$ and "aquarium filter."

This will retrieve all aquarium filters awarded to Eugene Danner between January 1, 1975 and December 31, 2004. Since this search is after 1974, the inventor name field was permissible.

FIGURE 1: RETRIEVAL FOR EXAMPLE 1

	PAT. NO.	Title
1	3,735,738	WALL MOUNTABLE AQUARIUM
2	3,276,428	**119/257** 392/451
3	2,814,895	**40/538** 119/257 40/779 40/800 428/14 47/41.01
4	2,595,085	**362/101** 119/246 119/253 119/257 362/122 47/66.6 D11/145 D26/51

Clearly the full-text database is ideal since it enables one to find patents that meet predefined requirements quickly and with precision. The situation with patents issued prior to 1975, however, is not anywhere near as satisfying. One seldom knows the patent numbers or the issue dates of the patents sought, leaving the researcher at the mercy of the classification system for these patents.

The classification code that includes almost everything dealing with the aquarium hobby is Class 119, "Animal Husbandry" (there is one exception that will be discussed later). As stated by the Patent Office, "This class provides for methods or apparatus for the propagation, rearing, training, exercising, amusing, feeding, milking, grooming, housing, controlling, handling, or general care of a living animal unless provided for elsewhere." Fortunately, there are subclasses that narrow the search further, and these are defined in Table I.

Unfortunately, only subclasses 245 through 269 are really specific to the aquarium hobby; the remaining subclasses include aquaculture patents as well. This

TABLE I
U.S. PATENT CLASSIFICATION CODES RELEVANT TO THE AQUARIUM HOBBY

	CODE 119 ANIMAL HUSBANDRY
51.04	FEEDING FOR AQUATIC ANIMAL, e.g., A FISH Subject matter wherein the nourishment supplying structure presents a food substance to an animal which lives in the water. Note. This subclass includes a device which may dispense feed above or below the surface of the water which may be in a time release form which dissolves in water to release food.
51.11	TIMER-CONTROLLED FEEDER Feeding devices in which the time at which an element of the feeding device is actuated, or the length of time of a feeding operation, is controlled by a timer.
51.15	RELEASED BY CLOCK ALARM MECHANISM FEEDER Feeding devices in which the trip includes the alarm mechanism of an alarm clock.
THE FOLLOWING CLASSIFICATIONS ARE UNDER AQUATIC ANIMAL CULTURING	
201	HANDLING AND TRANSPORTATION Subject matter including the preparation of and apparatus for sustaining one or more living aquatic animals during transfer, shipment, and temporary storage.
203	FISH TRANSPORTATION Subject matter wherein the aquatic animals transported are fish.
210	WITH FEEDING Subject matter including apparatus for providing a supply of food to each compartment.
215	FISH CULTURING Subject matter relating to the care and propagation of fish.
217	SPAWNING, HATCHING, AND EARLY DEVELOPMENT Subject matter including method or apparatus relating to fish egg fertilization, incubation, and emergent fry culturing.
218	FISH INCUBATOR OR HATCHING TRAY Subject matter including apparatus by which fish eggs are hatched artificially under controlled environmental conditions.
219	FISH DIVERTER OR BARRIER
223	FLOATING FISH REARING ASSEMBLY Subject matter including means to prevent or control the movement of fish past or through certain objects or locations.

TABLE I CONTINUED U.S. PATENT CLASSIFICATION CODES RELEVANT TO THE AQUARIUM HOBBY	
224	TANK ARRAY Subject matter including a plurality of interconnected or cooperatively arranged water containment structures for housing fish.
225	SEQUENTIAL OR STEPWISE TANK ARRAY Subject matter wherein the tanks are connected such that water serially flows therethrough.
226	FISH ENCLOSURE - RECIRCULATING TYPE Subject matter including a water containment structure for sustaining fish and having means for removing a portion of the water and returning it to the containment structure after treatment to improve its life sustaining properties.
227	WITH BIOLOGICAL FILTER Subject matter wherein the recirculated water is treated by a pass-through apparatus in which living organisms are utilized for water treatment.
228	FISH ENCLOSURE – NON-RECIRCULATING TYPE Subject matter including a water containment structure for sustaining fish life and absent any removal and return of treated water into such structure.
229	WITH HEAT EXCHANGER Subject matter including apparatus to affect the temperature of the water contained in the fish enclosure by heat transfer means.
230	FEEDING METHOD Subject matter relating to a process for the nourishment of fish.
231	WATER TREATMENT COMPOSITION Subject matter comprising chemical treatment including additives or other means to affect the life sustaining properties of the fish containing aqueous medium.
232	CLEANING-SWEEPER OR MECHANICAL AGITATOR Subject matter including apparatus utilizing pressurized water circulation to aid in removing fish tank sediment or apparatus to mechanically cause suspension of such sediment to aid in its removal.
233	COVER, LIGHT OR RAY AFFECTING Subject matter including means to selectively intercept visible light and other radiation impinging upon the water surface of a fish pond or tank.
245	AQUARIUM Subject matter relating to a water containing tank or vessel which ordinarily houses aquatic animals and which has one or more transparent portions so that the inhabitants thereof can be observed from the exterior. Note. This subclass includes aquarium equipment and accessories not elsewhere provided for. In certain instances, the aquarium may be partially or fully emptied and used to house small land animals, for example.
246	AQUARIUM COMBINATION (e.g., AQUARIUM-TERRARIUM, ETC.) Subject matter wherein there is in cooperation with aquarium structure additional structure directed to the housing and display of other life, such as plant, insect, or land animal life.
247	COMBINED Aquariums claimed in combination with subject matter not provided for in this class and which perform a function other than to perfect means that are provided for in the class, for example, aquariums combined with lamps or articles of furniture are proper for this subclass.

TABLE I CONTINUED U.S. PATENT CLASSIFICATION CODES RELEVANT TO THE AQUARIUM HOBBY	
248	MULTICOMPARTMENT Subject matter wherein the aquarium consists of a tank or vessel which is divided by structural means into two or more separate spaces.
249	SUPPORTED WATER COLUMN Subject matter wherein atmospheric air pressure is utilized to support a portion of the aquarium water media above the ordinary atmospheric exposed water surface of an aquarium.
250	FOR JOINING AQUARIUMS Subject matter wherein a water column provides a bridge between at least two separate aquariums.
251	TANK WITHIN TANK Subject matter including an enclosure for water which is adapted to be at least partially submerged in cooperative relationship inside another such enclosure such as a larger aquarium.
252	BREEDER TYPE Subject matter including structure for allowing the escape of live babies from a fish giving birth in the innermost submerged tank.
253	ORNAMENTAL Subject matter including aquarium apparatus and structure of the kind to embellish or adorn the basic visual attractiveness of the aquarium. Note. Ornamental features include, among others, aquarium shape, underwater decoration, toys, aesthetic use of a water or aeration device, and aesthetically improved fish viewing apparatus. Certain structures which conceal aquarium life support elements may be considered as visually enhancing and are included herein.
254	AIR OPERATED Subject matter including ornamental means which utilize pressurized gas to produce a visual effect such as a bubble driven ornament or device.
255	LIQUID DISPLAY Subject matter including ornamental means which utilize water beyond that ordinarily contained in the aquarium to produce a visual effect such as a waterfall.
256	SUBMERGED DISPLAY Subject matter wherein the ornamental structural feature is situated and viewed underwater while contained in the aquarium.
257	WALL-TYPE AQUARIUM Subject matter wherein the aquarium is structured to be mounted on or in a side or inner portion of a building or other such vertical structure.
258	EMPLOYING MIRROR Subject matter wherein one or more reflective surfaces are utilized to enhance the visual appearance of the aquarium.
259	FILTER Subject matter including means cooperating with the aquarium structure to cause recirculation of the contained water while removing contaminants therefrom as it passes through a media holding device.
260	BIOLOGICAL TYPE Subject matter wherein the filtering system contains organisms which process wastes to decontaminate the circulated water.

TABLE I CONTINUED U.S. PATENT CLASSIFICATION CODES RELEVANT TO THE AQUARIUM HOBBY	
261	WITH AERATOR Subject matter including means to provide oxygen enrichment to water in the aquarium.
262	AND HEAT EXCHANGER Subject matter including means to raise or lower the aquarium water temperature.
263	AERATOR Subject matter including apparatus providing oxygen enrichment to water in the aquarium.
264	AQUARIUM CLEANING (NON-FILTER TYPE) Subject matter including apparatus for removing contaminants from the aquarium environment without utilizing a water filter.
265	COVER Subject matter including a device extending over an air exposed opening of an aquarium to exclude dust or prevent the escape of an inhabitant therefrom.
266	WITH LIGHT Subject matter including an illumination device in connection with the cover.
267	AQUARIUM ILLUMINATION Subject matter including means cooperating with the aquarium structure to provide enhanced interior lighting thereof.
268	CHEMICAL TREATMENT Subject matter wherein selective chemical substances are utilized to alter certain properties of the aquarium water and environment.
269	AQUARIUM STRUCTURAL ELEMENTS AND ASSEMBLY Subject matter including aquarium structure such as floor, wall, and sealing means necessary to permanently contain the water environment therein and apparatus or a method of associating such elements.
	CODE 219 ELECTRIC HEATING
$	This searches all subcodes under 219 (the "$" is a "wild card."
	CODE 392 ELECTRIC RESISTANCE HEATING DEVICES
$	This searches all subcodes under 392 (the "$" is a "wild card."

means that each patent retrieved prior to 1975 in subclasses other than 245-269 must be examined individually to determine whether it is an aquarium patent or an aquaculture patent since, as previously shown in Example 1, the patents that are returned are listed by patent number only, not by title. This is a time-consuming, tedious process and especially frustrating since the number of aquarium-related patents are few and far between in most of these subclasses.

Patents describing aquarium heating are not included within Class 119, "Animal Husbandry," but in mostly two other classes, i.e., Class 219, "Electric Heating" (which also includes welding, microwave heating, auto windshield heating, etc.) and Class 392, "Electric Resistance Heating Devices" (which also includes hair driers, towel warmers, etc.).

An applicant for a patent must list related U.S. patents in their application, and these can be used to find many relevant patents listed prior to 1975. For example, one can examine the related aquarium patents issued prior to 1975 that were listed in the patents found for the period 1975 to 2004. This is only a partial solution, however, since related patents are listed only by patent number, date of issue, and inventor's name. One must therefore look at each of the related patent numbers to see if the patent is relevant to the search, a tedious process if there are many related patents.

TABLE II
PATENTS ISSUED BETWEEN 1945 AND 2004 IN FIVE-YEAR INTERVALS

CLASS CODES	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	TOTALS
51.04	13	0	13	8	7	11	5	5	6	19	8	6	101
51.11	0	0	7	5	5	2	1	1	1	7	2	2	33
51.15	0	0	0	0	0	0	0	0	0	1	0	0	1
201	1	0	2	0	1	0	2	0	0	3	1	1	11
203	0	1	0	1	2	1	1	0	0	2	0	1	9
210	0	0	0	0	0	0	0	0	0	0	0	1	1
215	0	0	0	0	0	0	0	1	0	0	1	1	3
217	0	0	0	1	0	1	0	0	0	2	1	0	5
218	0	0	0	0	0	2	1	2	0	0	0	0	5
219	0	0	0	0	0	0	0	0	0	0	0	2	2
223	0	0	0	0	1	0	0	0	0	0	0	0	1
224	0	0	0	0	1	0	0	0	0	0	0	0	1
225	0	0	0	0	0	0	0	0	0	0	1	0	1
226	0	0	0	0	1	0	0	0	2	4	1	2	10
227	0	0	0	0	0	0	1	1	1	0	0	4	7
228	0	0	0	0	0	2	0	0	0	1	0	0	3
229	0	0	0	0	0	0	0	0	0	1	0	0	1
230	0	0	0	0	2	1	1	0	1	1	5	2	13
231	0	0	0	0	0	0	4	0	2	4	1	2	13
232	0	0	0	0	0	0	0	0	0	0	0	3	3
233	0	0	0	0	1	1	0	0	0	0	0	0	2
245	0	1	1	1	3	15	6	4	6	10	12	29	88
246	0	1	1	1	2	3	9	5	3	20	12	23	80
247	1	1	1	1	4	5	0	1	0	5	14	6	39
248	0	1	0	0	1	3	4	1	3	6	12	20	51
249	0	3	0	0	0	0	2	1	0	3	4	2	15
250	0	0	0	0	0	0	3	0	0	1	4	5	13
251	0	0	0	0	2	3	0	1	0	1	0	1	8
252	0	0	0	1	5	3	2	0	0	3	1	2	17
253	0	3	2	3	3	5	4	5	8	7	10	13	63
254	0	0	2	3	4	2	3	1	2	1	3	4	25
255	0	0	1	0	1	0	0	0	3	0	4	3	12
256	0	0	1	2	1	7	7	2	3	8	9	19	59
257	0	1	1	0	1	1	2	1	0	4	4	4	19
258	0	1	2	1	1	3	0	0	2	4	0	2	16

Table II lists the number of patents issued between 1945 and 2004 in five-year intervals. It is interesting to plot the number of patents issued against time and this is shown in Figure 2. As might be expected, the number of patents issued generally increased yearly, although there was a marked decrease in the 1975-1979 time interval. In descending order, the most patents issued were in aeration (261 and 263), filtration (259 and 260), heating (HEAT, 219, and 392), and feeding (51.04), a not unexpected result.

TABLE II CONTINUED
PATENTS ISSUED BETWEEN 1945 AND 2004 IN FIVE-YEAR INTERVALS

CLASS CODES	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	985-1989	1990-1994	1995-1999	2000-2004	TOTALS
259	0	1	0	1	5	7	4	4	6	29	21	32	110
260	0	0	1	0	0	7	4	3	9	22	27	15	88
261	1	1	3	4	4	7	7	1	6	19	13	10	76
262	0	2	1	1	3	1	4	2	3	5	4	2	28
263	0	0	4	1	4	4	9	7	7	22	16	10	84
264	0	2	1	0	2	2	1	1	0	9	13	15	46
265	0	0	0	2	1	8	1	0	1	11	6	1	31
266	0	0	1	2	1	12	2	0	0	5	12	2	37
267	0	0	1	0	4	6	3	1	2	9	7	2	35
268	0	0	0	0	1	2	0	0	2	1	3	4	13
269	0	1	4	3	9	14	5	1	3	5	9	6	60
219	1	1	4	2	1	-	-	-	-	-	-	-	9
392	0	1	0	1	0	-	-	-	-	-	-	-	2
HEAT*	-	-	-	-	-	12	11	19	11	11	16	14	94
TOTALS	17	22	54	45	84	153	109	71	93	266	257	273	1444

*Since Class 392 is considered to be an integral part of Class 219 and thus often contain the same results, this line was obtained by using key phrases and a Boolean operator, i.e., “aquarium heater” OR “aquarium thermostat.” For patents issued after 1974 (and sometime even somewhat earlier), the use of key phrases and Boolean operators is often useful in reducing the number of non-relevant retrievals in Class 119 subclasses 51.04 to 233.

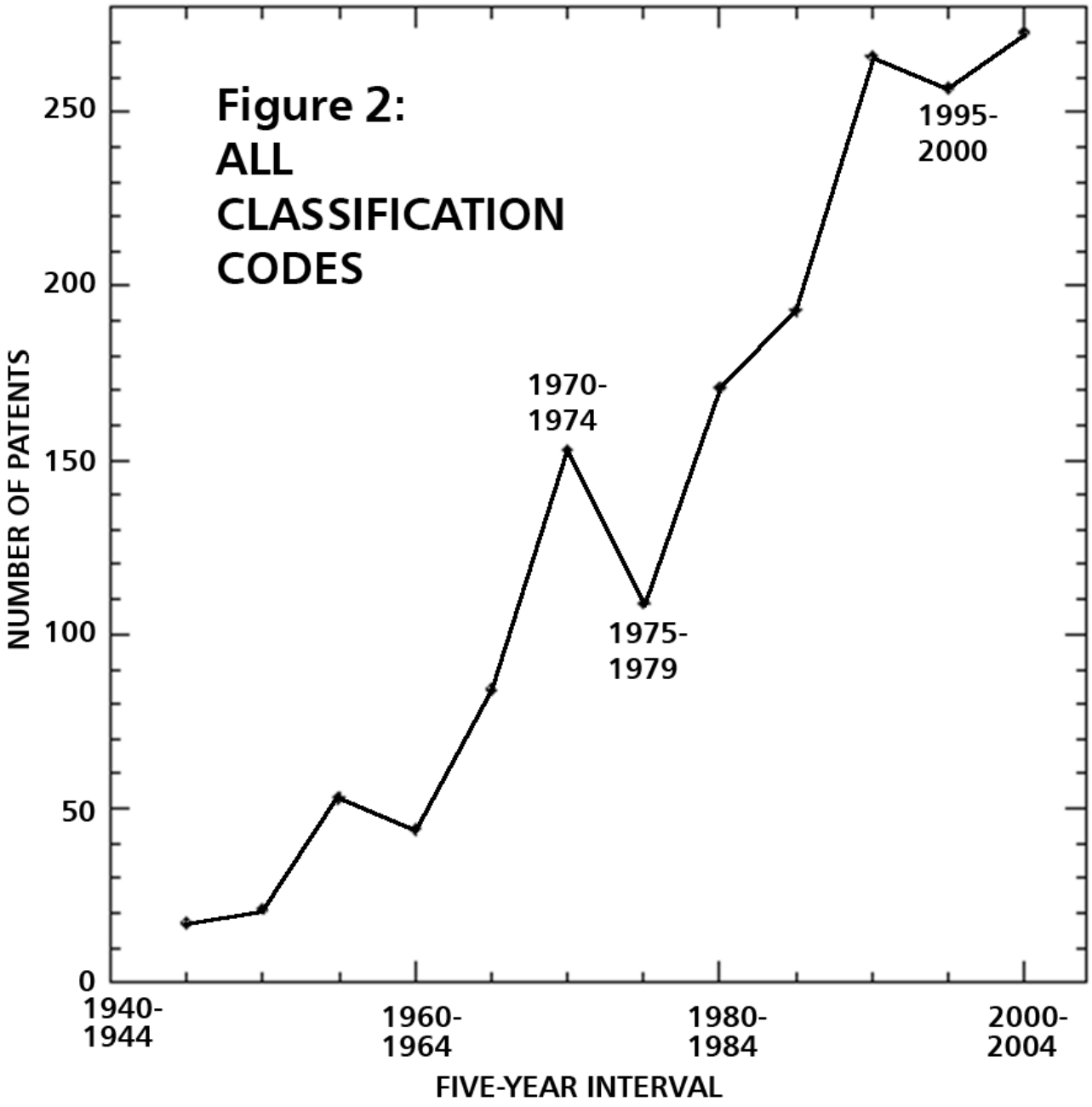


Figure 2:
ALL
CLASSIFICATION
CODES
NUMBER OF PATENTS
0
50
100
150
200
250
1940-
1944
1960-
1964
1980-
1984
2000-
2004
FIVE-YEAR INTERVAL
1970-
1974
1975-
1979
1995-
2000

THE CASE OF THE CONTESTED FILTER PATENT

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 25, 2005)

One aspect of aquarium hobby history that I have explored in some detail is that of patents relating to the hobby. Although the patents themselves are interesting and serve to add to our knowledge of such history, another element also is fascinating, i.e., the area of patent litigation. A good example is the following case history that concerns two very prominent filter designs, i.e., the Dynaflow and the AquaClear filters.

BACKGROUND

The story starts with Allan H. Willinger who, as a boy, had become interested in the aquarium hobby. He later worked for a manufacturer of aquarium heaters, eventually opened an aquarium shop, and finally became a manufacturer of aquarium supplies. He knew of the need for a filter that would be efficient, inexpensive, trouble-free, and reasonably quiet. Reading an article about automobile speedometers in the magazine POPULAR MECHANICS, Willinger learned about magnetic coupling.

This is a device by which a motor can drive a mechanism without a mechanical link. The driving mechanism moves a plate containing a magnet, and reacts to a second magnet located on another plate. When the two plates are placed near each other, the attraction of each set of magnets compels the plates to move in unison. In other words, the plate in the driving mechanism turns the plate in the driven mechanism and its attachments (See Figure 1 for a typical example).

The inherent virtue of this mechanism is that the driving and driven plates can be separated by a glass or plastic divider. The driven plate and its operating mechanism can thus be enclosed in a sealed unit without danger of contamination from outside substances. In the automobile speedometer mentioned above, for example, the delicate mechanism that turns the gauge seen by the driver is in an enclosed unit. The sealed unit contains the driven plate with its magnets; this is turned by a driving plate operated outside the unit. No dirt, dust, oil or water can enter the sealed speedometer. If there is a defect in the driving mechanism, it can be repaired without touching the sealed unit.

This principle had been used for other applications. Lunch counters, for example, frequently display juice dispensers in which orange juice or some other beverage is propelled in a spray around the walls of a clear plastic bowl. The customer is thus attracted by the sight of the foaming juice, and the spray impeller keeps the juice aerated and foaming. In this application the liquid inside the bowl is sprayed by a pump operated through magnetic couplings by a

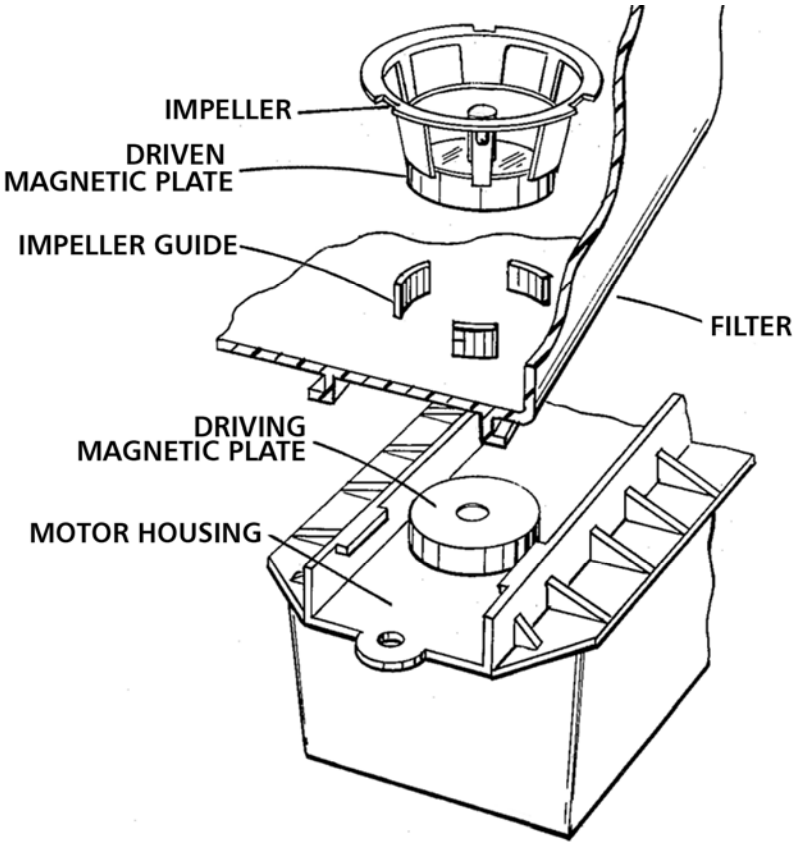


FIGURE 1: THE MAGNETIC COUPLING CONCEPT

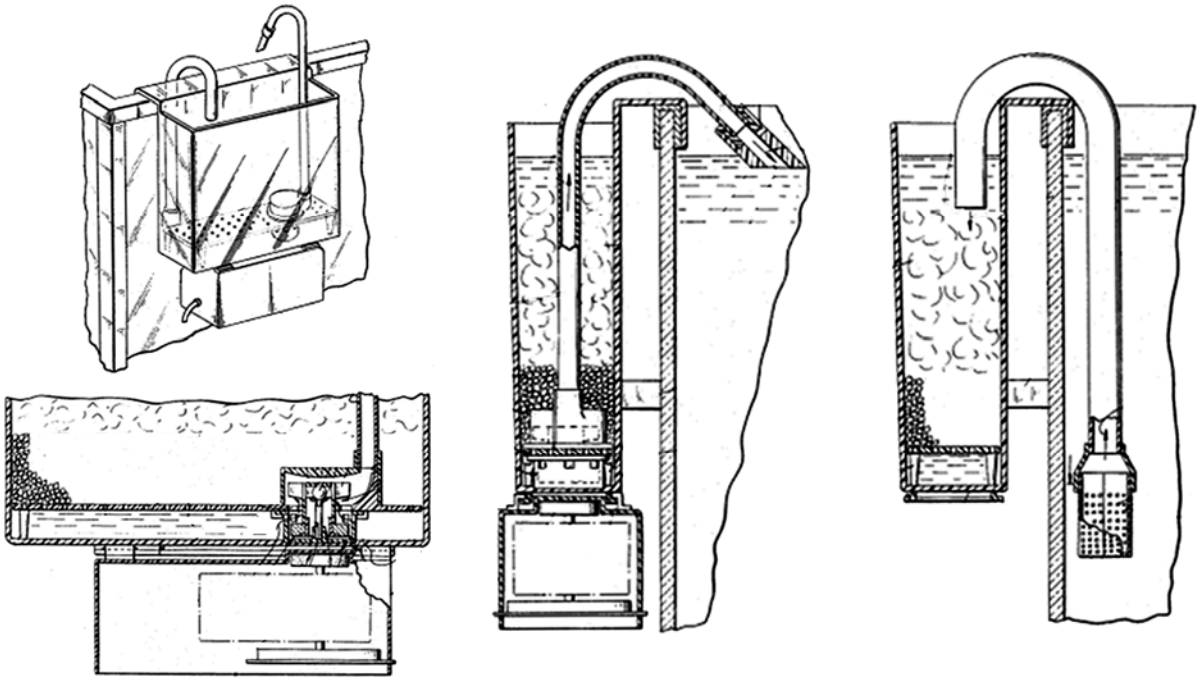


FIGURE 2: THE WILLINGER PATENT

driving plate and driving mechanism outside the juice container. The sealed container keeps the beverage free from contamination, and divides the pumping mechanism into two physically separate units.

Willinger knew nothing of these other applications, nor had he observed that the magnetic coupling had been previously used in this manner in the aquarium hobby. It was this POPULAR MECHANICS article that directed his thoughts to an application for fish tanks. He was able to produce a model using parts readily available in the commercial market. Later he obtained the patent that was involved in the lawsuit, a description of which is shown in Figure 2. This patent (U.S. 3321081) was applied for on June 18, 1964 and was awarded on May 23, 1967.

Basically, the Willinger patent describes an aquarium filter that is hooked to an aquarium tank. Water is siphoned from the tank into the filter where it is cleaned; then it is returned to the tank. The water enters the filter from the top. The filter material, e.g. charcoal, is placed on a horizontal divider in the filter chamber. The water flows down by gravity, filters through this material and passes into a clean water chamber. A centrifugal pump, supported in the divider, returns the filtered water to the aquarium tank through a water outlet. The centrifugal pump is operated by an electric motor that is coupled to it magnetically. The pump itself is located outside the aquarium tank, but inside the filter device. Beneath the impermeable bottom wall of the filter device outside of the fish tank is a driving magnet, directly connected to the electric motor. Thus the motor turns the driving magnet, and the driving magnet turns the driven magnet, motivating the pump. In this way, the water cannot be contaminated by oil or foreign material from the driving magnet or motor nor can water enter the motor. This is the filter, assigned to Aquariums Inc. of Maywood New Jersey (a forerunner of the Metaframe Corporation), that was placed on the market in the mid 1960‘s as the “Dynaflo.” It was extremely popular and was “THE” power filter of its time.

However, on March 25, 1970 an International Patent Convention application for a filter was filed by the Biozonics Corporation of Natick, Massachusetts (a description is shown in Figure 3). It was also filed on June 30, 1970 as a British patent (GB1300176), the complete specification being published on December

20, 1972. The inventor was Richard C. J. Palson, and the filter was marketed as the Biozonics 3-Stage Power Filter. The Rolf C. Hagen Corporation of Mansfield, Massachusetts acquired the rights to this filter and it was the forerunner of the series manufactured by Hagen under the name "AquaClear" (the name was first used in commerce in 1979).

Although The Biozonics patent described mounting facilities for four filter cartridges, only three are shown in detail in the patent drawings and the commercialized version also used just three (hence its name as a 3-stage filter). However, it used a magnet drive similar to that of the Willinger patent to draw the water through the filter media and pump it out and back to the aquarium. The similarity of the Willinger device in this regard to the Biozonics filter caused the suit for infringement to be filed. Because Biozonics admitted to the similarity, the single issue was the validity of Claim No. 3 of the Willinger patent, in particular the matter of the electric motor being magnetically coupled to the pump for moving the water. If the court decided that this claim was valid, then Biozonics would be liable for damages and its filter forced from the market.

ELEMENTS OF PATENT LAW

The lawsuit was brought before United States District Court for the District of Massachusetts and heard by Judge Carl B. Rubin. That Judge Rubin was somewhat of an aquarist himself is attested to by his opening opinion:

> "In a competitive struggle, almost as determined as that of two male betta splendens, or Siamese fighting fish, the manufacturers of concededly similar aquarium filtering devices, one the patent assignee, the other its challenger, here join battle to determine the validity of the patent. Since the patent is virtually conceded to possess utility, the victory turns on whether the two other legislative requisites are met: whether the device was obvious at the time it was conceived to a person of ordinary skill in the art, and whether the concept was novel. The issues are clear, but the waters are deep."

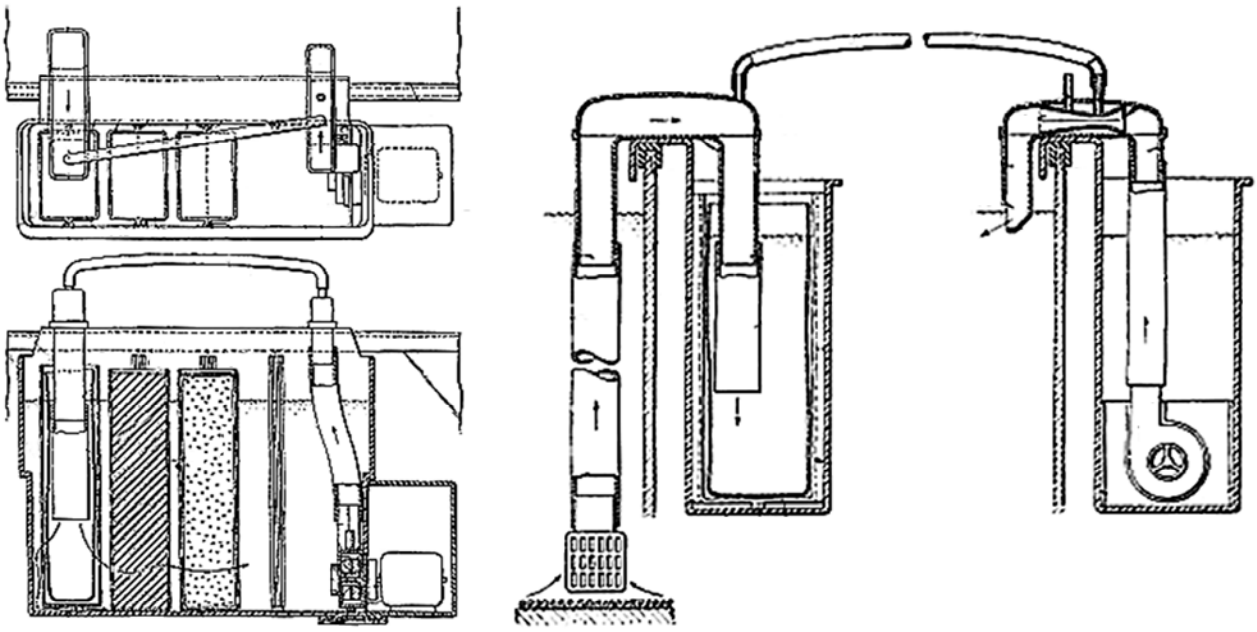


FIGURE 3: THE BIOZONICS PATENT

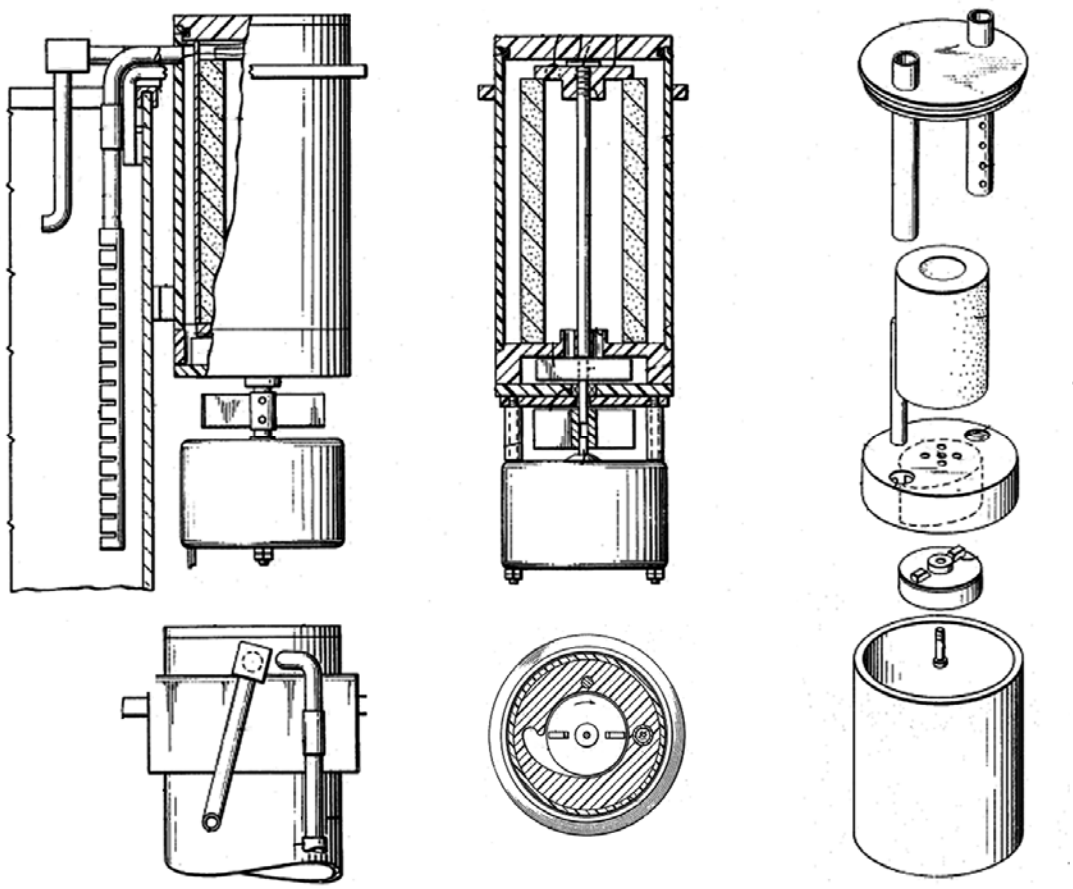


FIGURE 4: THE CANTERBURY PATENT

Prior to the development of the Willinger patent, magnetic coupling devices were in common use, e.g., a driven and driving magnet on opposite sides of a fluid impermeable wall had been used to couple a motor to a pump-impeller for pumping fruit juices and similar beverages; for deep well pumps and power transmission arrangements; for gas and fuel pumps; for refrigeration systems; for chemical and dairy pumps; and for centrifugal pumps generally. The use of an open tank raising water by siphon, aerobic filtration by charcoal, employing gravity for filtration - all of these were likewise in common use. All in all, Judge Rubin cited 10 patents. Willinger's patent consisted of a combination of these previously existing elements.

THE CANTERBURY PATENT

However, there was another patent of special importance, one for a "Combination Filter and Aerator" was filed by Howard M. Canterbury on October 2, 1963, more than eight months before Willinger's application. It was issued in September, 1966 (U.S. 3273717), at which time it was made public (a description of which is shown in Figure 4). Although Canterbury incorporated a magnetic coupling device into an aquarium pump, it utilized a sealed suction system, rather than the unsealed, open topped, siphon fed, aerobic filtration of the Dynaflo. (It also had a round shape, quite distinct from either the Willinger or Biozonics patents.) The record indicated that the examiner was aware of the Canterbury patent during the course of his assessment of the Willinger application, but there is no evidence that Willinger or his attorney at that time attempted to establish an invention date prior to the filing of Canterbury. The relevance of Canterbury in this case was contested by Willinger who argued that although Canterbury was filed prior to Willinger, he asserted that his conception and reduction to practice occurred prior to the filing date

of Canterbury. His testimony in this regard was uncorroborated, however, and it was not credited.

The judge took an easy way out here, stating that it was unnecessary to consider and resolve the questions of burden of proof, presumptions of priority, and the availability of procedures within the patent office to resolve such conflicts, because the questions of obviousness and novelty in this case could be determined without reference to Canterbury. He argued that the prior art utilizing magnetically driven pumps was exemplified in a host of other applications already noted. He also noted that even if Canterbury was not prior art, its application of the magnetic clutch principle demonstrated that the knowledge of such a possible use was gaining currency even in aquarium devices. To aquarium historians it also meant that it was not Willinger who was the first to apply the magnetic principle to an aquarium filter, but Canterbury. Willinger, however, was the first to commercialize it.

THE QUESTION OF OBVIOUSNESS

Willinger maintained that his inventiveness lay in devising the first use of such a device in aquarium filters, arguing that this drive mechanism was not known in the aquarium industry. Overlooking Canterbury for the moment, a preponderance of the evidence established that indeed no one had used magnetic couplings for aquarium filters before Willinger. Metaframe and Willinger both conceded that engineers were well acquainted with magnetic couplings and that manner of operating a pump was well known to mechanical engineers. Indeed, Willinger at all times asserted the invention resided in the novel combination and not in the elements of the combination.

The elements to assemble the device were commercially available and the theory was widely applied. Clearly this application would have been obvious to a person with mechanical engineering training in 1960. Indeed, there was testimony by a witness who satisfied the court as being both expert and reliable that the problem would have been too elementary for him to assign to an undergraduate mechanical engineering class if he were seeking to require them to develop a creative application. It is unchallenged that if the applicable art is “fluid dynamics” the application of the magnetic coupling would have been obvious to the ordinary person in that field. Is the test then the obviousness of an application to persons working in a particular field, such as the aquarium trade? Or does the test apply to persons having ordinary skill in the basic mechanical or scientific field, such as fluid dynamics, even though they are not actually working in a particular field that might call forth their skill?

The adaptation of a magnetic coupling to an aquarium pump would have seemed elementary to one with ordinary skill in the field of fluid dynamics. Here the original patentee, Willinger, had no experience or training in that area, but this does not restrict the test of obviousness, which presumes that “the inventor would have that ability to select and utilize knowledge from other arts reasonably pertinent to his particular problem which would be expected of a man of ordinary skill in the art to which the subject matter pertains.”

The bottom line is that the Willinger concept was obvious to one with ordinary skill in the applicable art. The combination it made was merely the intelligent use of mechanical ability to continue a previously existing magnetic coupling to the previously existing elements of an electric motor powering a centrifugal pump, an open top filter receptacle with a siphon tube, and a divided filter action chamber. (Various minor issues, said the judge, were of no significance. The argument that water pumped from Willinger's unit was clearer because of the divided chamber ignored the fact that the small filtration device processes only water taken from and returned to a contaminated source; the suggestion that it “polishes” the water was merely a result of the relative efficiency of the filtration process and rapidity of the cycle. None of these was the result of any inventive combination.)

THE QUESTION OF NOVELTY

Willinger's invention was a combination patent. It was conceded that all of its elements had long been known, but it was asserted that the invention was in the novelty of the combination. Such a patent must

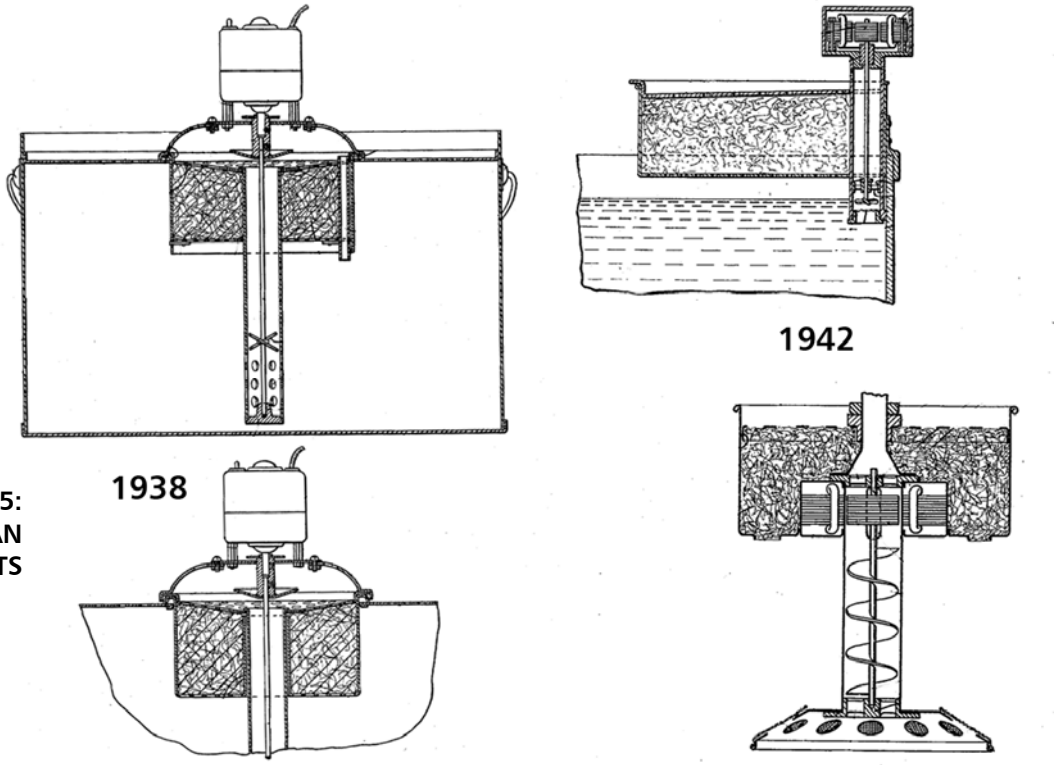


FIGURE 5: THE HALDEMAN PATENTS

of course satisfy the test for novelty. In the area of combination patents, the examination of a patent for novelty involves the consideration of many facts identical to those weighed in determining non-obviousness, but as the judge pointed out, these tests are discrete in the statute. The question of novelty, being one of judgment, is necessarily not susceptible of precise determination. But there seemed to the judge that there was such a close relation between the prior applications of magnetically driven pumps to the Willinger use that his concept lacked the requisite novelty.

ATTORNEY'S FEES

Biozonics brought up the matter of another filter, the Supreme (inspired by the 1938 and 1942 patents of James F. Haldeman - See Figure 5.), which unquestionably was issued years prior to Willinger. This was for an aquarium filter essentially identical to the Dynaflo filter except that the Supreme secured the electric motor above the filter receptacle and coupled it directly rather than by magnetic couplings to the centrifugal pump. Though the Supreme was not commercially popular because of its expense, vibration difficulties, difficulty in priming the siphon tubes, and the hazard of having an electric motor not designed to get wet in close proximity to water, it was technically part of the prior art considered in the case. However, the acknowledgment of prior developments was implicit in the Willinger's position that his invention was based not in the development of any element of his combination, but rather in the novelty of the combination.

Biozonics pointed out that since the Supreme patent was identical to the Dynaflo except for the magnetic coupling, it should have been cited to the patent office in the Willinger application. They argued that the effect of this absence diminished the presumption of validity of the Willinger patent, and therefore entitled them to attorney's fees.

The court, in exceptional cases, may award reasonable attorney fees to the prevailing party. However, the judge argued that the absence of a citation of the prior Supreme filter was not such an act of bad faith as to justify attorney's fees in this case even though Willinger was aware of the

Supreme filter. At the time Willinger developed his pump, the Supreme unit was not commercially significant. It was an expensive pump that Willinger himself had never carried in his shop. Though the Supreme was prior art, relevant to the issues of obviousness and novelty, Willinger's omission of it as a reference was deemed not motivated by an intent to deceive or mislead, or by lack of good faith. The judge pointed out that an applicant has no duty to cite every publication of which he knows merely because the publication is one likely to be referred to by a vigilant examiner in the Patent Office or by a rival in some future proceeding.

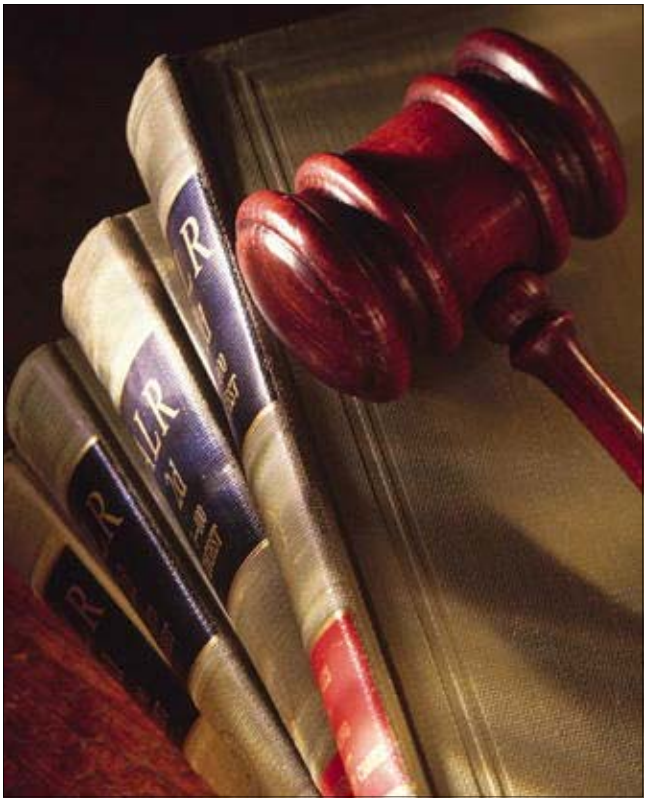
OUTCOME

On December 7, 1972, the Court rendered a judgment declaring the Willinger patent invalid, having failed to meet the tests of non-obviousness and novelty. It also rejected Biozonics demand for attorney's fees.

COMMENTARY

It is my opinion that Judge Rubin made the right decisions in this case. Other than the magnetic coupling, filter designs similar to that of Willinger's were common. In addition, Canterbury did have the prior patent on the coupling, although if his patent had gone through litigation similar to that of the Dynaflo, it too would most likely have been declared invalid because of the prior art in this area.

That being said, although the judgment went against the Willinger patent, it should be pointed out that the Dynaflo filter was revolutionary for its time and generated a host of competing designs that formed the basis for the power filters that are popular to this day. For this, Allan H. Willinger deserves the historical credit.



THE HISTORY OF THE UNDERGRAVEL FILTER - A CASE HISTORY

by Albert J. Klee, Ph.D

(Aquarium Hobby Historical Society, Yahoo Files, November 25, 2005)

Neil Foster, among others, has often lamented the lack of information regarding the historical development of aquarium equipment, such as air pumps, filters, lighting, etc., and I share his feelings. As one with an engineering background I have an inherent interest in such matters and have spent the past few years in trying to learn more about how we came to the hobby equipment of today and who got us there.

However, I have found that this is not an easy task. Pumps, filters, and lighting, for example, often have their origin in other areas, such as water purification or even fields not remotely connected with water, let alone aquarium water. Furthermore, if one takes this backward journey to its ultimate starting point we may well be delving into the invention of the wheel or the lever itself!

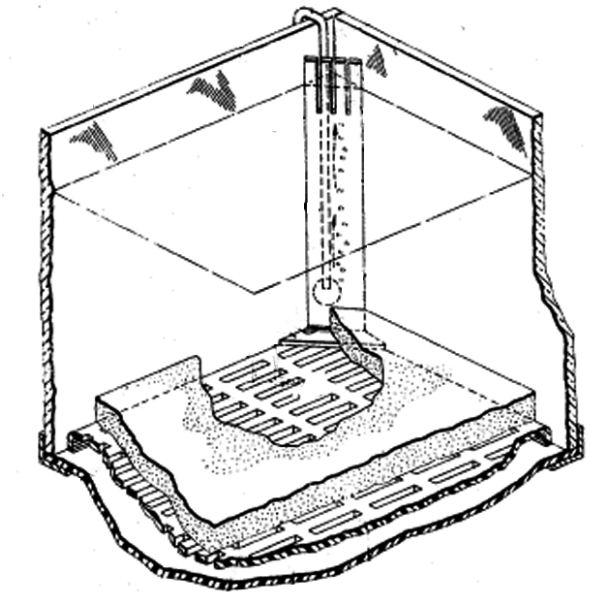


FIGURE 1: UNDERGRAVEL FILTER, 1968 Inventors: William E. Kelley, Euclid, OH and Robert J. De Fassele, Gates Mills OH.

The process can be simplified by restricting the search for a particular item to its first application in an aquarium. In some cases, however, this may take us back to the middle of the 19th Century, i.e., the days of Warington and Gosse, so even this might present a burden.

I wanted to give an example of the process so I selected a topic that was introduced after World War II, i.e., the undergravel filter (UGF), and I started with a model that appeared around the year 1970 since they haven't changed all that much since then (the changes mostly involve how they are powered).

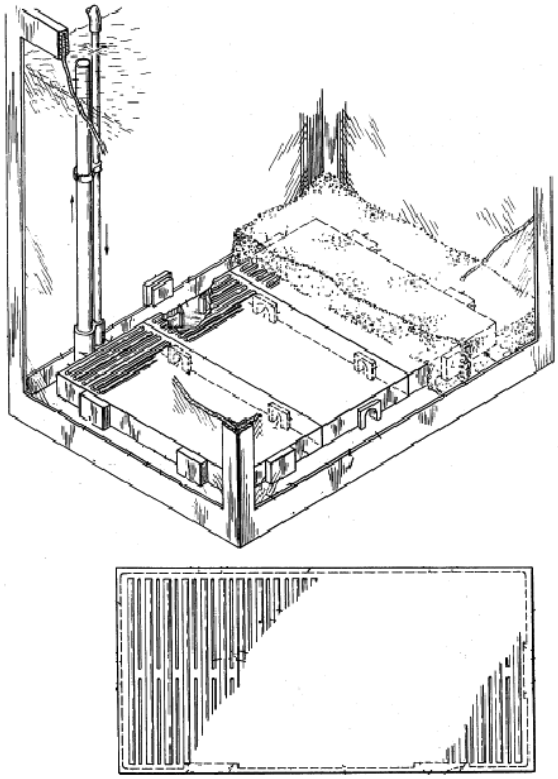


FIGURE 2: UNDERGRAVEL FILTER, 1968 Inventor: Walter Sesholtz, Park Ridge, N.J.

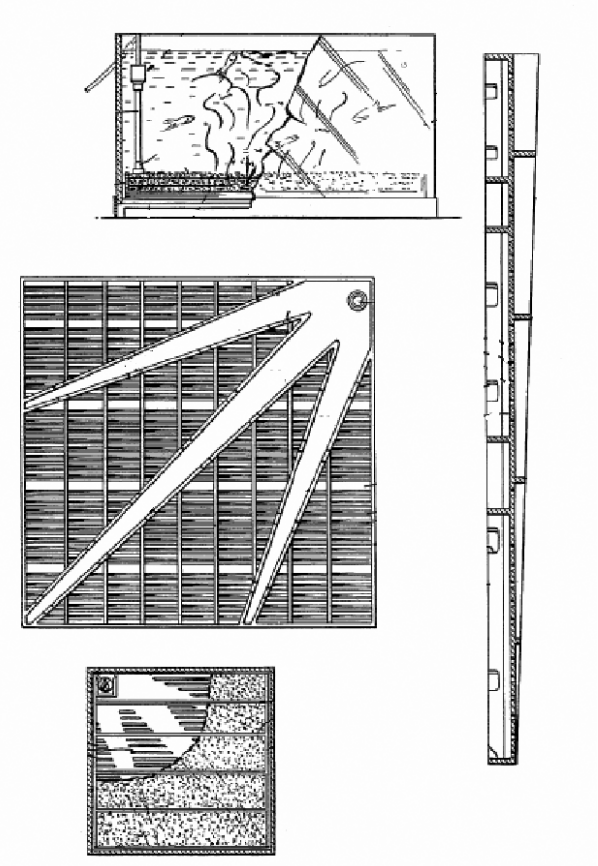


FIGURE 3: UNDERGRAVEL FILTER, 1958
Inventor: Alan H. Willinger,
New Rochelle, NY.

Figure 1 shows a UGF that dates back to 1968 (it was later manufactured by Aquarium Systems, Inc.) and I picked this one because it shows the typical slotted-box design of the time. Although simple in design and inexpensive to manufacture, it is not the origin of the original UGF. The improvement claimed for this particular design was the incorporation of a triangular corner plate that solved the problem of fish getting caught between the corner of the aquarium and the cylindrical return air/water mixture tube then commonly used. The 1968 design in Figure 2 (it was later manufactured by Sternco Industries, Inc. of Harrison, New Jersey) shows this typical cylindrical return air/water mixture tube. Aquariums come in different sizes so the box was constructed of interlocking modules so that various tank sizes could be accommodated, keeping its cost low. Again, this was not the origin of the original UGF.

Taking a leap back ten years to 1958, Figure 3 (an invention of our old friend, Alan Harding Willinger) shows another slotted box type but one that slopes towards the front, thus providing a more even suction to make up for the greater thickness of gravel that is usually found in the rear of aquaria. To further even out the suction, the water is not drawn out directly from the box but to a three-armed chamber that is narrower at the farthest point away from the vertical air/water return tube. Figure 4 shows an UGF design that appeared in 1955. The design left space in front so that the aqua-

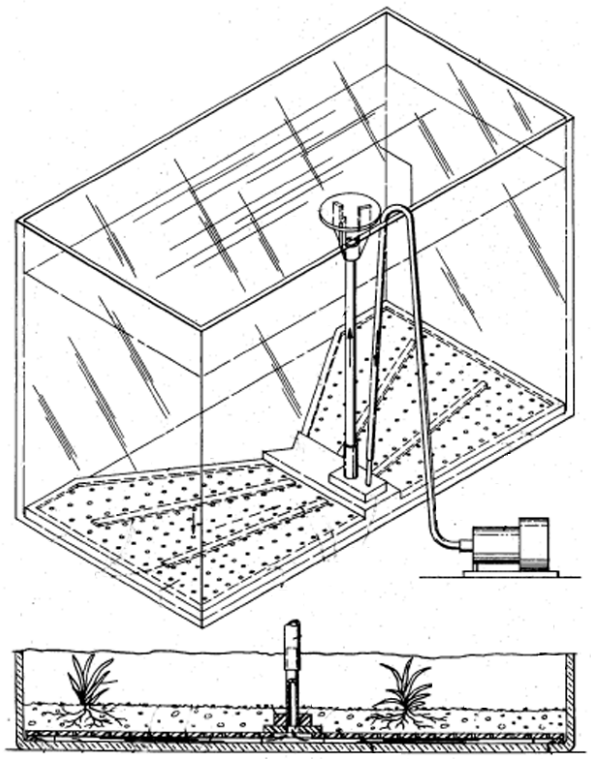


FIGURE 4: UNDERGRAVEL FILTER, 1955
Inventor: Edward F. Hayden,
Benton Harbor, MI.

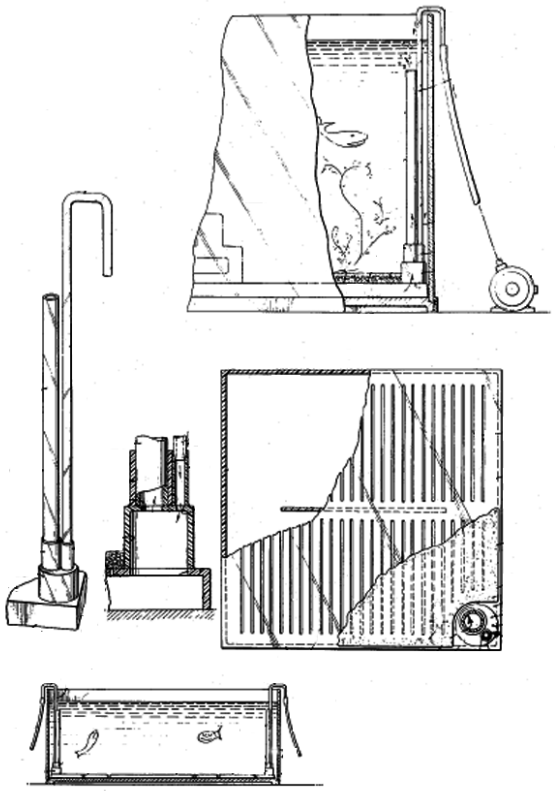


FIGURE 5: UNDERGRAVEL FILTER, 1955
Inventor: Norman G. Hovlid,
Long Beach CA.

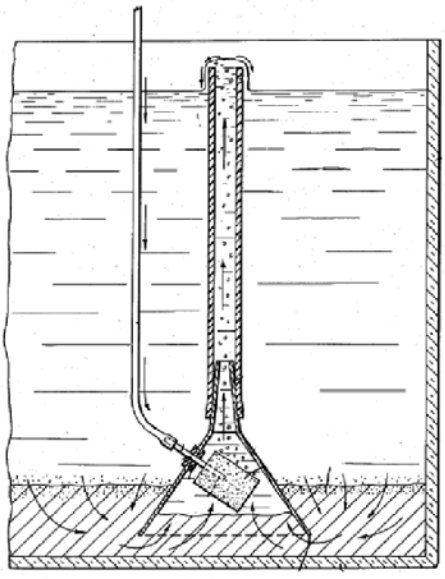


FIGURE 6: UNDERGRAVEL FILTER, 1954
Inventor: Joseph S. Lacey,
Washington, D.C.

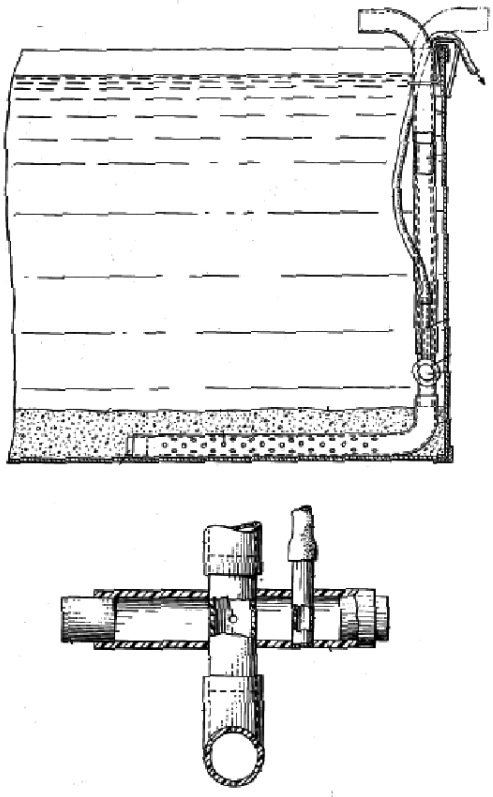


FIGURE 7: UNDERGRAVEL FILTER, 1953
Inventor: Joseph L. Zavod,
Upper Darby, PA.

rist manually could siphon the sediment that usually gravitated to the front of the tank. The odd-looking design at the top of the air/water return tube was to minimize the splashing of water when an excessive amount of air was used.

The earliest (1955) design for a slotted-box UGF is shown in Figure 5. It was invented by Norman G. Hovlid and was subsequently manufactured by the Miracle Filter Company of Long Beach, CA. However, previous inventions provided the background for all of these UGF designs. Figure 6 shows one such 1954 design that simply uses a funnel set into the gravel with a vertical air/water return tube attached to the narrow end and an ordinary air stone in the main part of the funnel. The problem, of course, is that the water was pulled on-

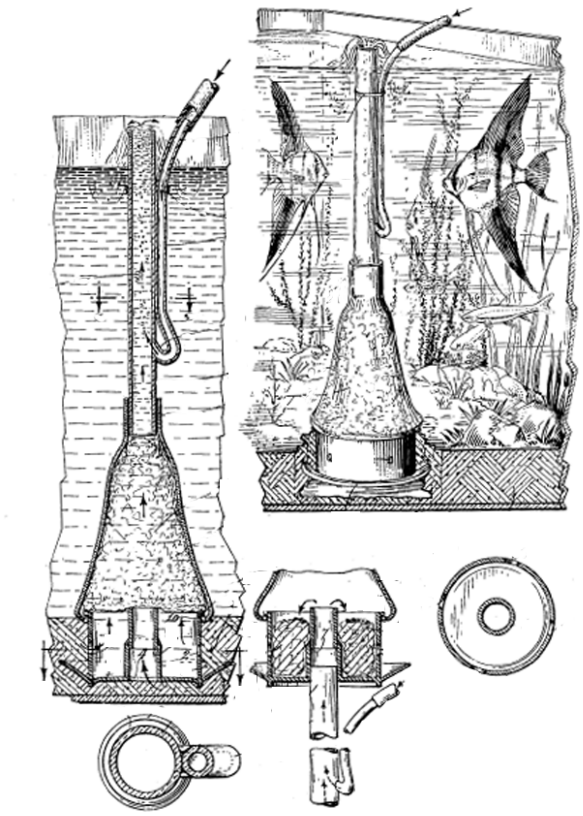


FIGURE 8: UNDERGRAVEL FILTER, 1952
Inventor: Constant Pettas,
Montreal, Canada.

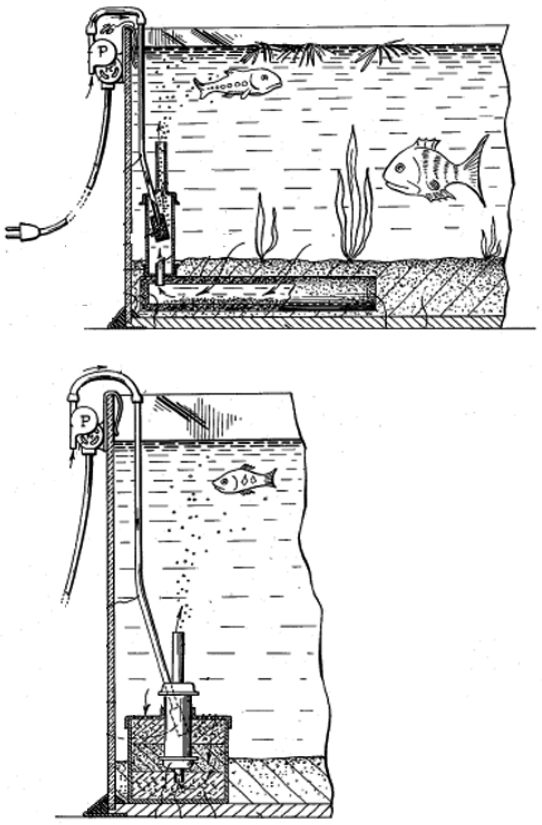


FIGURE 9: UNDERGRAVEL FILTER, 1950
Inventor: Mary L.M. Vansteenkiste,
Montgeron, France.

ly through the gravel situated near the funnel.

A design that appeared one year earlier (Figure 7) was better in that it utilized a perforated tube below the gravel. It had a vertical air/water return tube that could be elongated or shortened via a sleeve that surrounded one portion of it, and it had cleanout plugs at various strategic places, although these could be utilized only when the filter was taken out of the aquarium. The lower part of the diagram shows the air chamber that allowed a greater volume of air to be introduced, thus increasing the air/water flow through the outlet tube. Another device of the funnel design appeared in 1952 and is shown in Figure 8. It was designed to fit in the corner of the tank although it was also designed to be used as a mulm collector as well. Unlike the design in Figure 6, the funnel could also be packed with a filter material such as fiberglass. Because they did not pull water through all parts of the bottom gravel, these designs were in and of themselves not successful.

In 1950, Mary L.M. Vansteenkiste, of Montgeron, France, invented the filter shown in Figure 9. It was essentially a hollow porous cylinder, embedded with carbon so that when the water passed through the gravel certain impurities not removed by the gravel would be removed when it passed through the cylinder. Along with her husband, Vansteenkiste later modified this design and it was advertised and sold in this country during the 1960s and 1970s as the “Invisible French Filter & Aera-

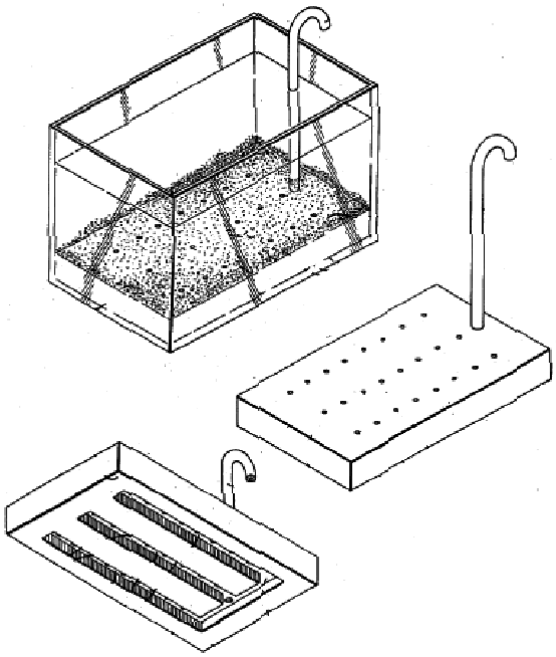


FIGURE 10: UNDERGRAVEL FILTER, 1951 Inventor: Albert J. Schwartz and Samuel H. Barbour of Philadelphia, PA .

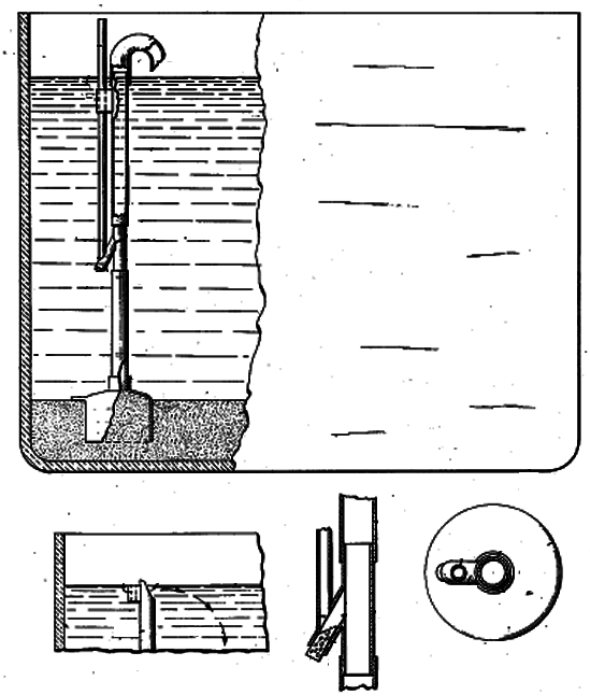


FIGURE 11: UNDERGRAVEL FILTER, 1951 Inventor: Thorwald H. Hansen, Rahway, NJ.

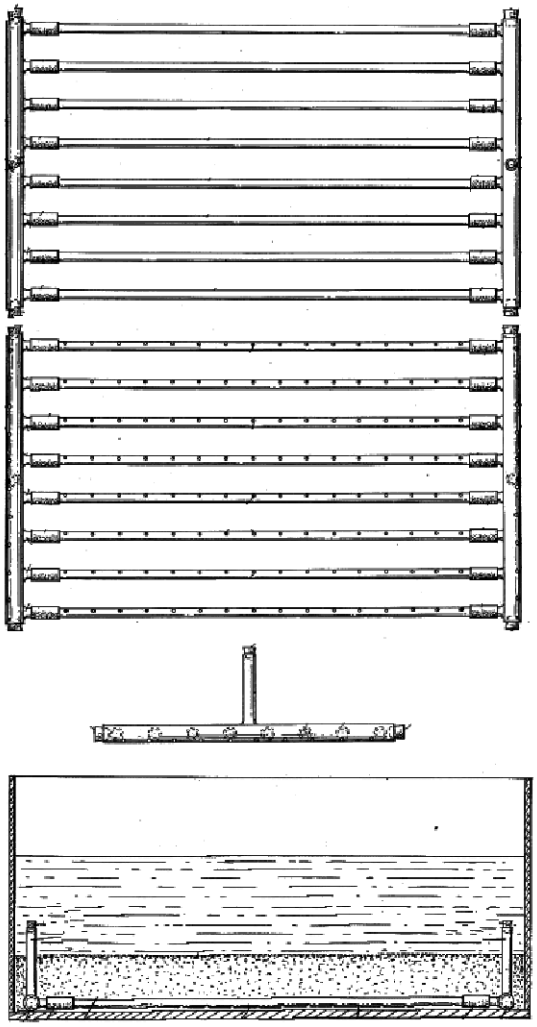


FIGURE 12: UNDERGRAVEL FILTER, 1950 Inventor: George W. Ludwick of Philadelphia, PA .

tor." Since it involved inserting a cylinder, it could be installed and uninstalled without taking down the tank.

Albert J. Schwartz and Samuel H. Barbour of Philadelphia, Pa invented the design in 1951 shown in Figure 10. It consisted of a solid plate with three channels drilled into it. A number of holes were drilled through each of the tops of the channels and all three emptied into a common channel. The curved siphon tube was used to draw the water from the tank into a standard filter (not shown) from where it

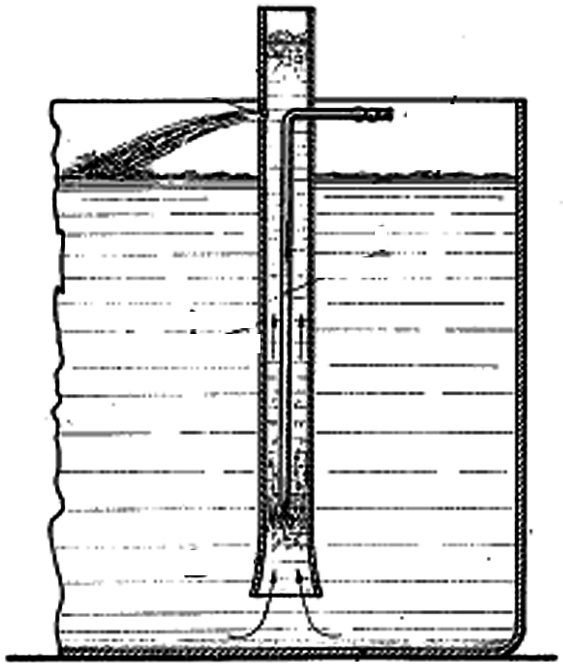


FIGURE 13: AIR LIFT, 1925
Inventor: Evert Willem Beth,
The Hague, The Netherlands.

was returned to the aquarium. If Schwartz and Barbour had incorporated air into the siphon tube, converting it into a vertical air/water return tube, we could credit them as being the first to invent the flat-bottomed UGF.

An early variation (1951) that later became the inspiration for the funnel type is shown in Figure 11. In this design what ultimately was to become the funnel was a cylinder that was open at the bottom so that it could be pressed down into the gravel. Like the funnel designs, it did not pull water through all parts of the gravel layer throughout the tank and so was ineffectual.

Figure 12 shows the tube-type UGF that was invented by George W. Ludwick of Philadelphia, Pa. in 1950. The vertical tube was capped but at intervals a hose was attached and the water within the tubes was siphoned. Again, close but no cigar. If Ludwick had incorporated air into the siphon tube, converting it into a vertical air/water return tube, we could credit him as being the first to invent the box-type UGF. However, the airlift had been invented many years prior to this (1925, by Evert Willem Beth of The Hague, The Netherlands – see Figure 13). As a consequence, this was coupled with Ludwick's tube grid and the resulting UGF was widely used during the late 1950s.

It took several inventors, therefore, each adding a piece to the puzzle, to arrive at a true UGF. This case history shows that it is not always easy to identify the first person responsible for a piece of aquarium equipment. Often the credit must be shared with many others.

UNUSUAL POST WORLD WAR II AQUARIUM PATENTS

By Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society, Yahoo Files, February 3, 2008)

This paper describes fourteen patents issued between 1966 and 2007 that are unusual, innovative and, at the same time, decidedly fanciful. None of them were commercially produced, although two of them were singled out by well-known manufacturers to whom the patents were assigned (what were they thinking?).

1. PATENT NUMBER 3265388 A RHYTHMIC AERATOR ACTUATED FLOAT FOR INDICATING WATER LEVEL

This patent was awarded in August of 1966 to Frank A. Kane, III of Stratford, Connecticut. Its purpose was two-fold: (1) To provide a form of aeration that "renders the aquarium more interesting and attractive," and (2) also functions as a means for indicating when the level of liquid in the tank has fallen below a proper predetermined level.

Patent Number 3265388

FIG. 1

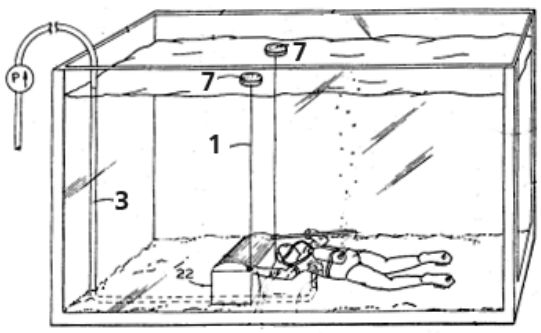


FIG. 2

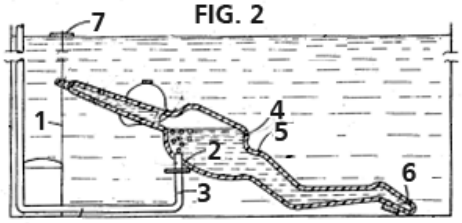
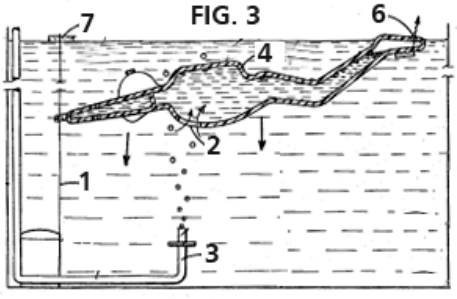


FIG. 3



The key object in this invention is a hollow form, the inventor indicating that it can be shaped to assume any simulated object such as a deep sea diver, a fish, or a submarine. Kane elected to use a scuba diver in his description. The hand of the diver is outstretched with a hole in it through which one guide line (no. 1) is threaded. The other hand is holding a spear through which the other guide line is threaded. When the diver is filled with water an opening (no. 2) in the underside rests against the opening of an air tube (no. 3). There are several smaller openings on top of the diver (nos. 4, 5, and 6). The guidelines are supported by floats (no. 7).

When air enters the diver at point no. 2 it displaces the water and causes the diver to rise. Since the trapped air is located for the most part within the head and shoulder portions of the diver, the figure in rising assumes a natural rising or swimming position in surfacing. As the figure rises, small amounts of the air may be exhausted through the port opening no. 4, giving the indication that the diver is actually breathing while ascending to the surface.

When the figure has reached the surface, water is taken on through the inlet opening no. 2, causing the air that made the diver buoyant to be displaced through ports no. 6 in the feet. The diver sinks, guided into its starting position by the guidelines. When it reaches the air tube opening the cycle is repeated and the diver will rise and sink as long as the aerator is operating.

A change in the water level causes the guideline to slacken, thereby stopping the diver from rising or sinking. As the inventor states: "When this occurs, one becomes appraised that the liquid level has reached a point at which additional liquid should be introduced into the tank."

Patent Number 3265388 Continued.

FIG. 4

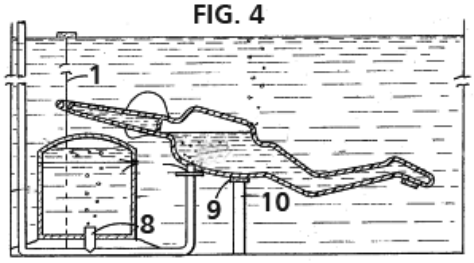


FIG. 5

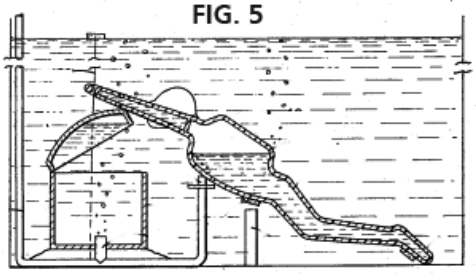
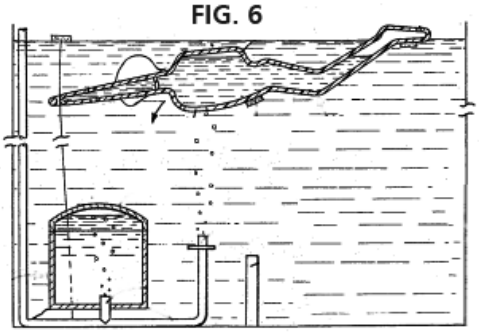


FIG. 6



The second shows a modification involving a treasure chest whose top also opens and closes as air is trapped when it is closed and then released as the top opens. The air is supplied by the additional nozzle, no. 8. An additional means for positioning the diver when at rest is a small magnet on the diver (no. 9) and a magnetic post (no. 10). When the lid of the chest opens it forces the diver up, breaking the magnetic connection and allowing the diver to rise as before.

In addition to taking up a great deal of tank space, not to mention the guideline wires, evidently it did not occur to the inventor that a drop in water level would be the first thing an aquarist would notice, diver or no diver!

2. PATENT NUMBER 4029050 FISH HANDLING APPARATUS

This patent was awarded in June of 1977 to Earl Wilfred Genest of Tarzana, California. This was a device for collecting and removing fish from aquarium tanks and was designed to minimize the amount of disturbance to the fish and to the aquarium environment.

The basic part of the design is a rectangular box with a triangular catch basin at the bottom. This is shown in the Figure 2 side view. The upper part of the container (the rectangular box part) has perforations to allow water to enter and escape as the container is inserted into the aquarium and removed. The triangular catch basin has solid sides all around (although the diagram shows an X-ray view of the fishes therein). The triangular part at the top forms a handle for inserting and removing the container.

Patent Number 4029050

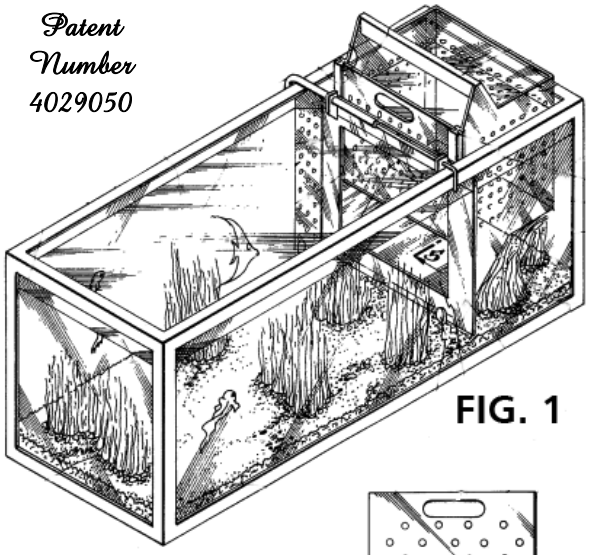


FIG. 1

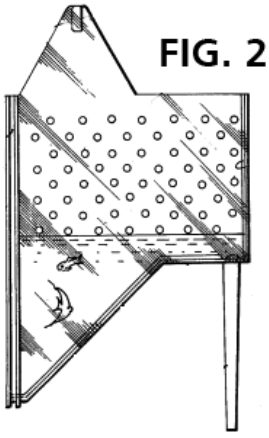


FIG. 2

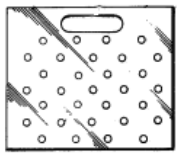


FIG. 3

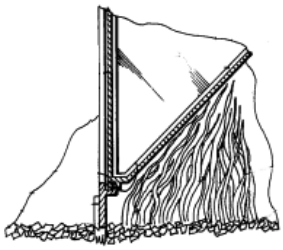


FIG. 4

The front of the container has flat plate that fits snugly against the side of the tank. It has two vertical grooves that accommodate the sliding door (also perforated) shown in Figure 3. The triangular design of the catch basin permits to device to be moved against any vegetation at the end of the tank without disturbing the roots (Figure 4). Hangers are provided

In practice the device is lowered into the tank and pushed towards the end of the aquarium, bending the plants but not uprooting them. The sides of the front panel are adjusted (or cut to size; the inventor specifies that the device is to be made of thin plastic) material to make a reasonably tight fit against the sides of the glass.

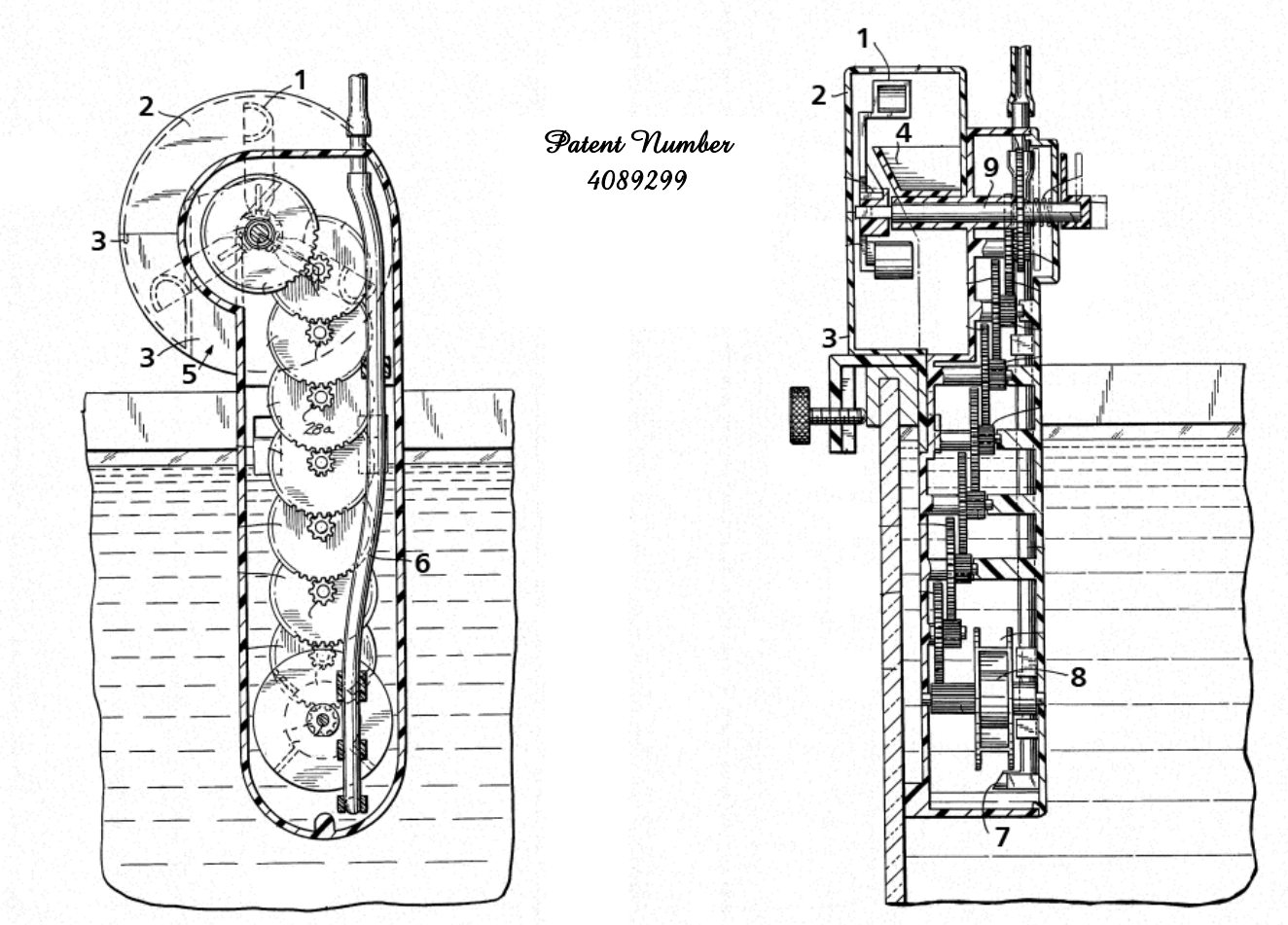
The fish are coaxed into the device (a hand in the water will do) and when they are in the sliding door is lowered. The device is then slowly lifted out of the aquarium, the water draining from the perforated sides of the box and the perforated door, leaving the fish to swim in the catch basin (the only water removed from the tank is that in the catch basis).

Although the design was carefully thought out, it is an awkward piece of equipment to be inserted and removed in any aquarium.

3. PATENT NUMBER 4089299 AN AIR-OPERATED FISH FEEDER

This patent was awarded on May 1978 to Bernard Suchowski of Marlboro, New Jersey but was assigned to Hartz Mountain who evidently seriously considered marketing it. What is unusual about this invention is that it is an air-operated fish feeder.

The feeder is essentially a vertically elongated housing composed of clear plastic such as polyethylene, secured to the side of the tank via a set screw. The housing is not sealed and is open to permit water to circulate between the housing and the aquarium tank. The upper portion of the feeder



includes a cylindrical food hopper containing rotatable feed cups. (no. 1)

The hopper is in two parts, an upper and lower portion, the upper portion (no. 2) being removable to admit the food, the bottom (no. 3) being the storage space for the food. Within the upper portion is a dispensing chute (no. 4) which has an outlet opening at its lower end (no. 5) which is located above the aquarium. As the cups rotate and fill with food they are inverted over the hopper, dropping their contents which then fall into the tank by gravity.

An air tube (no. 6) extends into the housing and opens at its end (no. 7). The air drives a paddle wheel (no. 8) which in turn drives a series of gears causing the shaft (no 9) to which the food cups are attached to rotate at a relatively slow rate. The aerated water ions released to the aquarium toward the upper portion of the open housing and water to be aerated is drawn into the housing in the lower portion. The inventor sized the apparatus so that there was one revolution of the shaft every 24 hours.

Although a clever design, since it simultaneously aerated the water and drove the feeding apparatus, the gearing was expensive and would have caused maintenance problems over time. Electric motors were cheap and could have provided a much more reliable power source and one that could easily been adapted to provide the aquarist with a means of varying the feeding schedule.

4. PATENT NUMBER 4094788 AQUARIUM GRAVEL CLEANER

This patent was awarded on June 1978 to Denzel J. Dockery of Flint, Michigan.

The invention comprises a housing having an upper and a lower chamber (Figure 1 shows the component parts). The upper chamber is open to the lower chamber and a hinged closure lid encloses and forms the bottom wall of the lower chamber. A fluid outlet on the upper chamber is adapted to be coupled to the intake line of an aquarium filter pump, while one end of a tube is connected to a fluid inlet in the upper housing chamber. A sieve is located in the upper housing chamber between the fluid inlet and the outlet.

In operation the pump draws water up through the tube, into the upper chamber, through the sieve and out through the fluid outlet (Figure 2). Thus, as the other end of the tube engages the aquarium gravel, the gravel is drawn up through the tube and into the upper chamber. The sieve retains the gravel within the upper chamber while the fluid flow washes the debris from the aquarium gravel. The water carrying the debris then flows through the sieve and out through the fluid outlet. Once cleaned, the gravel drops into the lower housing chamber.

The cleaned gravel accumulates and collects within

Patent Number 4094788

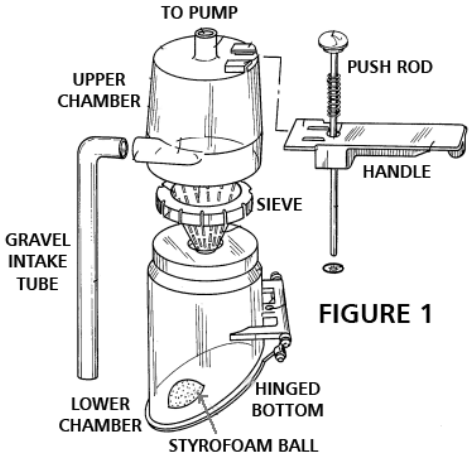


FIGURE 1

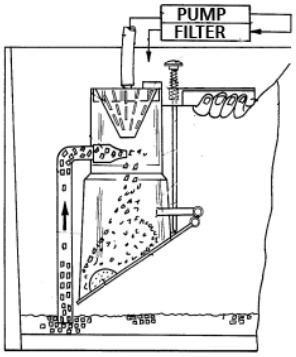


FIGURE 2

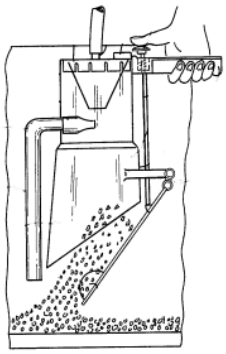


FIGURE 3

the lower housing chamber. When desired, the closure lid is opened by means of a push rod mounted to the housing which dumps the cleaned gravel back into the aquarium (Figure 3). The procedure is repeated until the desired amount of gravel within the aquarium has been cleaned.

This is another piece of equipment that would be awkward to insert into an aquarium. A cheaper and more efficient way to clean the gravel would be to use a plastic bucker, a food strainer suspended on top of the bucket, and a self-starting siphon hose typically used for siphoning gasoline or other fluids. The strainer would catch the gravel where afterwards it could be returned to the aquarium, and the dirty water could be discarded. A change of water is, after all, highly desirable for any aquarium.

5. PATENT NUMBER 4130089 AUTOMATIC AQUARIUM FEEDING DEVICE

This patent was awarded on December 1978 to Daniel J. Moran of Wrightsville Beach, North Carolina.

The invention is a simple automatic feeding apparatus operated directly by the evaporation of water. The device consists of a number of balance arms that pivot, attached at an intermediate point to a bracket clamped on the side of the aquarium. Each balance arm has a feed cup on one end suspended over the surface of the water in the aquarium, and a cup containing water attached to the opposite end.

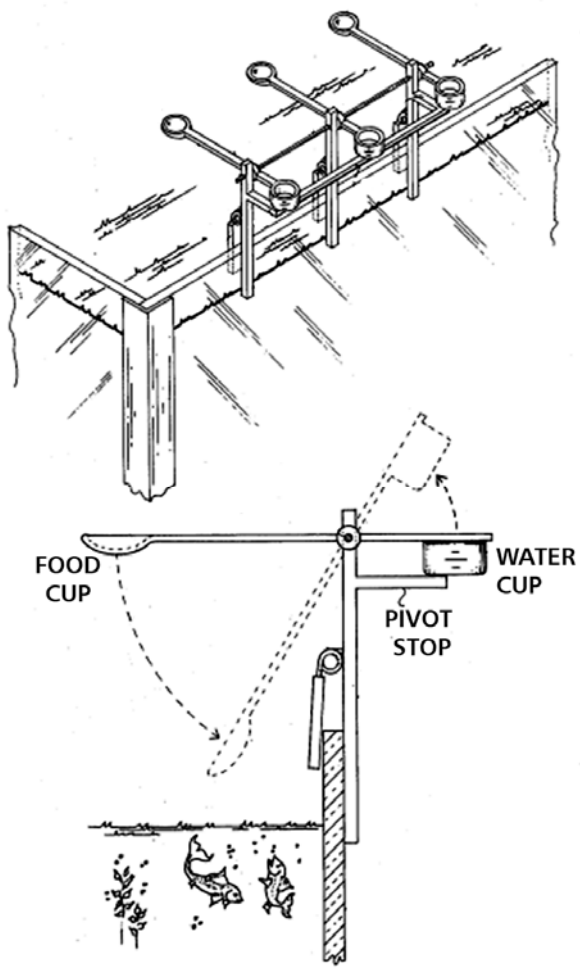
In operation, the feed cup is filled with an amount of food (of any type: flakes, pellets, etc.) equal to one feeding; the liquid cup is filled with water to a level whereby the force on each side of the pivot point is equal and the arm is balanced. Additional water is then added in an amount known to evaporate in a given period of time before feeding is desired.

When the second, pre-measured amount of water has evaporated the food bowl will begin to tilt downwardly and the food will spill into the aquarium. If more than one automatic feeding is desired, additional arms are attached to the aquarium and the water levels incrementally adjusted to cause activation of the arms at pre-selected intervals, thereby emptying the food bowls at intervals.

Construction materials may vary, including any light -weight but rigid plastic, wood, or metal etc., but the preferred material is any of the moldable polymers. The bracket or clamping device is a simple clamping spring mechanism which may be clipped to a side wall of the aquarium.

If a single reciprocating arm is employed for a single feeding it may be attached directly to the bracket by a pivot pin or other pivot means. If a series of arms is necessary, an elongated pivot pin is mounted between two of the upright supports or brackets which are clamped to one side of the aquarium. The food (of any type: flakes, pellets, etc.) equal to one feeding; the liquid cup is filled with water to a level

Patent Number 4130089



whereby the force on each side of the pivot point is equal and the arm is balanced. Additional water is then added in an amount known to evaporate in a given period of time before feeding is desired.

When a multiple apparatus is utilized a pivot stop device is placed to the rear of the bracket in a position extending just underneath the liquid containing cups. The pivot stop prevents the downward tilting of the liquid cups past the horizontal when they are filled with liquid which amounts to a weight or force heavier than that of the food bowls. The liquid cups thereby rest on the top surface of the pivot stop until the liquid evaporates to a predetermined level which will activate the downward tilting of the food bowl.

This an ingenious device, to be sure, but aside from the problems in adjusting the amount of water in the cups for multiple days' feedings, the inventor failed to realize that fish can go without food safely for at least 10 days and even more. The plethora of pivot arms needed would be mind-boggling!

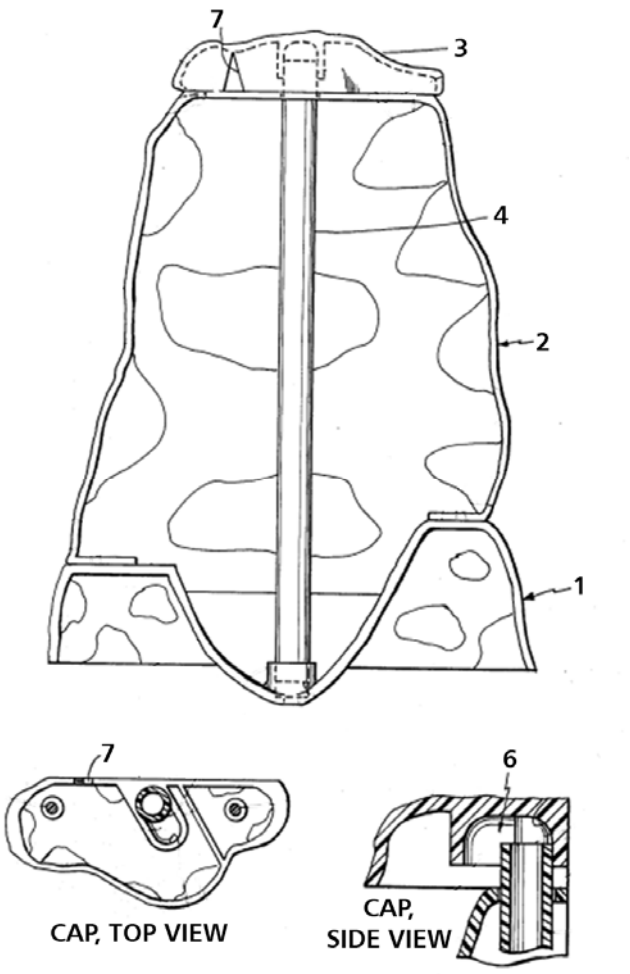
6. PATENT NUMBER 4160427 AQUARIUM WATERFALL

This patent was awarded on December 1979 to Arthur J. Holbrook of Lynnfield, Maine. This invention is a simulated waterfall designed to be mounted on the gravel bed of a home aquarium. Although not the first patent of this type, it was more realistic and better hid the more unnatural parts of the structure which detracted from the appearance of the unit.

In this design, the waterfall is simulated by a directed flow of water and sand down a simulated cliff having several outcroppings that redirect the falling sand in a prescribed path to create maximum interest. There is no reservoir or other artificial collection point forming part of the waterfall at the top of the unit to detract from its appearance, and the force flow allows the unit to function with a minimum amount of sand.

The waterfall is composed of three major molded elements: a base (20), a vertical member (22, and a

Patent Number 4160427

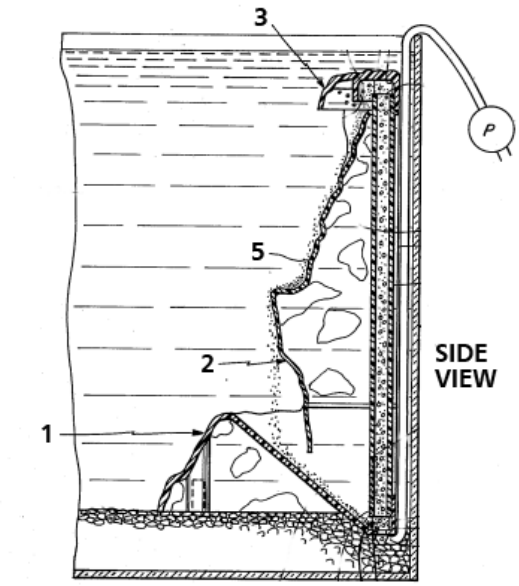


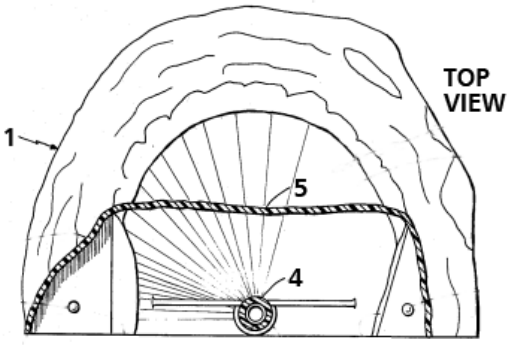
cap (24). The assembly also contains an air lift tube (26). The vertical member has a front surface (60) that simulates a rock surface. A fine grade of sand having a particle diameter of approximately 004" in diameter is used to simulate the falling water over the front surface.

The mixture of air, water, and fine gravel rises to the top via the air lift to a trough (80) under the cap where the water and sand are directed downward over the front surface. The air is released through a slot in the cap (90). The falling sand gives the optical illusion of a substantial flow while only a small amount of sand actually moves in the system (about 1/2 teaspoon).

One of the problems with these sand waterfalls is

Patent Number 4160427 Continued.

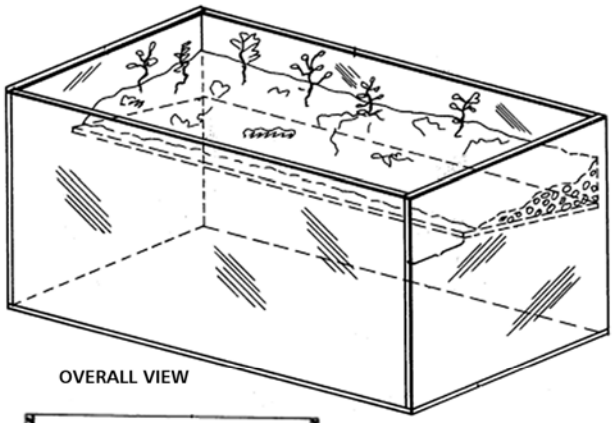


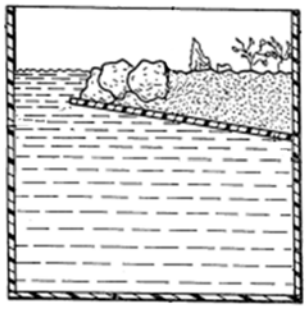


that one must be very careful in placing the sand in the well, as the fine particles are easily dislodged. The same is true if there is a substantial flow of water in the tank. They have, however, achieved some measure of success in the marketplace (this particular patent was assigned to Rolf C. Hagen, the maker of the AquaClear and Fluval filter lines).

7. PATENT NUMBER 4176620 AQUARIUM-TERRARIUM TANK

This patent was awarded on December 1979 to Thomas G. Kassos of Pittsburg, Pennsylvania.





Patent Number 4176620

The object of the invention is to provide a tank adapted for use as an aquarium and a terrarium, to enhance the aesthetic appearance of the tank, and increase the usefulness of the aquarium. Most prior designs for combination aquarium-terrariums incorporated ungainly rafts and/or ramps that protruded above the tank. This design incorporates the terrarium portion entirely within the tank.

The design is simple and pretty much self-explanatory. The problem is that this design basically is nothing more than a sheet of plastic, silicon-cemented to the inside of an aquarium. One wonders that a patent can be awarded for a rectangular piece of plastic! One also wonders how it would be marketed. Does the consumer open the box to find nothing more than a sheet of plastic?

This is a job that anyone can do in minutes, given a sheet cut to size. If the aquarist is not up to cutting plastic sheet, there are local plastic fabricators that can do the job for him.

Patent Number 4194620

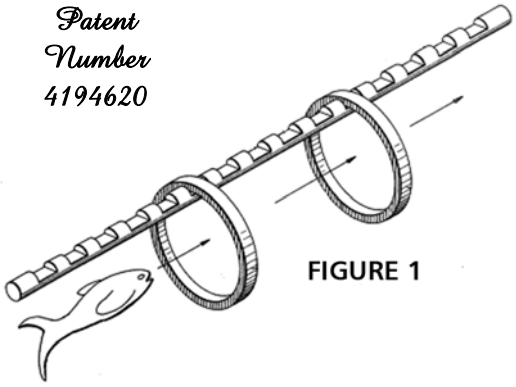


FIGURE 1

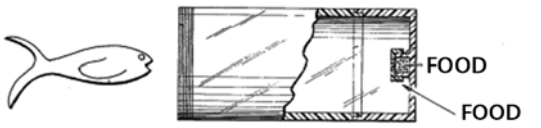


FIGURE 2

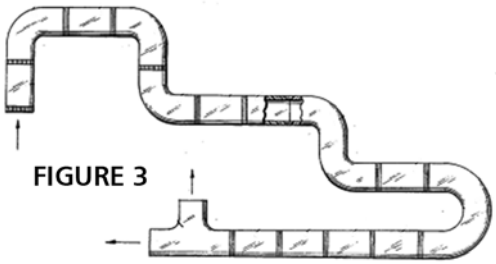


FIGURE 3

8. PATENT NUMBER 4194620 TROPICAL FISH TRAINING KIT

This patent was awarded on March 1980 to Natalie Soloway of Sherman Oaks, California.

A main object of this invention is to provide a novel tropical fish training kit. It includes a number of inter -connectable tubes, forming a maze through which a fish swims.

Another object of this invention is to provide a device for a simulated horse race game in which a housing is provided through which fish swim toward a gate having means thereon for holding fish food.

Lastly, another object of this invention is to provide a device for playing tic-tac-toe with the fish.

Figure 1 shows a notched rod holding a pair of rings through which the fish are trained to swim (one starts with one ring and then adds others as the training progresses). The training device is used by holding the rod at or just below the surface of the water. To quote the inventor: “It is presumed that the fish can be finger fed and the rod is held in one hand while fish food is held in the other.”

Figure 2 is a side view (with a portion broken away for clarity) and shows a tube having an open end into which a fish is attracted by food (F1) carried by a removable cap (19) at a closed end of the tube. Once the fish is conditioned by the rings, its natural curiosity prompts it to enter the tube where it is rewarded by the food.

Figure 3 is a side elevation view (with a portion broken away for clarity) of a tubular maze and

Patent Number 4194620 Continued.

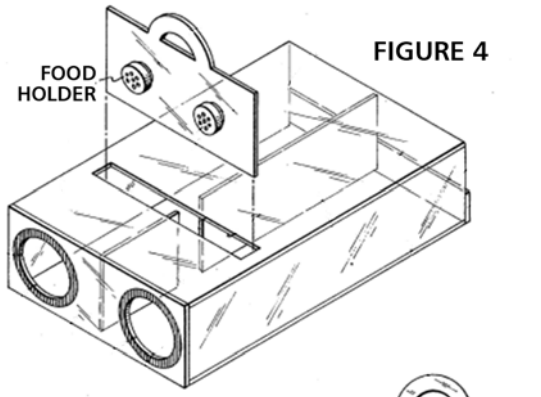


FIGURE 4

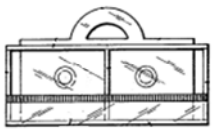


FIGURE 5

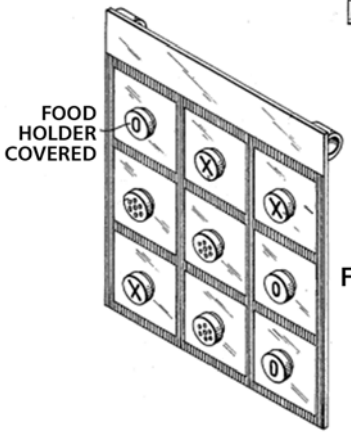


FIGURE 6

illustrates a variety of differently contoured individual tubular elements forming the maze. Once the fish is conditioned to swim through a shot tube it is ready to tackle the maze.

Figure 4 is a perspective view of another device of the kit, and illustrates a housing having a pair of entrance openings through which fish swim into individual chambers. Each as a gate (carrying fish food—57, 58) which can be moved to an open position to permit fish to swim along confined paths of travel toward an exit opening of the housing much in the manner of a simulated horserace. The rear of the device is only half-closed (its lower portion), providing a means for the fish to escape. Figure 5 is an end or rear view of the housing and illustrates the exit openings of the housing.

The final device is shown in Figure 6 and consists of a rectangular board each of which holds fish food and is meant to be slide into a nine-compartment housing similar to that shown in Figure 5. Eventually a fish will swim into one of the compartments and eat the food there. The food container is now covered by a cap with an “O” or an “X” on it, depending upon whose turn it is (i.e., the competing aquarist’s turn). The play continues until three “O”s or three “X”s are obtained in one of the usual tic-tac-toe patterns, indicating a winner.

I had to force myself to stop laughing as I read this patent. Perhaps fish can be trained, but I am reminded of the proposition advanced by statisticians, that given enough time, a room full of typewriters and chimpanzees will type out all the manuscripts in the British Library. I imagine that anyone playing the tic-tac-toe game and waiting for the fish to make the next move would be eligible for his Social Security checks when the game was over, even if he started out playing it when he was but ten years old!

9. PATENT NUMBER 4223471 AQUARIUM CRIB TOY

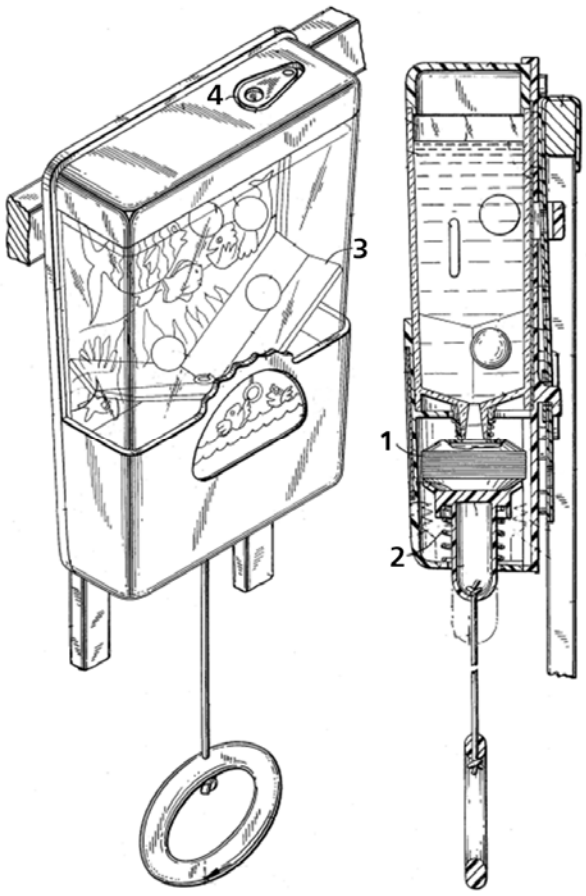
This patent was awarded on September 1980 to Sheldon Greenberg of Fort Lee, New Jersey. The object of the invention is: “... to provide an aquarium crib toy which is simple and easy to operate by a baby, infant or small child.”

The invention simulates an aquarium, and basically is a transparent enclosure made of polyethylene or a similar plastic. The enclosure is filled with water and contains a number of movable objects in the form of fish and other aquatic objects, constructed of hollow plastic, the density of the objects being greater than the density of the water.

A flexible, resilient bellows (e.g., neoprene - no. 1 in the diagram) is mounted to the bottom of the enclosure and attached to it is a pull cord or string with a terminal plastic ring. When the ring is pulled the bellows expands, drawing some of the water from the simulated aquarium into the bellows.

When the bellows is pulled down it compresses a circular spring (no. 2) located beneath it. When the

Patent Number 4223471



ring is released, the spring then forces the bellow upwards, sending water from the bellows back into the aquarium, whereby the objects in the simulated aquarium are agitated and swirl and move about within the water of the simulated aquarium.

A sloping trough with a hole in the bottom (no. 3) directs the objects to a central position when they drop to the bottom, and a closable opening (a rubber plug - no. 4) in the top provides a means for filling the aquarium with water as needed to fill it and replace any water lost by evaporation. The device is intended to be mounted inside of the crib.

Objects intended to be placed inside a baby's crib must be designed with much care. The rubber plug for filling the device is entirely removable in this design and could, if loosened, be a hazard to infants who will tend to swallow anything they can put in the mouths. If the aquarium is tipped, the small objects within may be released into the crib, affording further hazards of this kind. Furthermore, on general principles parents might be reluctant to place a vessel container water anywhere near a crib. Sooner or later the bellows would most likely fail.

. 10. PATENT NUMBER 4270489

FISH-OPERATED AQUARIUM FEEDER

This patent was awarded on June 1980 to Osmo K. Joronen of Victoria, B.C., Canada. The invention is an apparatus that can be operated by the fish to dispense a small quantity of dried fish food.

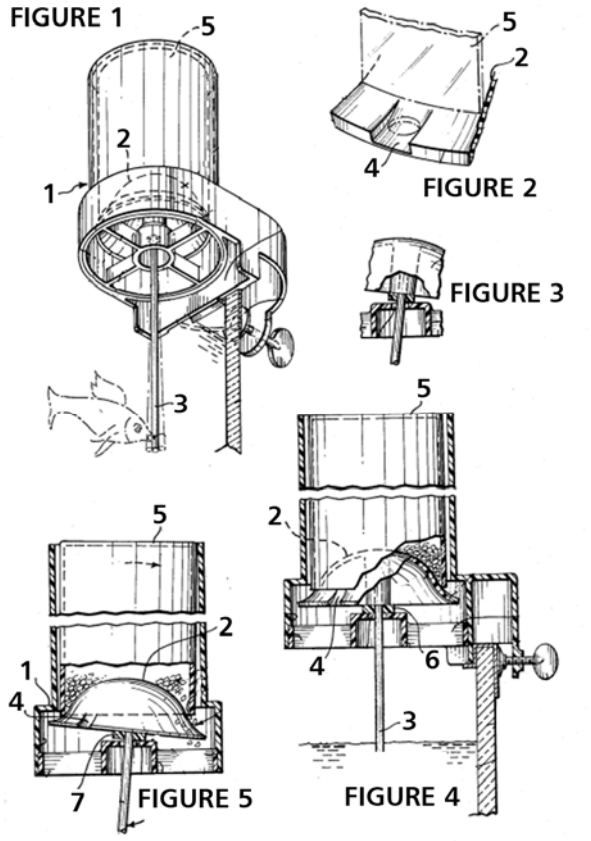
The inventor points out that previous U.S. patents typically dispensed fish food using an actuator rod of some sort in response to forces applied by the fish. These devices, however, presented one or more disadvantages or drawbacks. For example, because fish of various sizes are kept in aquariums and because of differences of the habits and feeding practice of various types of fish, certain fish may not be capable of displacing an actuator rod by the amount required to dispense the food. On the other hand, if the food dispenser is configured such that a relatively small force is required to actuate the food dispenser, overfeeding may result.

Furthermore, the reliability of these fish food dispensers is affected by the structural features of their designs. Such devices, for example, often become partially or wholly inoperative because of moisture that reaches the stored food supply. Furthermore, such structural complexity also often means that the procedure required to install and/or refill the dispenser is not as convenient as would be desired.

The inventor also argues that many prior patents are relatively complex in structure and therefore cannot be manufactured and sold at a cost that is economically attractive.

The feeder (no. 1) is attached to the side of the aquarium as shown in the figures. It contains a dome -shaped valve (no. 2) having a downwardly extending actuator rod (no. 3) that pivots with the feeder housing. The periphery of the valve contains a series of grooves (no. 4) each containing a hole. An

Patent Number 4270489



inverted food container (no. 5) rests on the top of the dome-shaped valve surface to form a substantially closed storage chamber for the fish food when the valve is in its equilibrium position, i.e., when the actuator rod is in its vertical position.

As the actuator rod is deflected by the fish, the dome -shape portion of the valve rotates within the opening of the storage container so that a portion of the valve periphery moves inwardly toward the edge of the inverted container. If this portion of the periphery includes one of the channel-like grooves, a small portion of fish food is allowed to flow from the container and fall into the water. Since the channel-like grooves are dimensioned to permit only one or a few particles or flakes of food to pass outwardly during the time required for the valve to return to the equilibrium position, a single deflection of the actuator can only supply a small, substantially controlled amount of food.

Since frictional contact between the lower edge of the feeder and the valve head upper surface may tend to also tip the feeder during deflection of the actuator rod, the inverted food container which is a bit smaller in diameter than the feeder maintains a near vertical position. Thus, should the feeder tend to tip along with the valve head, the food container comes into contact with the feeder wall, remaining in a substantially upright position in which the food dispensing operation just described can occur.

As is shown in Figure 3, a small crack-like opening (no. 6) is momentarily formed between the valve head upper surface and the lower edge of the food container. This permits relatively fine particles of fish food that often accompany a flaked-type fish food to pass outwardly and fall into the water. Further, movement of the valve head relative to the food container and the feeder agitates or disturbs the stored food in a manner which causes both the full sized food particles and any dust-like accompanying particles to flow smoothly and continuously toward the peripheral flange region.

Replaceable washer-like discs (no. 7) that form the contact region between the valve and the housing permit the force required to actuate the feeder to be adjusted for properly feeding fish of various species and size.

As for training the fish, the inventor has this to say:

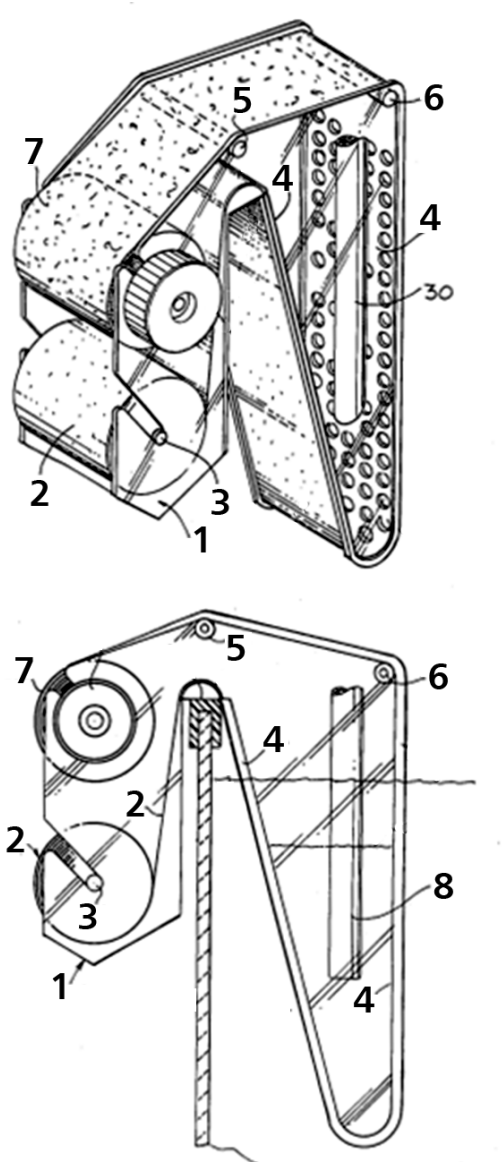
> "Little or no 'training' is generally required to acquaint the fish with the operation of the invention. In this regard, the submerged portion of the actuator rod includes a mark or other dot-like indicator that is preferably brown or another color that is highly visible under water. Since the mark appears to be food or another small foreign object, most fish will investigate in a manner that displaces the actuator rod. For example, various fish exhibit different behavior patterns and may bump the region of the actuator rod that includes the mark, may direct a stream of water at the mark by rapid action of their mouth and gills, or may strike out at the mark with their tail or other portion of their body. Once the fish have operated the food dispenser a number of times and cause food to fall into the water during at least some of the operations, an association is formed between the behavior utilized to displace the actuator rod and the act of feeding. The fish will then operate the food dispenser whenever they desire food."

Devices like this one rely on unclogged passages. Dry fish food contains fines and feeders are near a humid environment, i.e., an open aquarium. The combination is ready-made for these particles to set up like concrete and prevent the disbursement of the food. The replaceable washer-like disks allow the aquarists to set the force required to activate the feeder, but a variety of valves containing different-sized grooves would be required to regulate the size of the food portions. All in all, this is an iffy way to feed fish while the aquarist is away. A motor-driven feeder would be a much more reliable.

11. PATENT NUMBER 4282095 AQUARIUM FILTERING SYSTEM

This patent was awarded on August 1981 to Parker I. Tsuhako of Gardenia, California.

Patent Number 4282095



This invention involves a filtering device providing for easy change of filtration material, external supply and take-up of the filter material, and an immersed filtering surface traversed by a filtering medium.

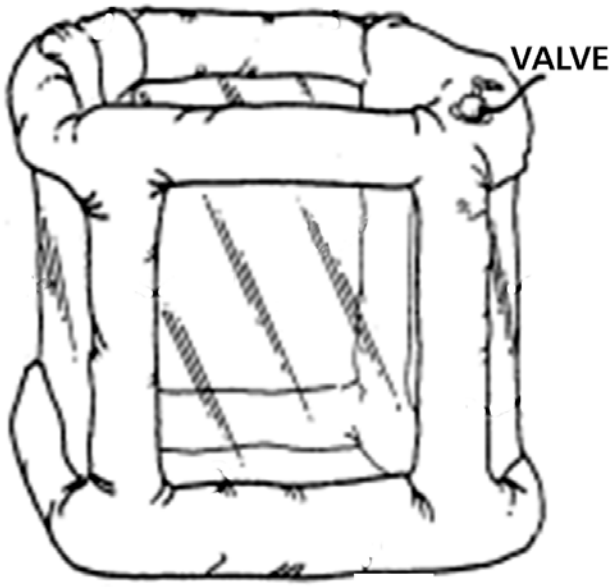
The basic part of the device is a filtration housing (no. 1) that is immersed in an aquarium along one of its edges and is perforated on its opposed walls (no. 4) and along its lower or bottom surface. The preferred form (shown) has perforated walls that are joined at the bottom to form a “V” or “U: shaped structure, but more rectangular shapes may be used. The housing is provided with one or more extensions that form an external support for both used and unused filter material. In Figure 1 the new filtration material (no. 2) is on reel (no. 3) which is placed in the housing. Rollers (no. 5 and 6) guide the filtering material through to the take-up reel (no. 7) located outside of the aquarium. Aquarium water passes through the holes in the housing, then through the filtration material, and then passes out of the aquarium to a pump (not shown) where it is returned to the tank.

As a result, the filter medium supply and used medium storage are external to the aquarium, and can be renewed without disturbing the aquarium itself. A new supply can be drawn over the edge of the aquarium, utilizing a connection between the depleted and new supply of filtration medium as a means to guide the new medium over the perforated surface of the immersed housing, and return it to the used filtration material take-up mechanism. The latter can be combined with either mechanical, electrical, electro-mechanical, or any other drive means to pull the material through the immersed housing. If a manual fed is used, when the filter material in the aquarium becomes clogged or dirty, the filter may be manually advanced, clean filtering material replacing the old material.

The aquarium water is either fed to the central portion of the housing by, for example, a pipe (no. 8) placed centrally in the housing and externally connected to the water circulation/heating pump, or the same tube may be utilized as a pickup tube to draw the water in the tank through the filter material, into the central portion of the housing, and back to the tank via the pump.

The design is reminiscent of the continuous towel dispensers in washrooms but there are a number of problems with the concept. For one thing, the spent filtering material would be wet and therefore some sort of drip container would be needed under the take -up roll. Changing the roll of filtration material would also be an awkward and dirty process. Finally, the cost of the filtration material would make this a very expensive way of filtering aquarium water.

Patent Number 4858755



12. PATENT NUMBER 4858755 INFLATABLE DISPLAY CONTAINER

This patent was awarded on August 1989 to Lawrence J. Kuivanen of Stanford, Connecticut.

The invention comprises at least four flexible side panels and an inflatable, tubular, flexible framework surrounding the side panels. The material used is a clear or transparent flexible film material such as a vinyl film. The framework includes an upper tubular rim, a lower tubular rim and at least four upstanding tubular columns. Each of the side panels is joined to the upper and lower tubular rims and to two of the tubular columns. A flexible bottom panel is joined to the lower tubular rim and a valve is provided in the framework for inflating the container. The joining is effects by heat-sealing. Since the concept is simple, the diagram is pretty much self-explanatory.

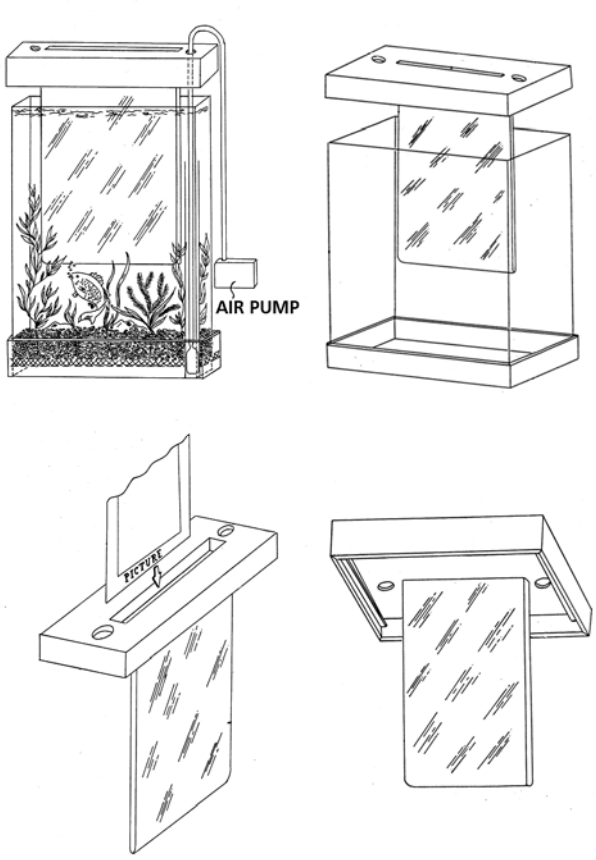
Actually, this is not a bad idea and I would have welcomed such a device on my collecting trips in remote rainforests, although I probably would have modified it so that one side was replaced with a pane of a good optical-quality plastic so the device could be used as a portable photographing tank. Since only one side would then be rigid it still could be folded up for traveling.

13. PATENT NUMBER 5078093 AQUARIUM WITH AN INTERNAL DISPLAY DEVICE FOR A PICTURE

This patent was awarded on January 1992 to Daniel G. Flaherty of Irving, Texas.

Generally speaking, proposals for including a picture in combination with an aquarium have included structures for mounting a picture directly to the backside of the tank. These pictures, however, are mounted on the exterior of the aquarium and present only an imperfect illusion of a picture within an aquarium. In one patent a proposal was made to indent the rear side wall of the aquarium so as to mount a picture more interiorly of the aquarium. However, such constructions are often difficult and/ or expensive to manufacture in order to assure that the indentation formed in the backside wall of the aquarium will remain water-tight. Further, such constructions do not serve effectively to position a

Patent Number 5078093



picture within the aquarium for viewing from the rear.

The object of the present invention is to provide an aquarium having internal structures for displaying a picture such as a photograph within the aquarium that do not need extensive manufacturing techniques in order to assure that the aquarium will remain watertight, and display a picture from more than one direction.

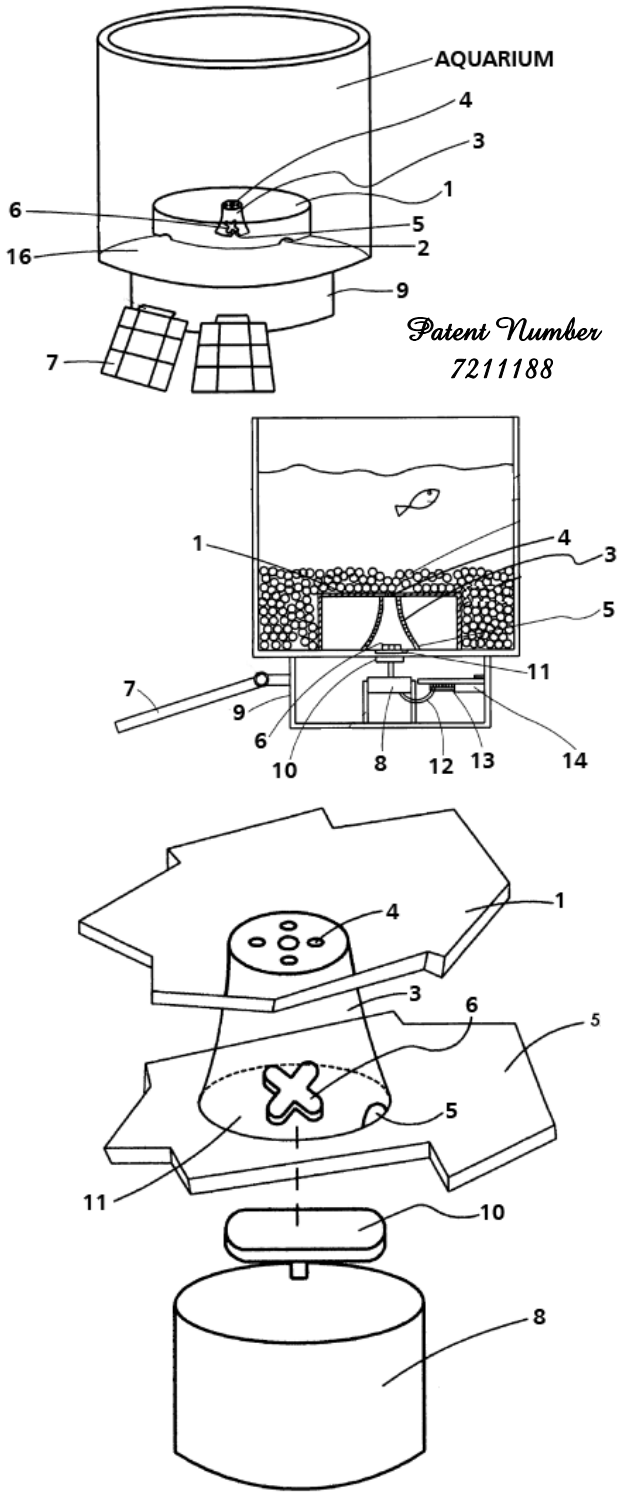
The invention is simple, so the accompany images pretty much explain all. This display device for a picture includes an aquarium of conventional design. A cover member is positioned over the open top and has a slot for receiving a picture. Hanging from the slot in the cover is a water-tight member formed of a transparent material that is adapted to receive the picture to display it inside of the aquarium.

This invention does do all it claims. A nice feature is the fact that, when the picture holder becomes covered with algae it can easily be removed for cleaning. An added advantage to the design is that two photographs may be inserted back-to-back so a picture is displayed no matter where the viewer is standing. However, since this is a simple invention, any aquarist with rudimentary skills can manufacture the top insert picture holder himself to tailor-make it to any tank. It would, therefore, have little commercial interest.

14. PATENT NUMBER 7211188 SOLAR POWERED AQUARIUM

This patent was awarded on May 2007 to Jeffrey G. Lawson of San Francisco, California.

This invention relates to a solar powered aquarium. Within the aquarium is a compartment (1), the side wall of which has a number of notches or openings at the bottom (2) that allow the passage of water. Within the compartment is a small flared cylindrical member (3). Holes (4) on the top of the cylinder allow water to flow into from the tank. A hole (5) at the bottom of the cylinder allows water to exit. The spinning of a magnetic stirring member (6) causes a pumping action that causes water to be drawn into the holes on top of the cylinder and then out through the hole at the bottom. The total area of the holes at the top is approximately equal to the area of the hole at the bottom so that no excess water pressure is built



up within the cylinder, thereby allowing for the smooth flow of water into and out.

Solar panels (7) power a small DC motor (8) located within bottom skirt (9). The motor shaft terminates in an iron plate (10). By magnetic attractive force, it spins the magnetic stirring member. The addition of a thin foam plastic layer (11) under the magnetic stirrer helps create a more silent spinning action so that when the aquarium is in place in a quiet environment such as a desk, the sound of the spinning magnetic member is not objectionable.

Wires (12) connect the DC motor to a charging circuit (13) that includes rechargeable batteries (12). A spinning metal plate (15) is located just under the base plate (16) primary object of the invention is to but not touching it. Because the force to rotate the magnetic spinning member is so small, the motor uses very little power, approximately one hundred and fifty milliamps, which can be fairly easily generated by the solar panels in moderate daylight. The inventor's experiments indicated that exposure to direct sunlight is not necessary, and that enough electrical power is stored in the rechargeable batteries during the day that the motor continues to spin through the night on the stored energy.

The pumping action caused by magnetic spinner 20 causes fish related debris in the water to be drawn into the gravel bed (10) where it is trapped. Periodically, the user has to exchange the debris filled gravel for new clean gravel. The solar cells 28 are mounted on frictional hinges 30 so that they can be optimally adjusted to face a light source. Additionally, the solar panels can be folded to be close to the skirt for purposes.

The idea has a number of problems. For one thing, the solar panels are fragile and are easily damaged since they would stick out from the aquarium. Assuming the motor was powerful enough to move water through the gravel, even the inventor points out that the user has to exchange the used gravel for clean gravel. In this case it means that the fish must be removed, as well as any aquascaping (plants, rocks, etc.) that might have been set up in the tank. I also have my doubts about the power generated by solar panels that would be practicable on a desktop. One also might ponder where one could find those DC-rechargeable batteries for the device.

CONCLUSION

It is fun to read aquarium patents, especially those devised by inventors with inquiring, creative minds as exemplified here. One does come away, however, with the thought that the majority are not really experienced aquarists, since the design defects are readily apparent to anyone who has kept fish for any reasonable amount of time. Two patents were assigned to manufacturers whose aquarium equipment is well-known among fish keepers, so I wonder at their expertise as well (perhaps it is I who has the wrong end of the proverbial stick, not realizing that some people will buy anything if the marketing is persuasive enough).

In any event, practical inventions come about by people who are not afraid to take chances. However we might laugh at the failures, we should always remember the successes as well for these have made our hobby a lot easier for all of us.

Now that transparent aluminum is available for beverage cans, who'll be the first to patent its use as an aquarium?

THE INVENTIVE MIND OF ALLAN H. WILLINGER (1927-2001)

by Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society, Yahoo Files, December 21, 2007)

Probably the most prolific and best-known inventor in the aquarium field, Allan Willinger started his creative journey at age 11, when he figured out how to encase a 15-watt hair curler from Woolworth's in a glass test tube, and thereby got his aquarium water warm enough to keep his tropical fish. Along with his brother, Harding, he founded Metaframe (a descendant of the old Potts Aquarium Company of Caldwell, New Jersey) which, in addition to publishing THE AQUARIUM magazine, became one of the world's best known firms producing air pumps, air stones, filters, heaters, cleaners, spawning devices, and other aquarium-related products. Over the course of his lifetime, Allan Willinger was awarded 116 patents of which, with few exceptions, he was the sole or senior inventor.

The Willinger Brothers foray into aquarium patents actually started with his older (by six years) brother Harding, who obtained his first patent in 1954, an improved filter stem for an inside filter that reduced splashing of the return water; his second, also in 1954, was for a breeding trap, and his third, in 1955, was for a dip tube. However, his most successful patent was for the bottom filter shown in Figure 1, an immensely popular filter for the time. Along with his brother Allan, he patented five additional inventions between 1963 and 1978 that concerned aquariums, air pumps, and an aquarium thermometer. This essentially was the last of Harding's patent activities until 2000 when he subsequently obtained three design patents for a decorative rim and a decorative base for a fishbowl, the last one awarded two weeks prior to the death of his brother.

Allan Willinger's first patent was awarded in 1960, for an undergravel filter. Prior to this, undergravel filters drew the water from the corner near the air lift, and since water travels through the path of least resistance, most of the flow through the gravel took place near this corner. Willinger's design (Figure 2) incorporated special channels and a greater amount of space below the gravel bed near the air lift,

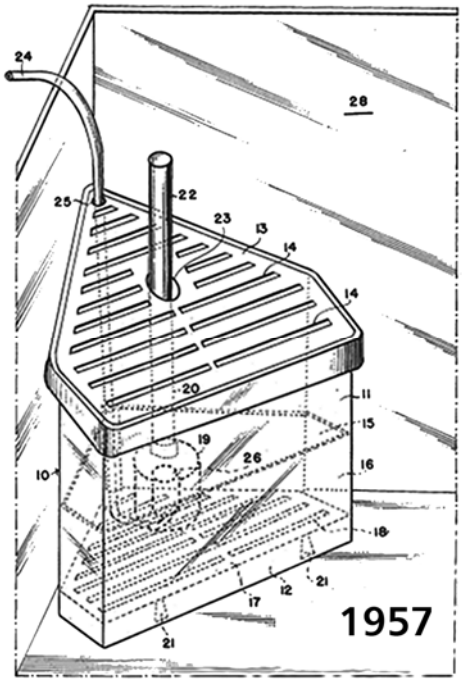


FIGURE 1

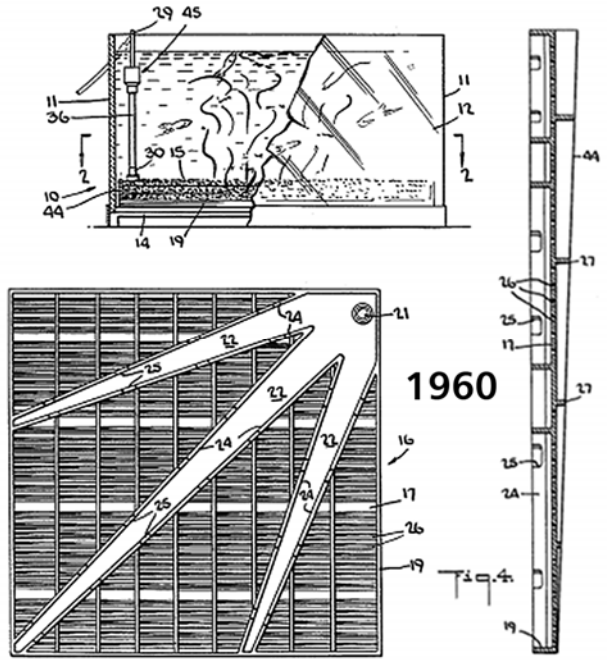
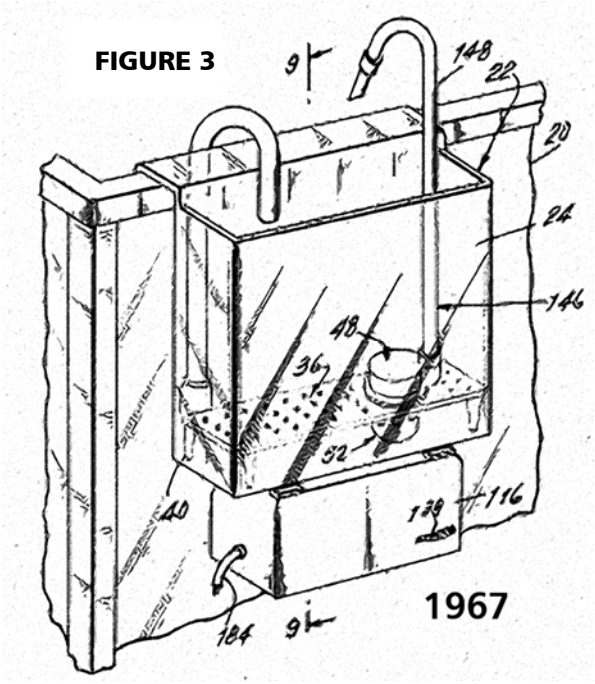
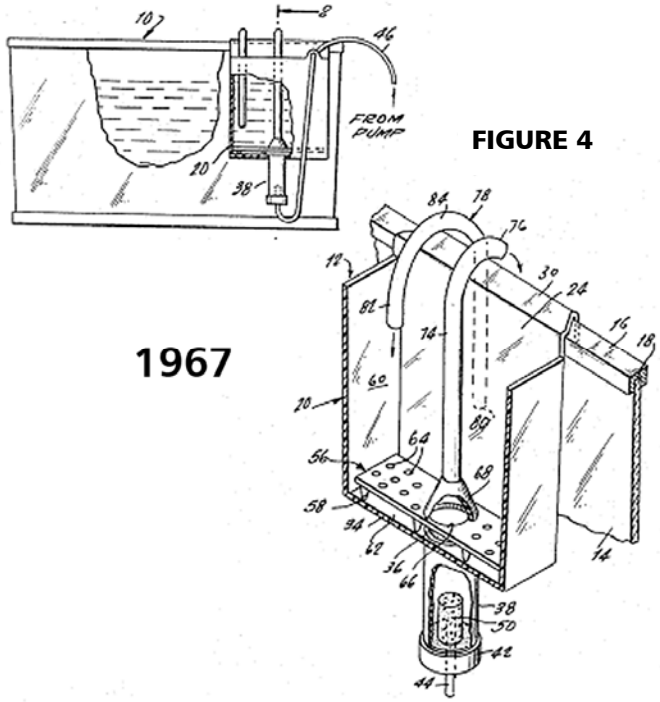


FIGURE 2

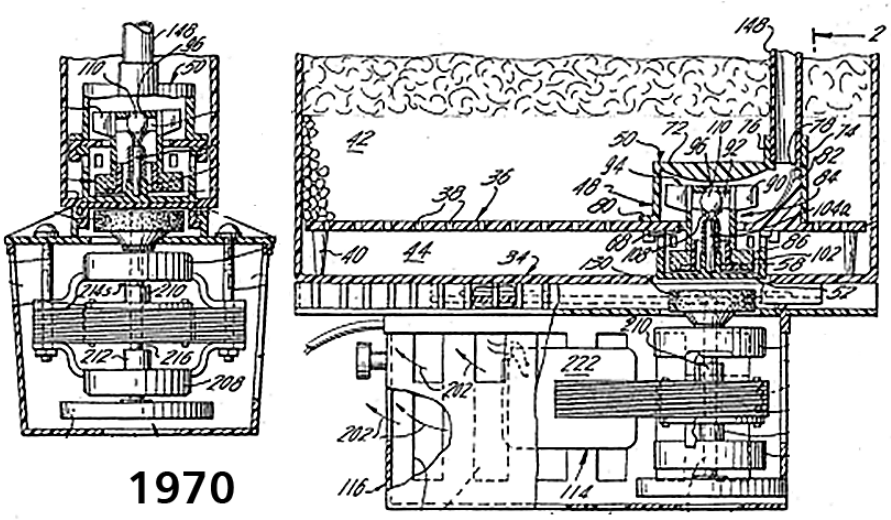


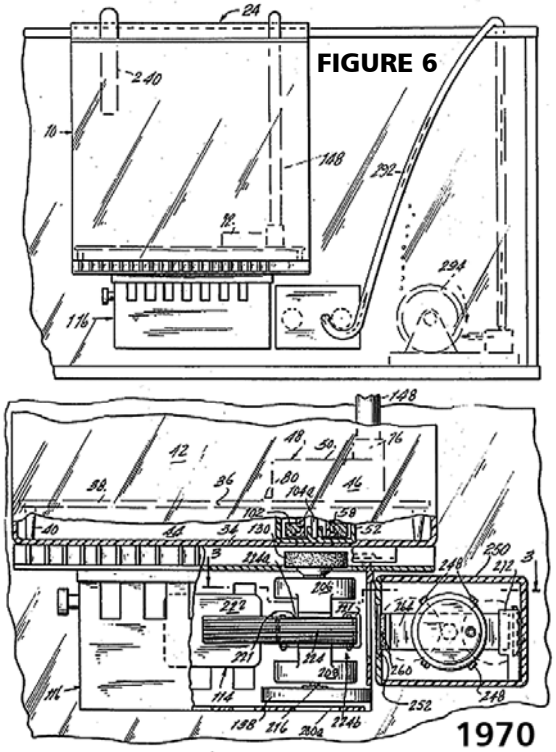


resulting in a more uniform flow of water through the filter bed. His second patent was (with his brother) awarded in 1963 for an aquarium and cover molded of plastic, and his third, in the same year, for an aquarium heater. Willinger's forte, however, was not in heaters although he did receive a total of five patents in this area. These patents involved improvements in heater repair and calibration, and in the minimization through better circuitry of malfunctions such as sticking contacts and sparking between the contacts. Two of these patents involved heater mounts that eliminated denting the metal edge of the aquarium, reduced scratching of the glass, and accommodated aquariums with various types of frames.

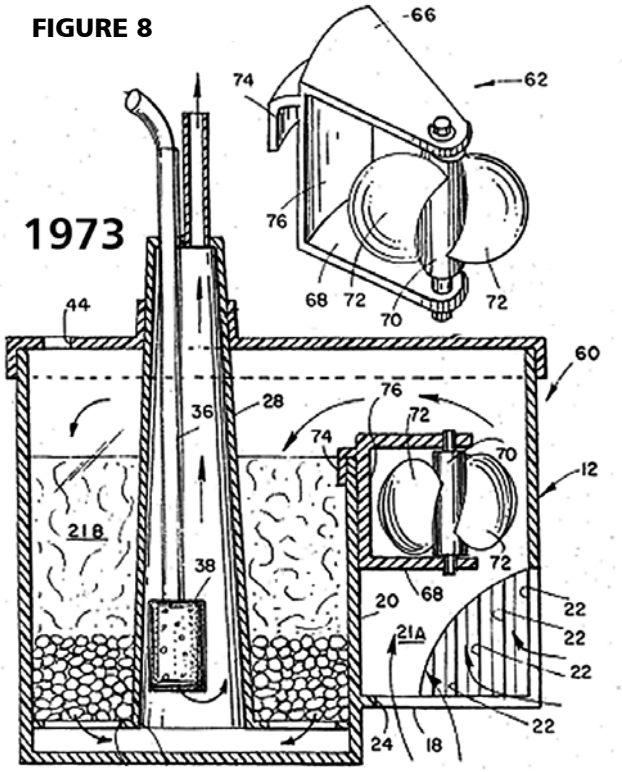
His greatest impact was in filter design, almost half of his patents being awarded in this category. In 1967 he designed an outside filter in combination with a submersed centrifugal-type pump (Figure 3) where, to ensure that no water leaked into the motor compartment, the pump impeller was fitted with a magnet, as was the rotor in the pump compartment. This magnetic connection was a real first. The pump was quiet, could not burn out even if the impeller became jammed, and it moved a relatively large amount of water for its size. Another patent awarded in the same year was for a filter that used an air lift to move the water (Figure 4). The design of this air-lift, however, permitted a larger amount to water to be moved than in prior designs. Furthermore, the inner compartment was fitted with a bottom shelf, permitting the filter contents to be removed without taking the filter off the tank.

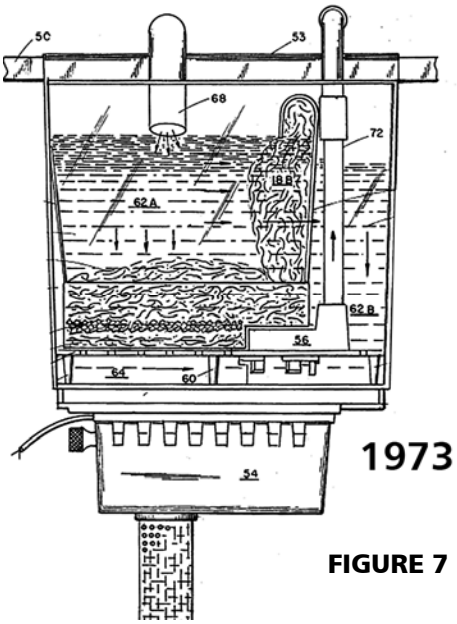
FIGURE 5

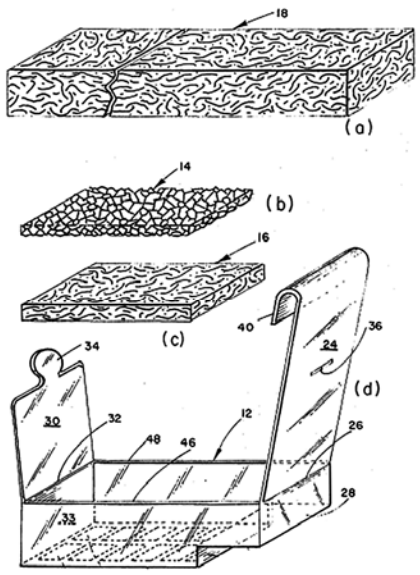




An important design patented in 1970 that was to be part of the well-known "Whisper" filter eight years later was of the outside type with a built in motor where the lower magnet was on a floating assembly, thereby taking the weight off the bottom of the rotor, reducing the friction and providing a longer life for this vital moving part (Figure 5). Willinger also provided slots in the pump housing so the heat produced by the motor could rise and warm the water in the filter. The same year he patented a similar filter, but this time the motor included a vibrating armature that drove a small vibrating air pump (Figure 6). This was less of a success because the vibrating armature did not produce much of an air stream, and it did pass the vibration onto the aquarium.







In 1973, Allan Willinger introduced an improvement on the idea of permitting the filter contents to be removed without taking the filter off the tank with the design shown in Figure 7. Basically, this is how all current-day outside filters are arranged for cleaning their contents. A more fanciful design was a novel bottom filter patented in the same year that incorporated a rotary indicator that signaled the clogging of the filter medium. This was a vane-like device that spun when water flowed past it (Figure 8). If the filter clogged, the water flow diminished, slowing the vane's

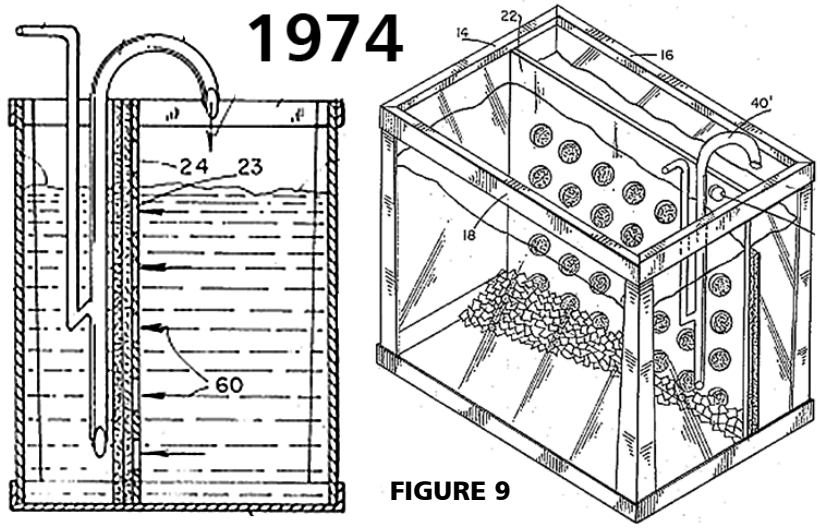


FIGURE 9

rotation. When the filter was completely clogged, the vane stopped moving entirely. Willinger argued that:

> "... there is an aesthetic value in visible movement of solid objects. This is evidenced by the popularity of air activated 'action ornaments' in aquariums, ornaments in which parts are caused to move by a stream of air bubbles which strike displace-able parts of the ornament structure. Such ornaments serve no functional purpose in an aquarium beyond adding a small amount of air to the aquarium water. If an 'action ornament' provided useful information to the aquarium owner, the value of such 'action ornaments' would be increased. Such is one function of the present invention."

One of Willinger's more unusual filter inventions was patented in 1974 and is shown in Figure 9. He argued correctly that undergravel filters were hard to clean when clogged, and that small inside filters did not have the capacity to do much biological filtration and that they had to be cleaned frequently. His solution was a vertical filter composed of a sheet consisting of a polyester floss material having two layers of two different porosity foam plastics, supported by an impervious panel on each side containing holes for the water to flow through. This was placed at the rear of the aquarium, the impervious sheet being secured to the aquarium with silicone rubber cement with enough space behind it to accommodate the air lift, a heater, and a bag of activated charcoal if desired. A hole in the top part of the sheet permitted water to flow back into the main part of the aquarium should the filter become clogged. When it was necessary to clean the filter, it was merely lifted up and out from the impervious sheets and cleaned. However, this is another design that did not see the light of day commercially, since it was unsightly and decreased the space available for the fish.

Even though some of Willinger's designs were not especially practical or even useful, his patents are nevertheless a joy to read, and the background sections of his patents can easily serve as a basis for a history of the development of aquarium equipment. The following is an example, taken from his disposable filtration cartridge patent shown in Figure 7:

> "Generally speaking, filtration housings usually incorporate an apertured partition for dividing the housing into a first chamber for receiving debris-laden fluid and a second chamber communicating with the first chamber into which cleansed fluid may pass from filtering materials extending along the partition in the first chamber. In this respect, the filtering materials may be generally constituted of a dissolved material adsorbing means such as charcoal and a particle trapping means such as plastic wool or the like, and the conventional manner of arranging the filtering materials is simply to deposit the charcoal and plastic wool randomly along the partition in the first chamber to be constrained solely by the walls of the filtration housing.
>
> "Clearly, as those skilled in the art readily understand, filtering materials, after a period of time, must be replaced with substitute filtering materials since, in fact, after a particular period, the filtering materials which entrap debris become clogged, thereby, delimiting the capacity thereof to cleanse debris-laden fluid. Obviously, since the filtering materials, such as the charcoal and

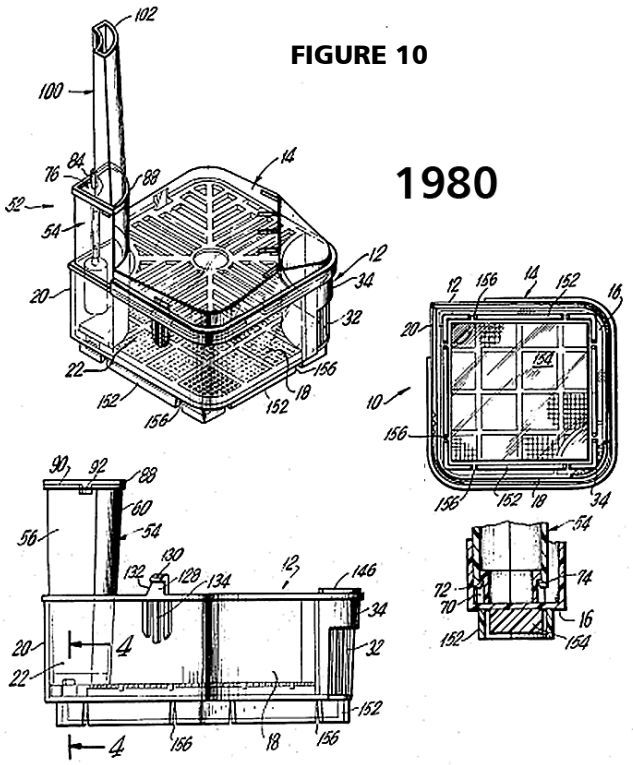


FIGURE 10

plastic wool, extend freely along the partition in the first chamber, it is often an extremely difficult and dirty process to remove the debris -laden and clogged filtering materials from the filtration housing.

"Furthermore, as those skilled in the art readily under-stand, the plastic wool generally blackens and accumulates an odor due to the debris it entraps, and there is little means for the hobbyist to recognize that the filtering materials require replacement other than by the eventually sustained black color of the plastic wool and the odor emitted thereby. Thus, the conventional type of filtration housing is not provided with adequate means for indicating that the filtration materials re-quire replacement."

Willinger patented several undergravel filters designed for round fish bowls, and also a number of bottom filters. The most interesting design in the latter category was one he devised in 1980. Bottom filters, especially those using activated charcoal and/or lightweight filter floss, tend to rise from the bottom unless weighted or partially embedded into the gravel. Also, when it came time to clean the filter, they often came apart when the filter stem was pulled. Willinger's design (Figure 10) incorporated a restraining plate to keep the filter floss from its tendency to rise within the filter, and a weighted chamber. Furthermore, even with the filter partially buried in the gravel – thus helping to conceal it – its internal parts, including the filtering media, could be lifted out without disturbing the gravel.

Drawing upon a number these prior patents, Willinger created his well-known "Whisper" filter (Figure 11). The patent was filed in January of 1983 and was awarded in April of 1985. The Willinger brothers put the filter on the market under the name "Whisper filter" the same month the patent was awarded, and the Whisper trademark was filed the following month with the registration becoming official in July of 1986. The original design incorporated a vertical filter cartridge and over time was modified in several ways (Figure 12).

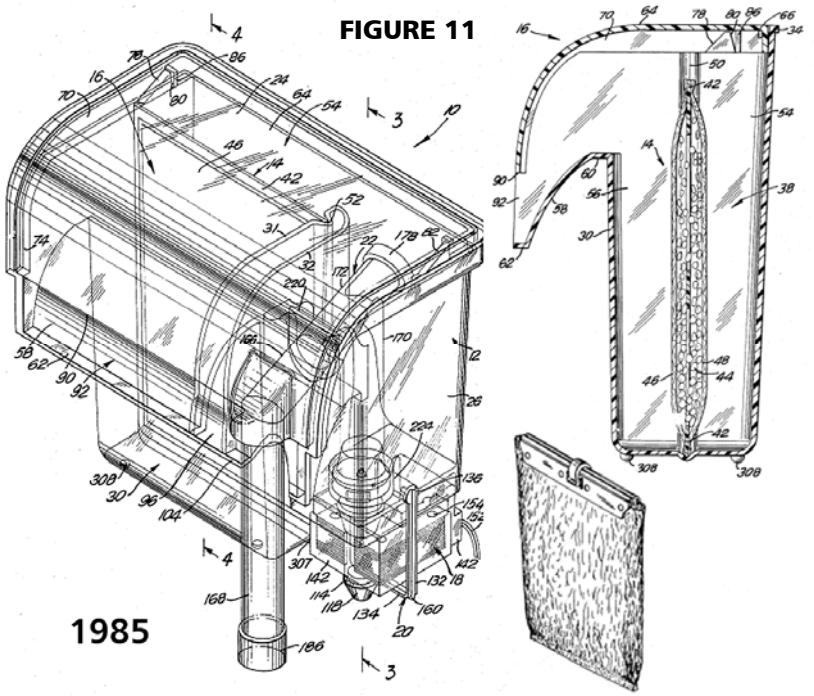


FIGURE 11

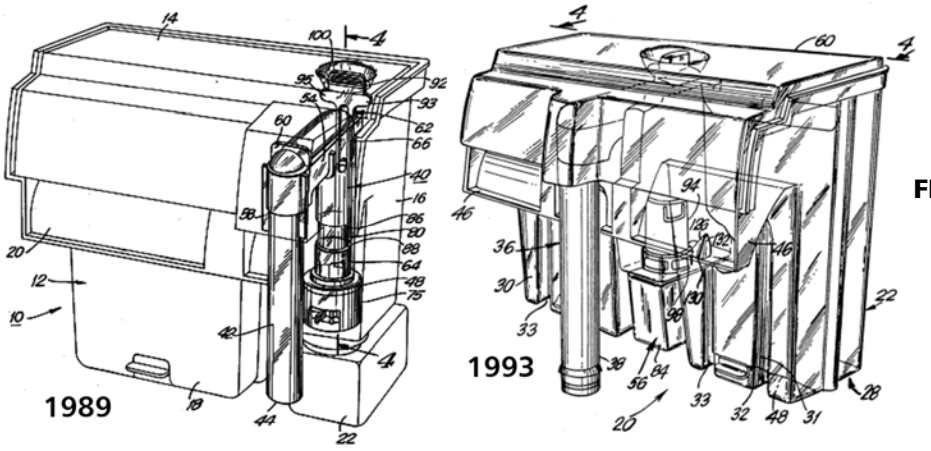


FIGURE 12

Underground filters are essentially biological filters, but they are difficult to clean when clogged and although external filters do not have these cleaning problems, their surface area is limited. In 1981 Willinger developed an external biological filter powered by an air pump that solved both problems (Figure 13). Willinger's filter could be back-flushed for cleaning, and the area available for bacterial action was at least as large as an undergravel filter. The design was unwieldy, however, and required a large horizontal surface for its location, usually the bottom shelf of the aquarium stand. His design of 1986 was based on a bag made of a porous membrane (Figure 14). As the filter clogged, the bag expanded, permitting the water to flow and continue filtering. The filter could be placed below or above the surface of the water, but one variation shows the filter built into the aquarium cover. This facilitated cleaning and also increased the aeration effect of the filter. However, it was a cumbersome design and not viable commercially.

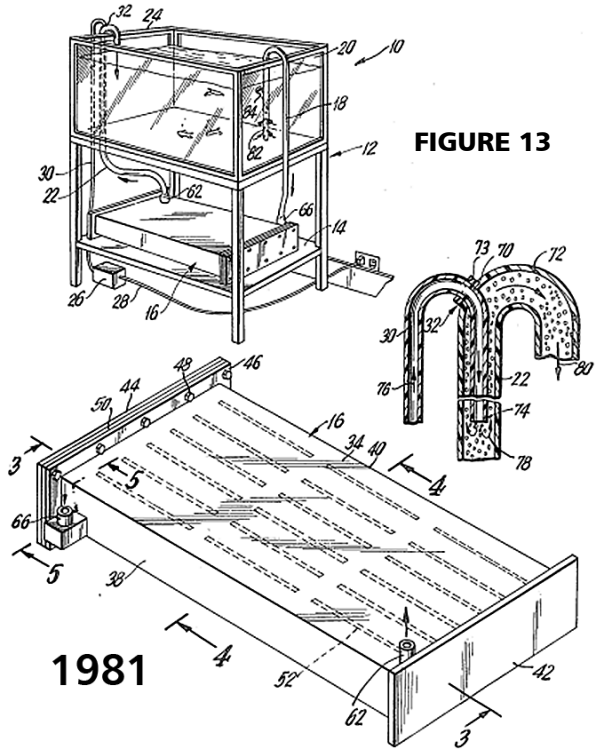


FIGURE 13

Willinger continued to patent versions of bottom filters, filter cartridges, and improvements in external hanging filters. In 1990 he patented his first canister filter (Figure 15). The filter was rather squat – thus taking up a larger footprint than those of a more vertical shape, but this shape provided a greater surface area for bacterial growth. In 1992 he patented a self-priming, diatomaceous earth filter (Figure 16).

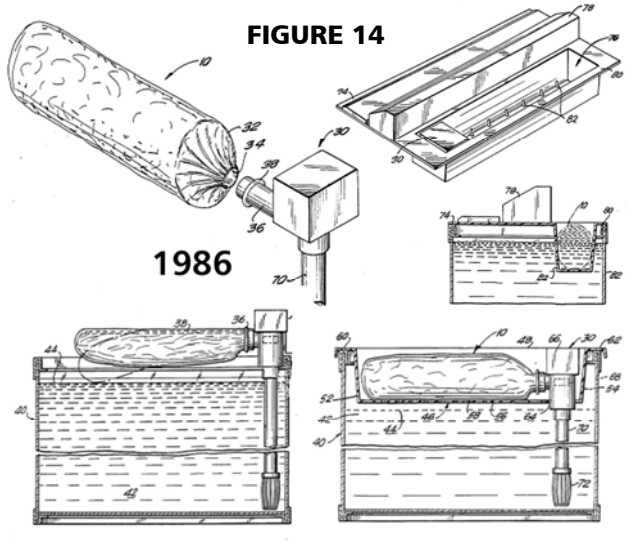
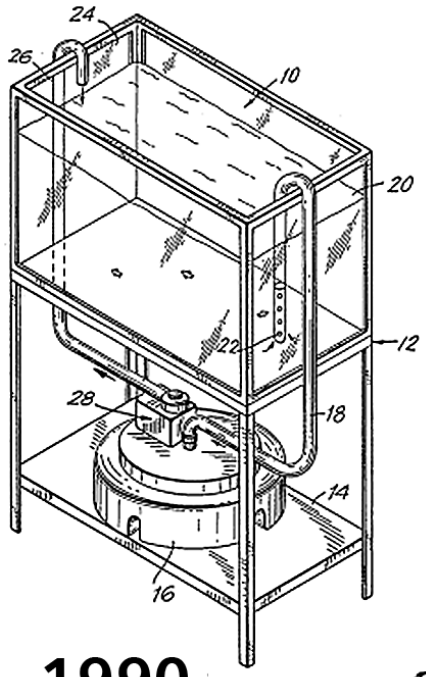
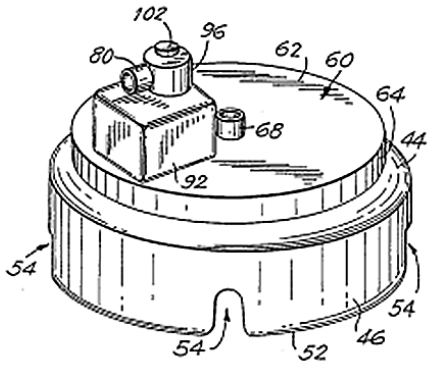


FIGURE 14



1990

FIGURE 15



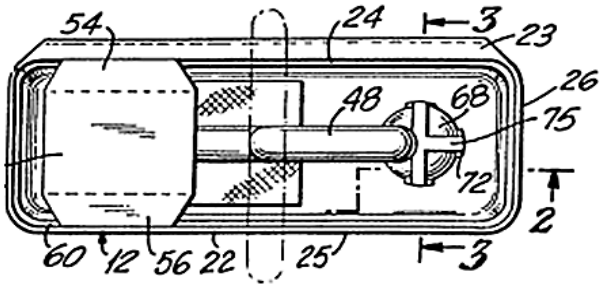
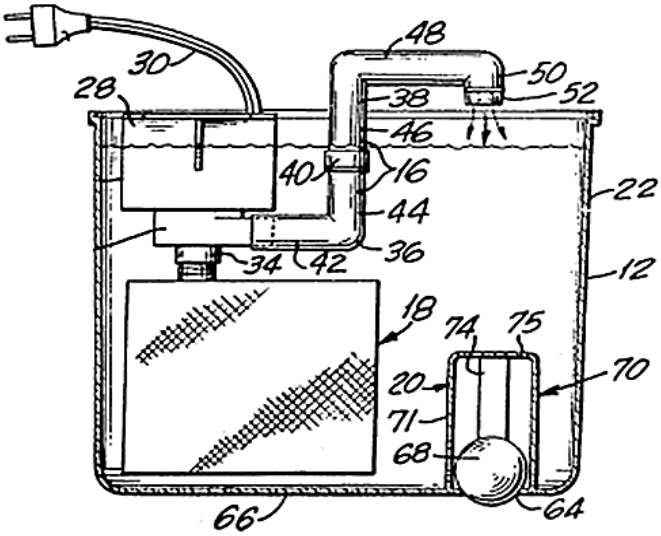
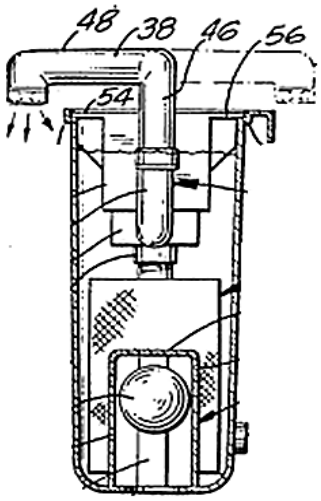
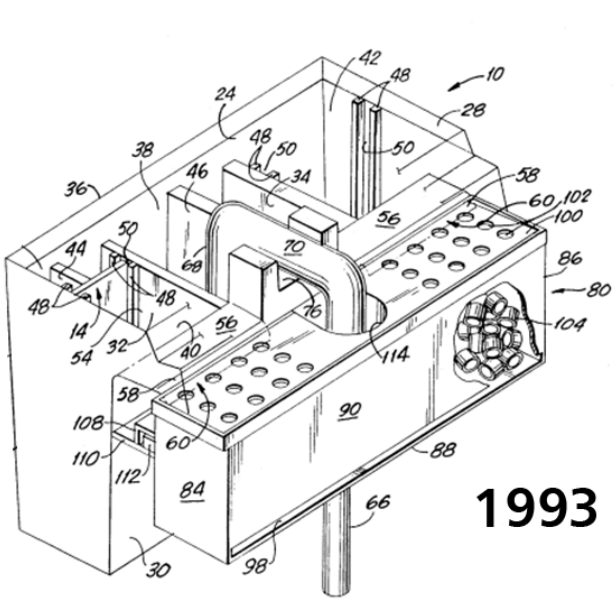


FIGURE 16

1992







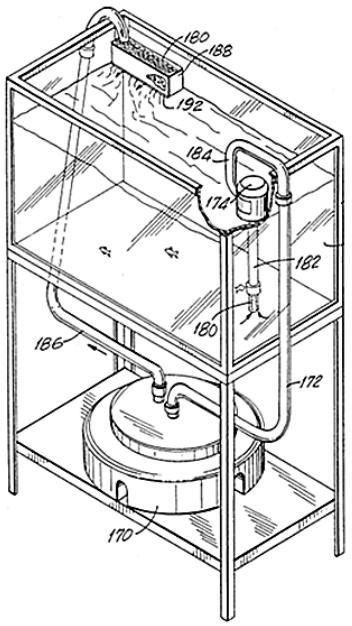


FIGURE 17

In addition to the self-priming feature, this filter did not need to be hermetically sealed, as with prior diatomaceous earth filters. It could also be used with the usual filtration media and thus served as a double -duty filter. The following he patented an add-on aerobic filter that received the output of a primary filter to enhance its biological filtration. The filter is shown in Figure 17, along with its application to a canister filter.

This is only a fraction of the filter designs invented by Allan Willinger. We turn our attention now to the area of aeration (Figure 18). His first design was for a plastic air valve (1964), his second for an air pump (1968), and the third for an air stone (1970). In the last named, Willinger pointed out that prior designs relied on cementing the rigid tube to the air stone, but that the spread of the adhesive tended to block the passage of air through the interior portion of the stone. Furthermore, the stress of attaching and unattaching the air line often chipped the stone. In Willinger's design a lip on the rigid tube preventing chipping, and since the adhesive was applied between the bottom of the lip and the top of the stone, the adhesive did not clog the stone. (Note: The air pump was a design patent, indicated by the letter "D" preceding the patent number in Table I. Unlike utility patents, design patents are a matter of form, not function, and generally are short with little or no text, the accompanying figure essentially describing the patent. However, if the utility invention is simple, inventors often file them as a design patent for convenience.)

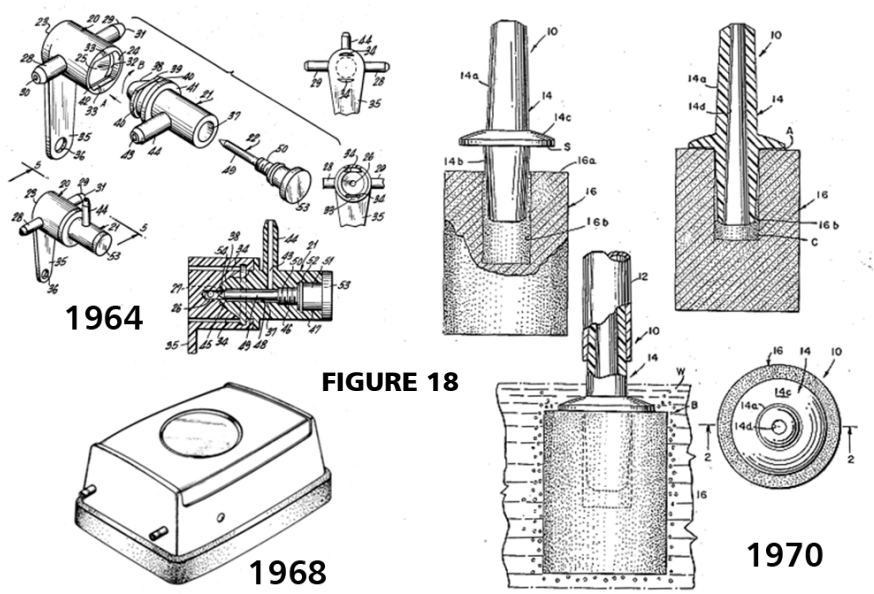


FIGURE 18

Willinger was awarded patents for a number of other air stone designs, three being shown in Figure 19. The air stone of 1971 is another familiar

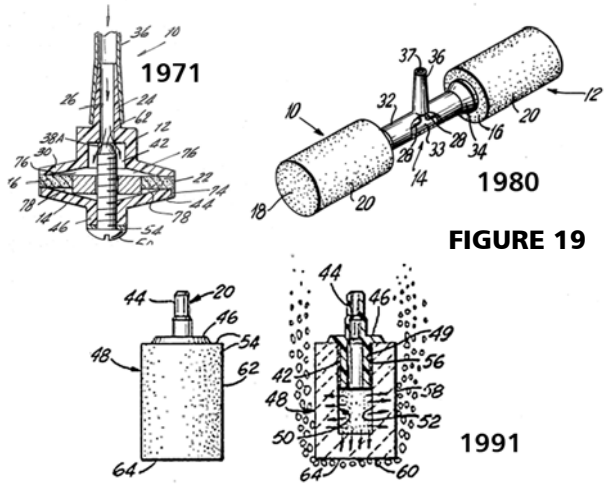
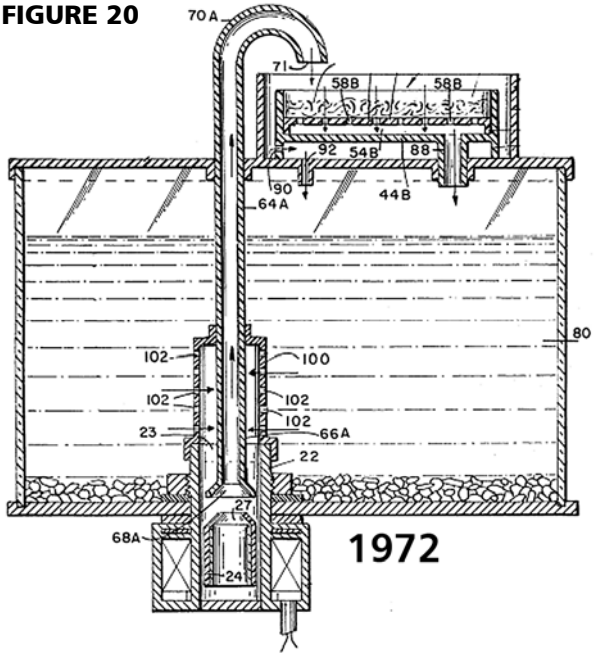


FIGURE 19

and popular design, using a fiber disk compressed within two stainless steel disks. This was held together with an adjustable screw so that the air flow could be altered to control the flow and size of the bubbles. The 1980 design addressed the problem of maintaining the position of an air stone. Air stones tend to rise since the material is porous and also contains air, both of which are lighter than water. The 1991 design addressed another problem, that of distributing the air more equally through the air stone. Willinger provided a hollow chamber through which the air could travel before passing thorough the stone. These were not trivial modifications by any means.

In addition to several ornamental air pump designs, Willinger patented four utility aeration patents. The first was in 1972 for an ingenious valveless pump mounted below a fish tank (Figure 20). The annular outside of the circular pump housed a magnetic field producing coil. The inner section (which was isolated from the motor and any electrical connections), contained a piston made of a magnetic material that, as the electric current varied, moved up and down. This moved the water that entered around the vertical tube that led to the filter (which could be placed on top of the gravel or on top of the tank, the latter placement being shown in the figure). However, the need to drill a hole in the bottom of the tank made this design impracticable. The second was in 1973 for a wall-mounted air pump, the third in 1991 for a vibrating air pump, and the fourth in 1992

FIGURE 20



for an aquarium powerhead designed for use with an undergravel filter (Figure 21). Finally, two somewhat frivolous designs patented in 1970 were for the ornamental filters, diver and water wheel, shown in Figure 22. Both incorporated improvements in introducing the air to the ornament, the water wheel for example, having the air introduced into the support base of the wheel, thus prevented the tipping experienced in prior versions patented by others.

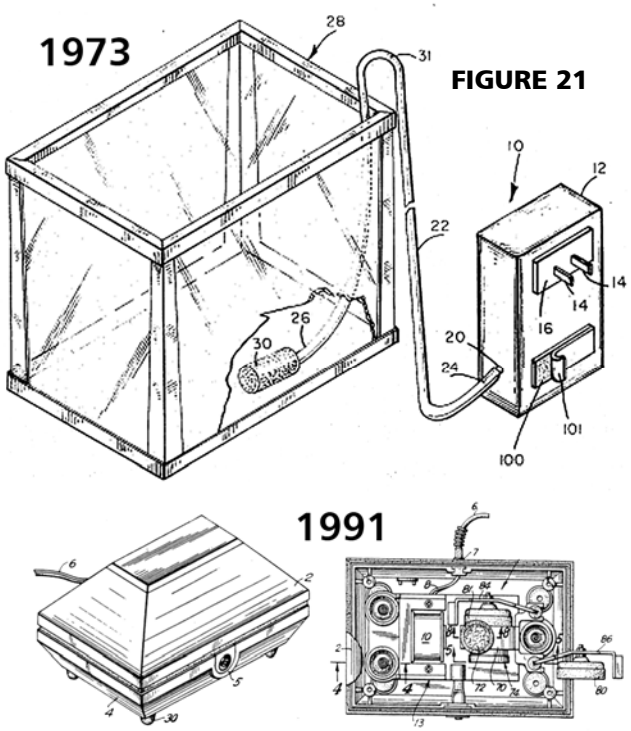


FIGURE 21

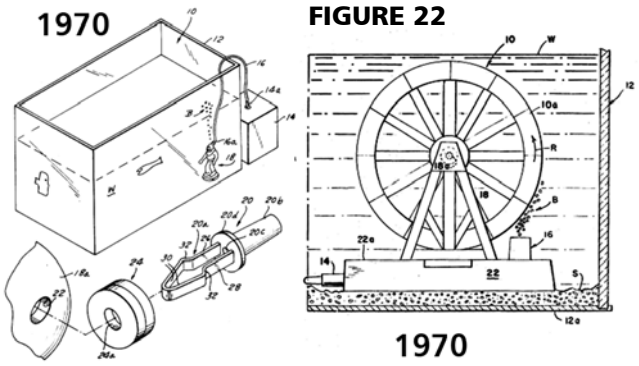


FIGURE 22

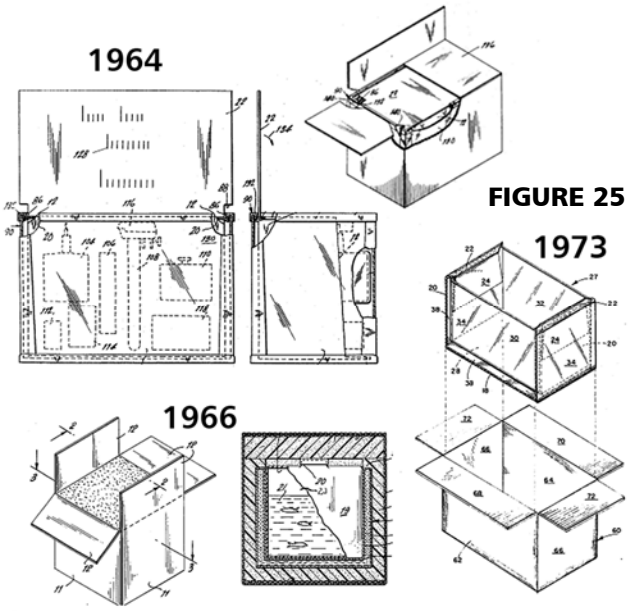


FIGURE 25

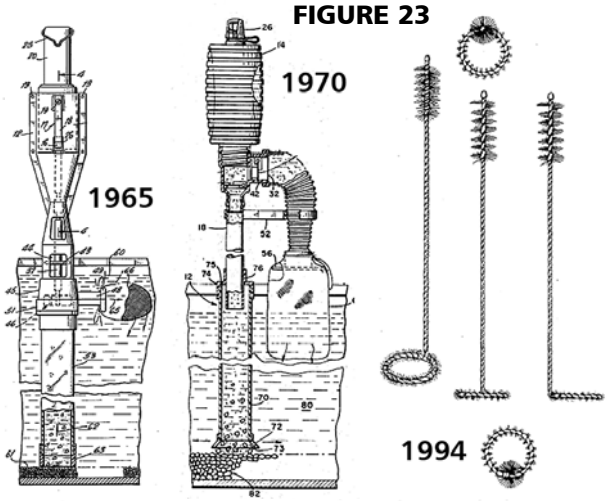


FIGURE 23

Willinger patented a number of cleaning devices and shown in Figure 23 are two bulb-operated cleaners and also some cleaning brushes. He also invented two siphon devices, one hand-held related to the bulb -operated cleaners, and the other built into a filter (Figure 24). Since Metaframe was, of course, in the business of shipping aquariums, Willinger also had two patents in this area, one awarded in 1967 and the other in 1973. These are shown in Figure 25, along

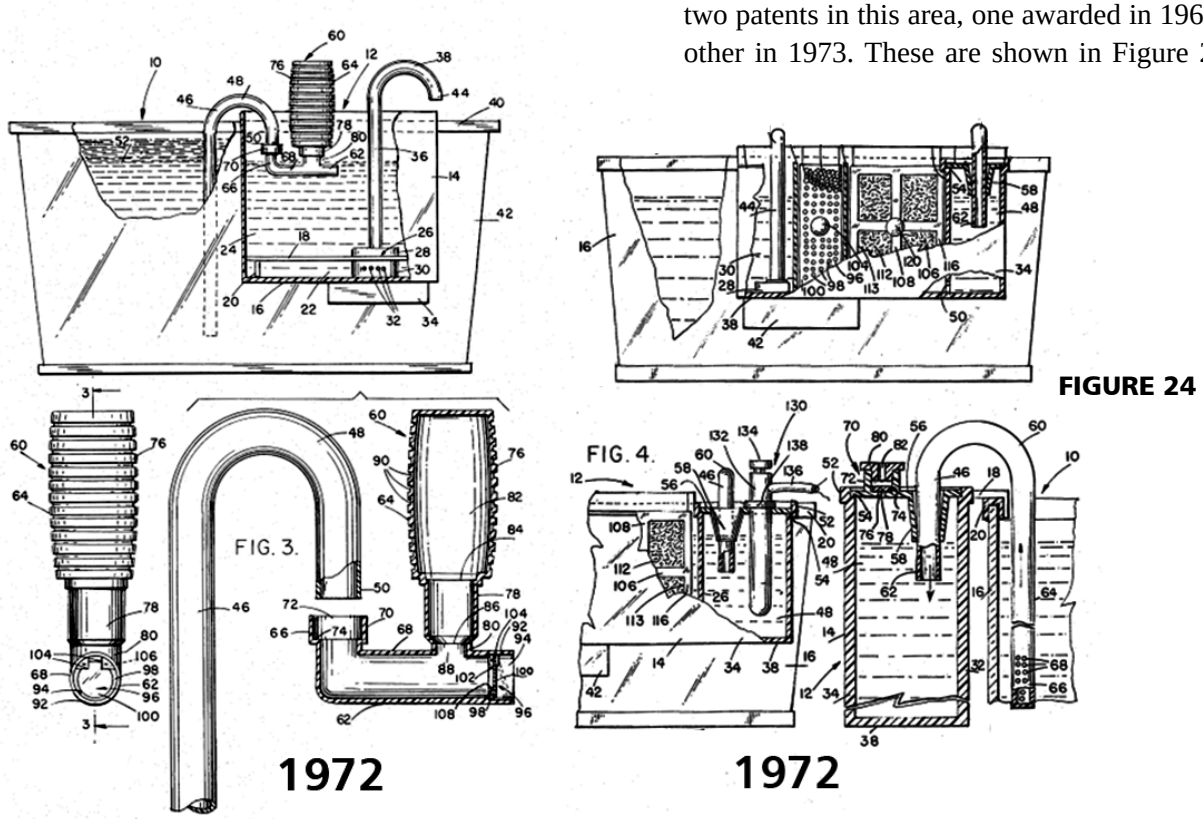
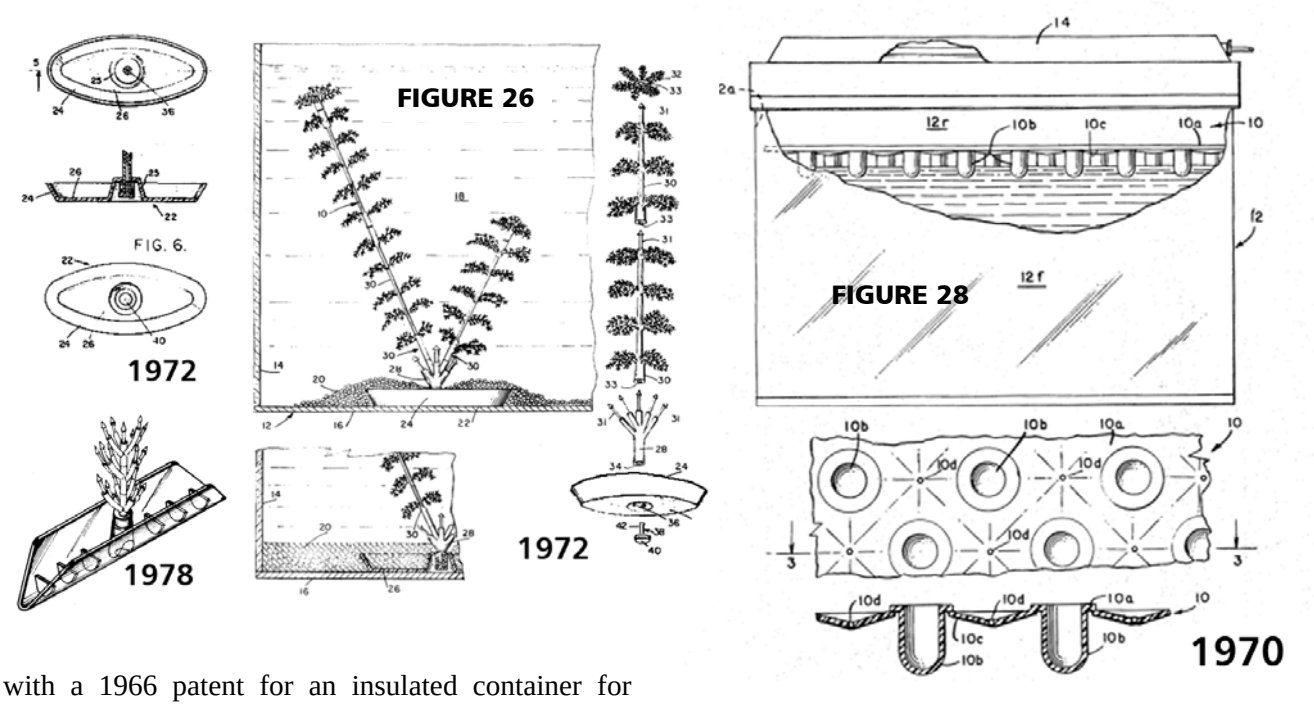


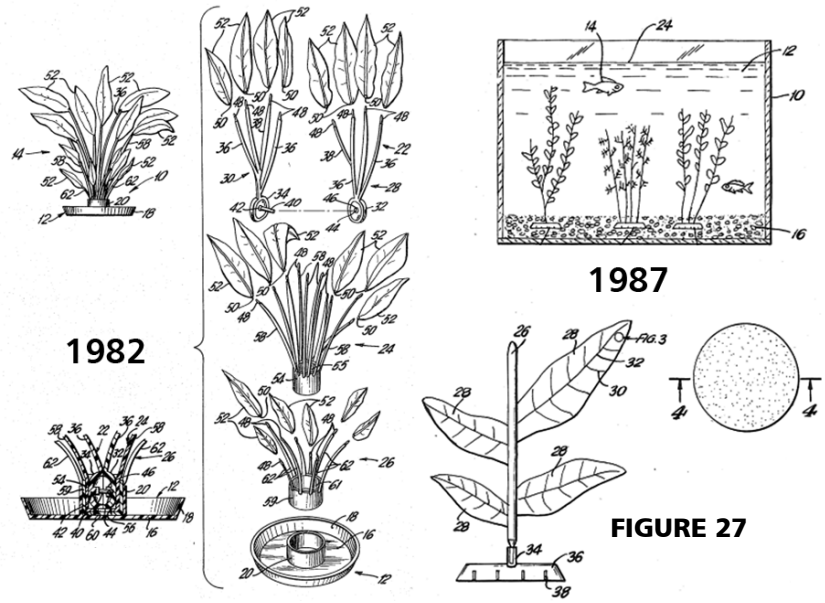
FIGURE 24



with a 1966 patent for an insulated container for shipping fish.

He also had numerous patents involving artificial aquarium plants. Figure 26 shows an oval dish-type anchor (1972) and a trough-like anchor (1978), both familiar to aquarists even today. The 1972 artificial plant to the right in the figure was designed to wave in the movement of the water returning from a filter. Figure 27 shows two additional artificial plant patents. The plant in the 1982 patent could stand upright on a shelf in a pet store, thus improving its display and sales appearance. The 1987 patent on the right in the figure featured a rough plastic surface that encouraged the growth of algae, thus providing a more natural appearance.

Willinger patented a number of small but useful devices, the thermometer (still widely used in the hobby today), fish feeder, and artificial gravel bed shown in figure 28. The fish feeder was designed to hold freeze dried foods such as tubifex, and cleverly packaged in one unit as a feeder and a container for the food. Re the artificial gravel bed, Willinger argued that gravel was heavy, thus inconvenient to purchase and carry home, and increased the overall weight of the aquarium; that it was difficult for beginners to estimate the amount of gravel needed; that gravel contained interstices that trapped food particles; and that the novice was uncertain as to the optimal placement of the rocks and gravel, and where to place the plants in a tank, i.e., "aquascaping." Note that characteristic of many of Willinger's patents, even when they were incremental or subtle, they were valuable improvements.



Finally, there were a number of patents that were quite inventive, showing a

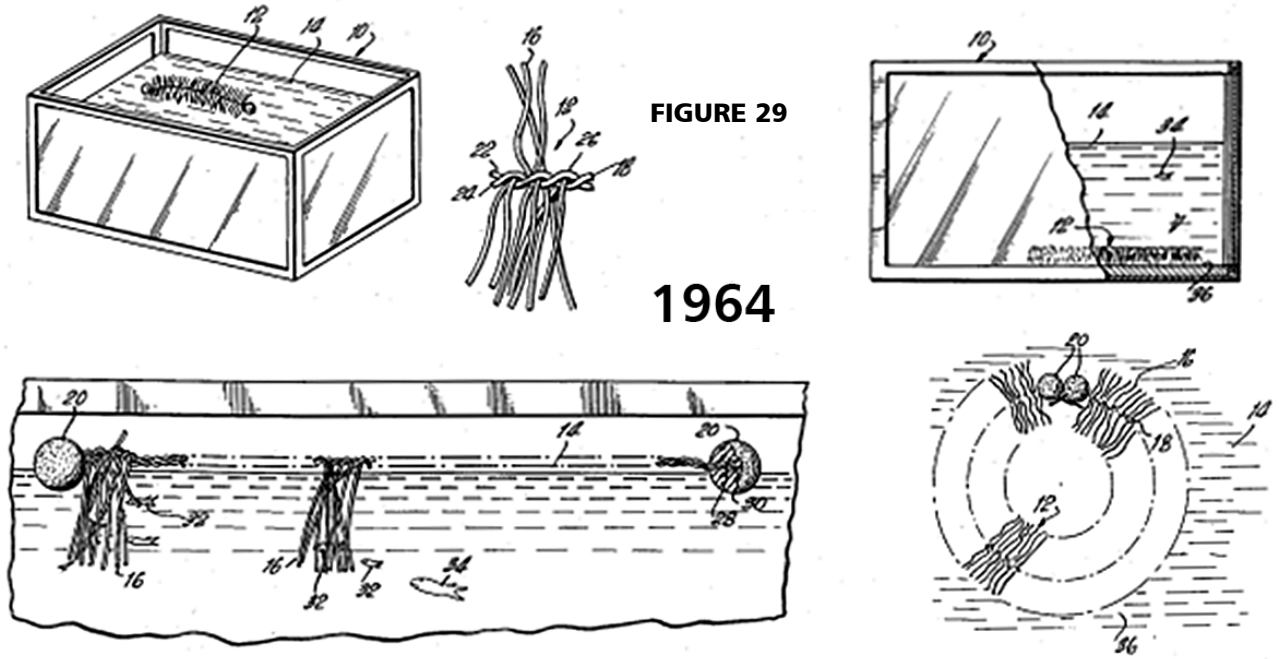


FIGURE 29

1964

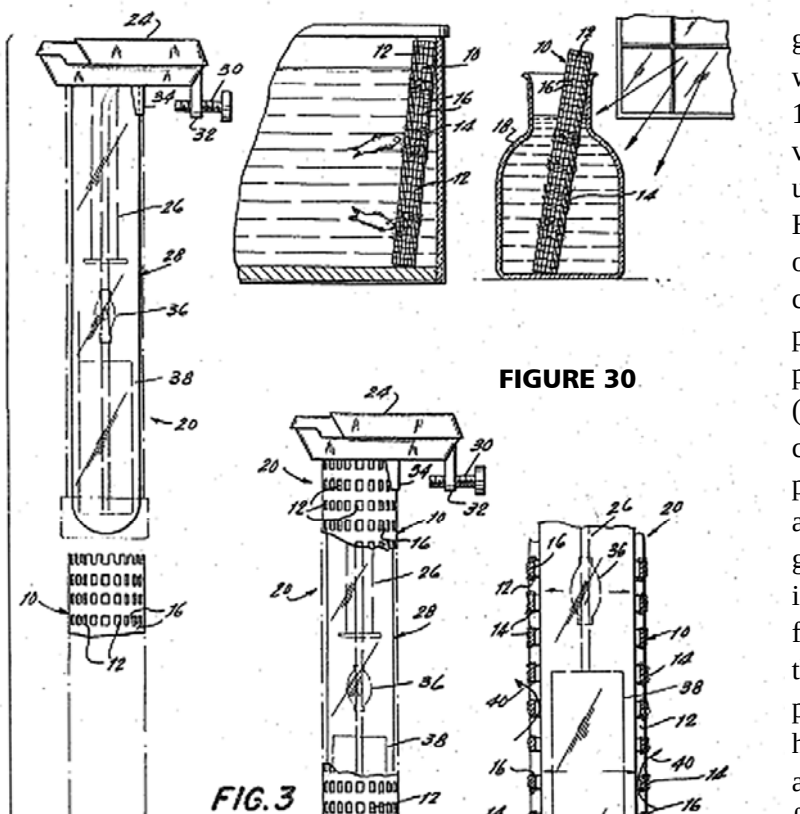
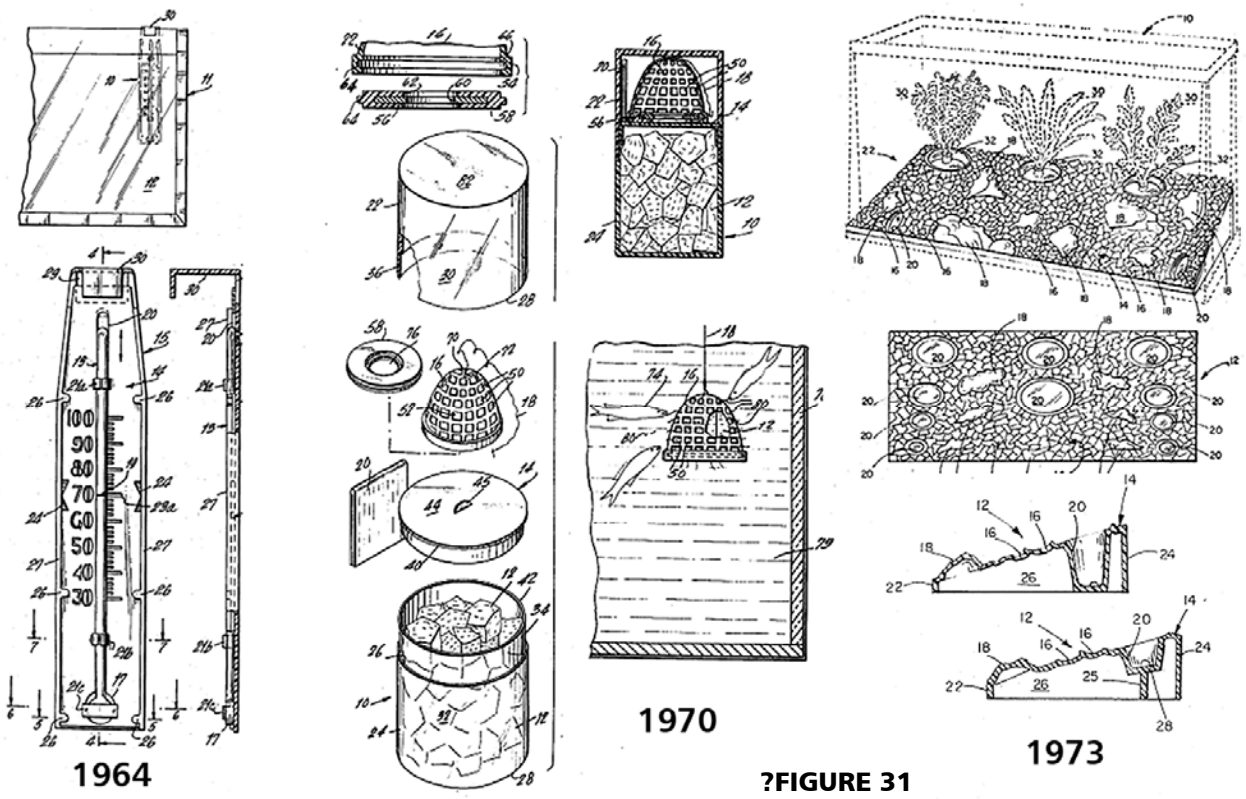


FIG. 3

FIGURE 30

1967

great deal of imagination. An early one was that shown in Figure 29, patented in 1964, for a spawning device. This was a variation on the nylon spawning mop, used for many years by killifish fanciers. However, aquarists generally make their own mops so this patent was never commercially appealing. An interesting patent awarded in 1967 was for an algae propagating and fish feeding system (Figure 30). It consisted of a mesh tube, constructed of stainless steel or plastic, placed in a jar or water where the sun was allowed to shine on it, thus producing a growth of algae. The tube was then placed in an aquarium where the fish could then feed on the algae. A variation was to slide the tube over a heater containing a bright pilot light. The combination of light and heat then would spur the growth of algae and provide an algal browsing site for the fish. A patent awarded in 1970 for a floating cover was designed to prevent evaporation from an aquarium (Figure 31). The cover was molded from a thin sheet of plastic that could be cut with a pair of scissors to fit the in side of the



?FIGURE 31

tank. The tubes molded into the cover provided the floatation, sufficient that the top of the cover floated some distance above the surface of the water, proving airspace between the surface of the water and the cover for the interchange of oxygen and carbon dioxide. Small holes were provided between the flotation bodies to permit any condensation water from a reflector cover to drain back into the tank.

Thomas Alva Edison once said, “Genius is 1% inspiration, 99% perspiration,” and so many people have patents: Abraham Lincoln, Harry Houdini, and Hedy Lamarr are among some of the more famous (Lincoln received a patent for a device to lift boats over shoals, Houdini received a number of patents for diving suits, and Lamarr had the original idea and patent that led to cellular phone, i.e., the concept of “frequency hopping”). Inventiveness is closely related to the concept of entrepreneurship, particularly with regard to the idea that the freedom to succeed requires a corollary freedom to fail. The virtue of inventiveness is that it explores new territory, a task which requires challenging the status quo, and an aversion to failure is simply not consistent with the “1% inspiration, 99% perspiration” kind of genius that Edison embodied. Thus it was with Allan Willinger’s aquarium inventions. Some were fanciful or convoluted and therefore failed, some were simple but nevertheless productive, and some were invaluable additions to the equipment of the aquarium hobby. Success or failure, in the history of aquarium inventions, none really surpassed the creativity, ingenuity, or imaginative mind of Allan H. Willinger.

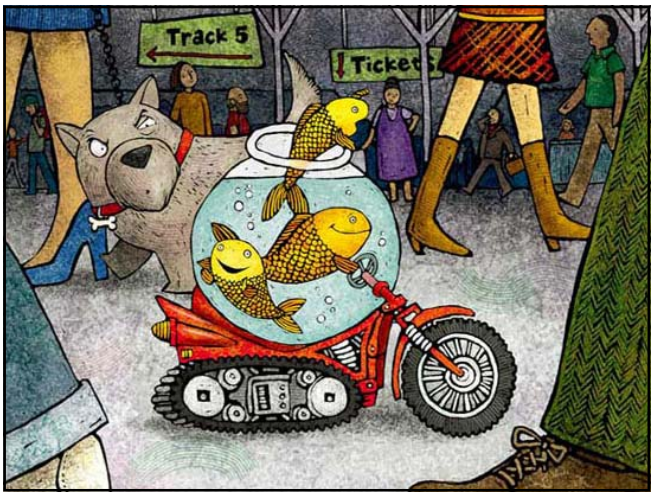


TABLE I: PATENTS AWARDED TO ALLAN H. WILLINGER		
PATENT NO.	DATE	DESCRIPTION
2935199	1960	UNDERGRAVEL FILTER
3091220	1963	AQUARIUM
3107289	1963	HEATER
3107290	1963	HEATER
3117587	1964	PLASTIC AIR VALVE
3118424	1964	SPAWNING DEVICE
3161058	1964	THERMOMETER
3199678	1965	WATER TREATMENT UNIT
3225736	1965	AQUARIUM
3225930	1965	BULB-OPERATED CLEANER
3236206	1966	PACKAGE FOR SHIPPING TROPICALS
3314396	1967	ALGAE FEEDING SYSTEM
3321081	1967	OUTSIDE FILTER
3321082	1967	OUTSIDE FILTER
3332544	1967	AQUARIUM PACKAGING
D247436	1968	ORNAMENTAL DESIGN FOR AIR PUMP
D247435	1968	ORNAMENTAL DESIGN FOR AIR PUMP
3392836	1968	WATER CONDITIONING APPARATUS
D213555	1969	FILTER
3477580	1969	BOTTOM FILTER
3499526	1970	FEEDER
3507253	1970	AIR STONE
3512223	1970	SYNTHETIC FIBER LOOP FOR CONNECTING
3512503	1970	COMPARTMENTED DISPLAY CASE
3512646	1970	WATER CONDITIONING DEVICE
3516543	1970	WATER CONDITIONING DEVICE
3524430	1970	ORNAMENTAL AERATOR (DIVER)
3530288	1970	INSULATED REFLECTOR
3530829	1970	FLOATING AQUARIUM COVER
3542324	1970	HEATER MOUNT
3548786	1970	ORNAMENTAL AERATOR (AIR WHEEL)
3549015	1970	BULB-OPERATED CLEANER
3566840	1971	TOP MOUNTED FILTER
3575350	1971	AIR STONE
3584901	1971	PLASTIC TUBING CONNECTOR

TABLE I: PATENTS AWARDED TO ALLAN H. WILLINGER CONTINUED		
PATENT NO.	DATE	DESCRIPTION
3630367	1971	BOTTOM FILTER
D224031	1972	ANCHOR FOR ARTIFICIAL PLANT
3640302	1972	SIPHON DEVICE
3640516	1972	AERATOR
3669297	1972	SIPHON FILTRATION DEVICE
3670758	1972	SIPHON PRIMING DEVICE
3682753	1972	ARTIFICIAL PLANT
3687291	1972	VALVE-LESS AIR PUMP
3718275	1973	SHIPPING & DISPLAY WRAPPER
3720317	1973	BOTTOM FILTER
3738494	1973	REMOVABLE FILTER COMPARTMENT
3744454	1973	ROCK & GRAVEL BED BLANK
3746168	1973	FILTRATION INDICATOR
3746169	1973	FILTRATION INDICATOR, SPHERICAL HOUSING
3746478	1973	WALL MOUNT AIR PUMP
3747250	1973	FISH NET
3751188	1973	VALVE-LESS PUMP
3763997	1973	DISPLAY FOR ACCESSORIES
3815547	1974	VERTICAL FILTER
3857366	1974	HINGED AQUARIUM COVER
D246724	1977	ORNAMENTAL BOTTOM FILTER
D249897	1978	AIR STONE
D249879	1978	ANCHOR FOR ARTIFICIAL PLANT
D248965	1978	UNDERGRAVEL FILTER FOR ROUND BOWL
D247436	1978	ORNAMENTAL AIR PUMP
D247435	1978	ORNAMENTAL AIR PUMP
4099544	1978	VENT VALVE
4148730	1979	UNDERGRAVEL FILTER FOR ROUND BOWL
4186093	1980	BOTTOM FILTER
4192255	1980	AIR STONE
4255648	1981	HEATER
4265751	1981	EXTERNAL BIOLOGICAL FILTER
4301767	1981	CLAMP
4315143	1982	HEATER
4340625	1982	ARTIFICIAL PLANT

TABLE I: PATENTS AWARDED TO ALLAN H. WILLINGER CONTINUED		
PATENT NO.	DATE	DESCRIPTION
D269633	1983	CHECK VALVE
4369216	1983	ARTIFICIAL PLANT
4392570	1983	AQUARIUM NET
D273409	1984	FISHNET
D280658	1985	ORNAMENTAL FILTER
4512885	1985	FILTER (WHISPER)
4532037	1985	FILTER/AERATOR
4602996	1986	FILTER (WHISPER TYPE)
4622148	1986	FILTER IN AQUARIUM COVER
D291721	1987	FILTER CARTRIDGE
D291722	1987	FILTER CARTRIDGE FRAME
D291720	1987	FILTER PUMP
D289914	1987	ORNAMENTAL ROUND BOTTOM FILTER
4699829	1987	ARTIFICIAL PLANT
4714547	1987	TUBULE INSERT FOR FILTER
D294172	1988	ORNAMENTAL FILTER DESIGN
4735715	1988	POWER UNIT FOR FILTER (WHISPER TYPE)
4753723	1988	ROUND BOTTOM FILTER
4761227	1988	SELF-PRIMING OUTSIDE FILTER
4783258	1988	FILTER CARTRIDGE
4842726	1989	ROUND BOTTOM FILTER
4842727	1989	FILTER (WHISPER TYPE)
4861468	1989	ROTOR IMPELLER ASSEMBLY
4880549	1989	CARTRIDGE FILTER
4886093	1989	VENT VALVE FOR AIR PUMP
D307626	1990	FILTER CARTRIDGE
4895646	1990	CANISTER FILTER
4907772	1990	CLAMP
D317966	1991	ORNAMENTAL FILTER
4997559	1991	FILTER (RESTRICTED PUMPING WINDOW)
5034165	1991	AIR STONE
5052904	1991	AIR PUMP
5053125	1991	FILTER CARTRIDGE
5098585	1992	FILTER, DIATOMACEOUS EARTH SELF-PRIMING
5137433	1992	POWER HEAD WITH INTEGRAL MUFFLER

TABLE I: PATENTS AWARDED TO ALLAN H. WILLINGER CONTINUED		
PATENT NO.	DATE	DESCRIPTION
D338018	1993	AIR PUMP
5176824	1993	AEROBIC FILTER, BACTERIAL CHAMBER
5228986	1993	POWER FILTER (WHISPER TYPE)
5238367	1993	WATER PUMP
D353715	1994	AQUARIUM TUBE CLEANING BRUSH
D353649	1994	AQUARIUM FILTER BAG
5282727	1994	WATER PUMP AERATOR
5282961	1994	FILTER PUMP (WHISPER TYPE)
5290157	1994	CLAMP FOR POWER HEAD
5304003	1994	STICK-ON THERMOMETER
D355701	1995	ORNAMENTAL FILTER DESIGN

TABLE II: PATENTS AWARDED TO HARDING W. WILLINGER		
PATENT NO.	DATE	DESCRIPTION
D171472	1954	BREEDING TRAP
2665250	1954	FILTER STEM
2702125	1955	DIP TUBE
2782161	1957	BOTTOM FILTER
3091220	1963	AQUARIUM
3161058	1964	AQUARIUM THERMOMETER
3225736	1965	AQUARIUM
D247436	1978	AIR PUMP
D247435	1978	AIR PUMP
D435702	2000	DECORATIVE BASE FOR FISHBOWL
D435701	2000	DECORATIVE RIM FOR FISHBOWL
D435942	2001	DECORATIVE BASE FOR FISHBOWL

THE EARLY HISTORY OF AQUARIUM AERATION

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, February 2, 2013)

To describe the early development of aquarium aeration, we start in 1854 when Dr. Robert Ball introduced a novel mode of aeration at the newly opened Dublin Aquarium.

Ball (1802-1857) was born in County Cork, Ireland and ultimately became one of Ireland's most noted naturalists. After a career in the civil service, he became Director of the Dublin University Museum in 1844. He was a Member of the Royal Irish Academy and President of the Geological Society of Ireland. Dublin University conferred on him the degree of LL.D. He became Secretary of the newly founded Queen's University of Ireland in 1851, and was a Fellow of the Royal Zoological Society. About 1838 Ball devised a dredge net to collect marine organisms. It was used all over the world, and was so apt for its purpose that it was little modified later. It is known as Ball's dredge or more generally simply "the dredge," and it was commonly used by aquarists when collecting their own fishes from ponds or the seashore (Figure 1).

Of all the Dublin Societies of which Dr. Ball was a member, the Royal Zoological Society, founded in 1830, was that with which he was most pre-eminently associated. It was there that he acted, for more than twenty years, as an Honorary Secretary, devoting to it "a large portion of valuable time, and the energies of a strong and cultivated understanding." The Zoological Society was responsible for running the Dublin Zoo and Ball understandably was involved. He devised a method whereby all of the tanks in the aquarium were connected by a tube with a single pair of bellows. From this long tube, branches passed off and opened into each tank so that one puff of the bellows supplied air to the whole of the tanks (Figure 2).

The passing of the air into the tanks had a very pretty effect, and visitors were so fond of blowing the bellows, that Dr. Ball, who described this arrangement at a meeting of the British Association at Cheltenham, stated that the authorities of

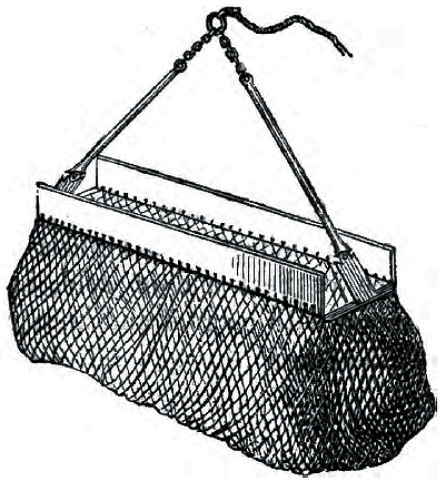


Figure 1: Ball's Dredge.

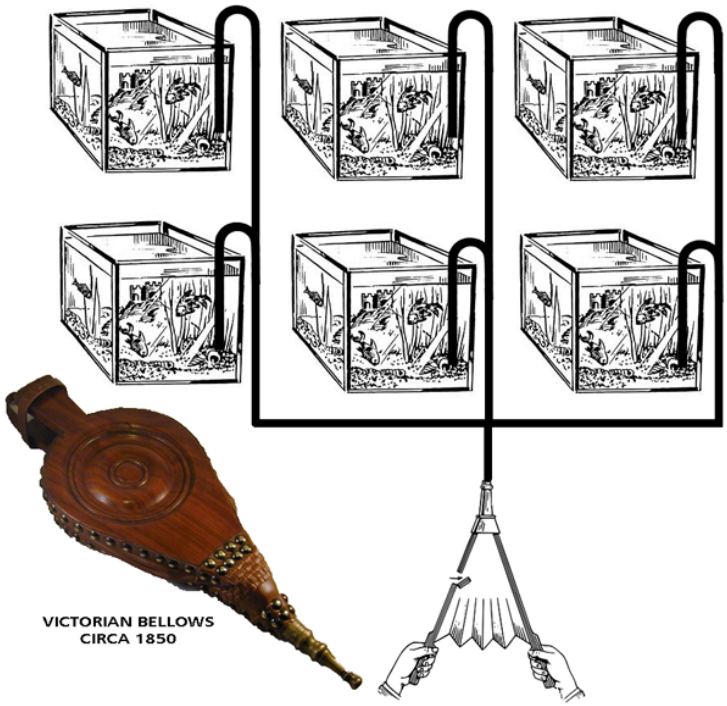


Figure 2: The Dublin Aquarium Bellows System.

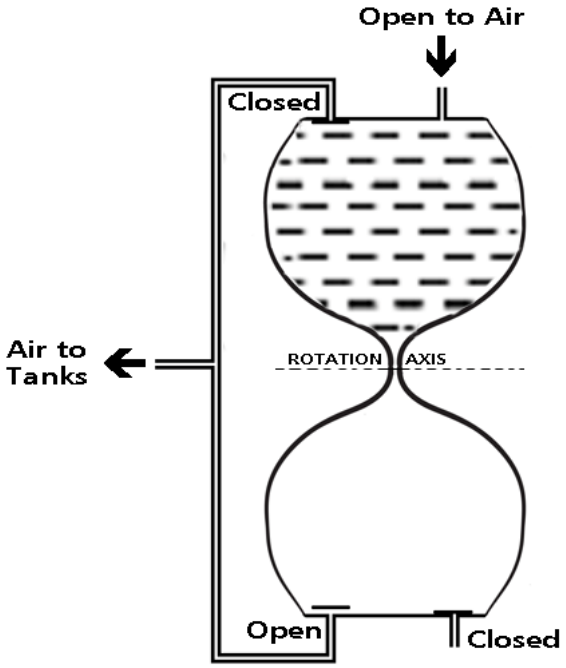


Figure 3: The "hourglass" aerator devised by Henri Milne-Edwards.

the Gardens had found it entirely unnecessary to employ any of the men in the Gardens to pump in the air. This worked well for this small public aquarium and for the one later established in Paris 1860, but it of course was not practical for larger public aquariums. (It should be noted that the early public aquariums, such as the ones in London, Dublin, Paris and Hamburg, actually had only a few on view, typically 12 to 14.) Ball's method of using a bellows to aerate private aquaria was recommended in by Edwin Lankester in his book, *The Aquavivarium, Fresh and Marine* (1856) so it was employed by hobbyists as well as public aquariums.

In 1856, Baron Jules Cloquet revived the use of bellows for the purpose of aeration. Cloquet (1778-1883), was "a prince of medical science in France" who died in Paris at the great age of 104, thus having known most of the great men of his day. He was given the rank of Baron by Napoleon III, and was a Commander of the Order of the Legion of Honor. Cloquet was the author of many works on anatomy and surgery, but it was through his great monograph in five volumes on descriptive anatomy that his fame chiefly survives.

Cloquet was a member of the Société zoologique d'acclimatation, established by Isidore Geoffroy Saint-Hilaire in 1854. Is name was later changed to the Société nationale d'acclimatation de France (i.e., The National Society for Nature Conservation) to better reflect its main objective of nature conservation against the increasing destruction of habitats by industrial development. Cloquet was an active member, and was responsible for the importation of exotic plants into France. He also took part in establishing the Paris aquarium, located in the Jardin d'Acclimatation de Paris (or the Jardin Zoologique d'Acclimatation as it was first called - essentially a zoo).

His instrument had a gutta-percha pipe fitted to its nozzle, and at the extremity of this was a lead tube that extended to the bottom of the aquarium. The innovation here was that the opening of the tube was covered with wire-gauze, which produced extremely fine bubbles and hence, enhanced aeration. (We are all familiar with this type of aeration, since the faucet aerators in our homes consist of a little wire mesh that fits over the ends.) Cloquet's innovation was the beginning of the air stone in its many incarnations and he deserves the credit for this now common aquarium device.

The next development was by Alphonse Milne-Edwards (1835-1900), the son of the great naturalist, Henri Milne-Edwards. He obtained a medical degree in 1859 and in 1876 became an assistant to his father at the Jardin des Plantes, the main botanical garden in France. In 1891, he became the director of the Muséum National d'Histoire Naturelle, devoting himself especially to fossil birds and deep-sea exploration.

His apparatus took the form of an hourglass (Figure 3), consisting of two chambers connected by a narrow passageway. The upper chamber was full of water, the lower full of air. The water descended by its own gravity from the upper

chamber into the lower, expelling the air and driving it via tubes into the tanks and thus aerating them. Because of its large size and the narrowness of the passageway, the operation of emptying the upper chamber took a long time, but when once this was accomplished the entire apparatus was rotated, reversing itself, during which time it closed one set of valves and opened another. Since the former air chamber now contained water and was uppermost, the water continued to be aerated as before. I have not been able to uncover any evidence, however, that the device was ever adopted either by any public aquarium or private aquarist. Figure 4, however, shows an adaptation of the idea to a fountain aquarium shown in a German aquarium book published in 1886.

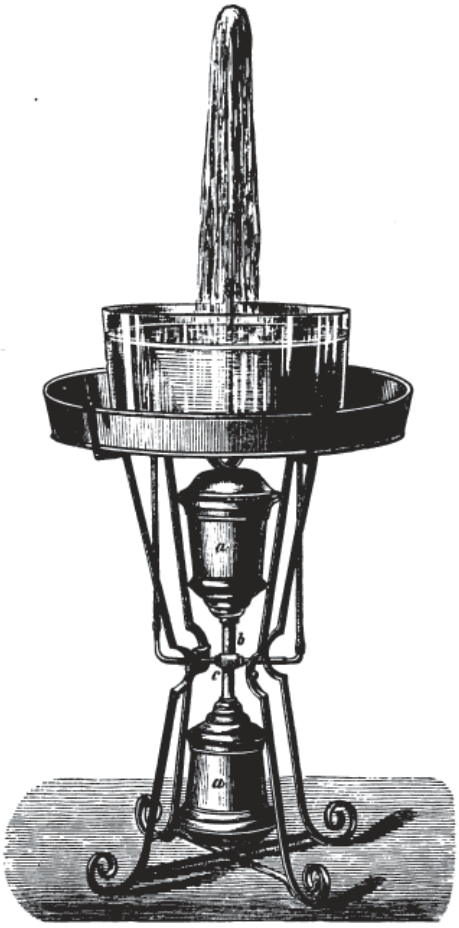


Figure 4: An aquarium based upon the Milne-Edwards aeration principle (from "Das Süßwasseraquarium und seine Bewohner: Ein Leitfaden für die Anlage und Pflege von Süßwasseraquarien," by Wihelm Heß, 1886.

In 1855, Mr. George Hurwood (1798-1864) of Ipswich, which is in Suffolk, England, used the pressure of a stream of water, either from the waterworks in towns or from the high cisterns that often existed in the dwellings of the day, to compress air that in turn forced a current of seawater into an aquarium.

Hurwood, a civil engineer, was at one period frequently employed by the Admiralty to conduct investigations on the probable effect upon tidal waters of projected railway and other works, and he invented and patented several ingenious and useful mechanical contrivances that were extensively employed. He was, for example, well known in farming circles for his invention of mills for grinding corn as well as other pieces of agricultural equipment. In 1861, the

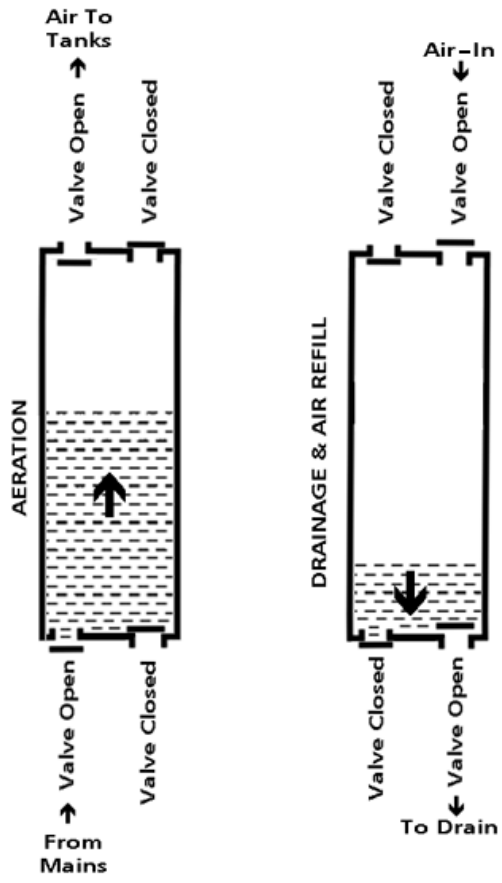


Figure 5: George Hurwood's Aerator.

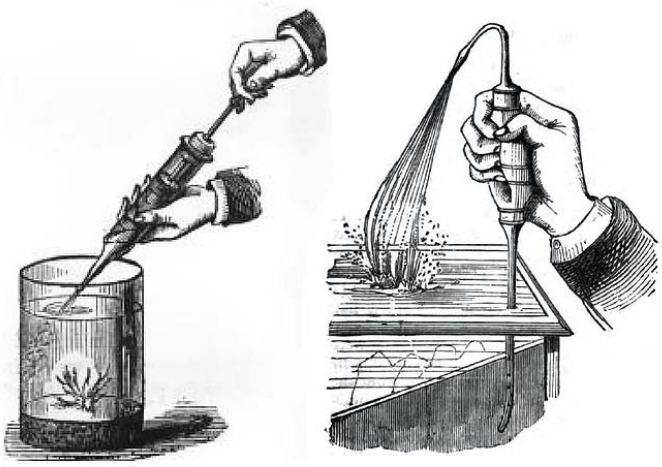


Figure 6: Lloyd's Simple Aeration Devices.

Council of the Institution of Civil Engineers awarded him a Telford medal for his paper "On the River Orwell and the Port of Ipswich." In Hurwood's device (Figure 5), as the water from the mains flowed upwards, the air above it would be compressed and driven out (where it could be used directly or else used to pump seawater). The motion was of necessity intermittent (unless the apparatus was in part doubled) since as the water neared the top of the tank, the drain and air-in valves were opened and the aeration ceased until the air was thus replenished. This arrangement was adopted by several private aquaria in England and therefore it was the first aquarium pump in the history of the hobby.

This arrangement was introduced by William Alford Lloyd into the Paris Aquarium in 1860; it was eminently successful and continued in operation for thirteen years. Hurwood's apparatus was also applied by Lloyd in the Hamburg Aquarium in 1864 where the air was used to drive a pair of water pumps as this kept the fresh water from being mixed in with the seawater.
For the purpose of occasional aeration in the home aquarium, a drip-glass was recommended by Philip Henry Gosse (1788-1854) in his 1856 book, *The Aquarium: An Unveiling of the Wonders of the Sea*.

"One of the simplest modes by which this object can be effected, is the drip-glass. I have been accustomed to suspend over the Aquarium, a perforated bell-glass (I think it is called a bee-glass) of suitable size, into the orifice of which a bit of sponge may be pushed, or a cork drilled with small holes. The cord which suspends the drip-glass passes over a pulley at the top of the window, so as to be raised or lowered at pleasure. Every morning sufficient water from the Tank is drawn or dipped off, to fill the drip-glass, which is then hoisted to its full height. The contents run out in slender streams, or in a rapid succession of drops, which, passing through some four or five feet of air before they reach the Tank, become effectually purified."

George Brettingham Southerby (1788-1854) in his 1857 book (published posthumously), *A Popular History of the Aquarium of Marine and Fresh-Water Animals and Plants*, suggested:

"A fountain-Aquarium, with apparatus for drawing the water up into the reservoir, would be a very good contrivance. This would save all the trouble of baling the water out of the tank, at the risk of disturbing the living organizations within it. A small pump, drawing the water through fine holes from near the bottom, would effect the purpose. The unsightliness of the apparatus could be disguised by rockwork, and the fountain, assuming the form of a cascade, might be so placed as to present an elegant object."

In his 1858 catalog (*A List, with Descriptions, Illustrations, and Prices of Whatever Relates to Aquaria*), William Alford Lloyd shows two aeration devices on sale in his store: (1) a syringe and a rubber squeeze bulb siphon starter (Figure 6).

A complicated arrangement of aquariums, aerated fountain style with its hoses cleverly concealed within the stand, is also pictured in Lloyd's catalog (Figure 7). His description of how the air was supplied was as follows:

"A slate cistern of 100 gallons capacity is placed

in any convenient and cool place, and at any convenient distance, either in the apartment containing the Tank, or elsewhere, and at such a height that the base of the cistern is not less than 12 inches above the summit of C. A second cistern of 100 gallons capacity is placed in any convenient and cool place, so that its top is at a not less depth than 24 inches below the surface of B. A feed-pipe of half-an-inch diameter is conducted down from near the bottom of the upper cistern, and, near the floor, at the points marked "entrance," it is divided into two branches, each of three-eighths of an inch in diameter, which (shown in dotted line, G) run up the stand, and are concealed in its legs. Then they are subdivided into four branch pipes of a quarter of an inch diameter each, and these pass through four holes in the base of A, and rise through C, at the top of which their orifices diverge outwardly, and they then discharge their contents equally over the rocks into the four divisions of A, overflowing which, the water falls into B through pipes inserted in four other holes in A, and finally run over the mouth of the exit pipe F, into the lower cistern, whence it is raised again once a day to the upper cistern, ready to perform another circuit, and thus the same water may be used continuously for years.

"The mode of raising the water from the lower cistern to the upper is either by a pump constructed so as not to be injuriously affected by the action of sea-water, or better, by employing the pressure of a column of fresh-water obtained from a main or from an upper cistern as a motive power to lift a somewhat shorter column of sea-water. The operation is then effected without labour, and the fresh-water (of course, unmixed with sea-water) may afterwards be used for ordinary household purposes."

Lloyd's reference to raising the water from the lower cistern is, of course, Hurwood's system. Oddly enough, the block print (Figure 8) of his store shows none of his aquaria being aerated.

In his book, *The Aquarium, its Inhabitants, Structure & Management* (1876), John Ellor Taylor (1837-1895) describes a number of schemes to aerate aquaria. The first involved taking the easy way out, i.e., a continuous stream of water from the household tap:

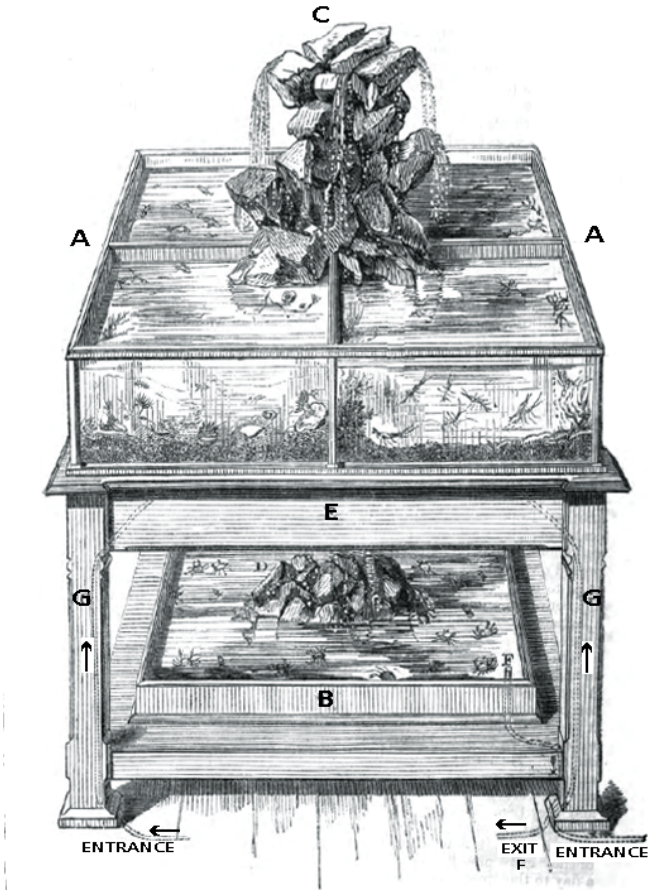


Figure 7: Lloyd's Tank with Fountain Aeration.

"It will be noted that all the foregoing directions apply only to streamless fresh-water aquaria. When opportunity affords (as it often may do) of constructing them so that the water may be conducted by a pipe from the usual household supply, and a constant circulation and aeration can be kept up, much labour will be saved, and the objects will appear more healthy and active."

This scheme, however, is not conducive to keeping tropical fish today where both water quality and temperature are critical factors.

His second method was simply to place water

Figure 8: Lloyd's Store.

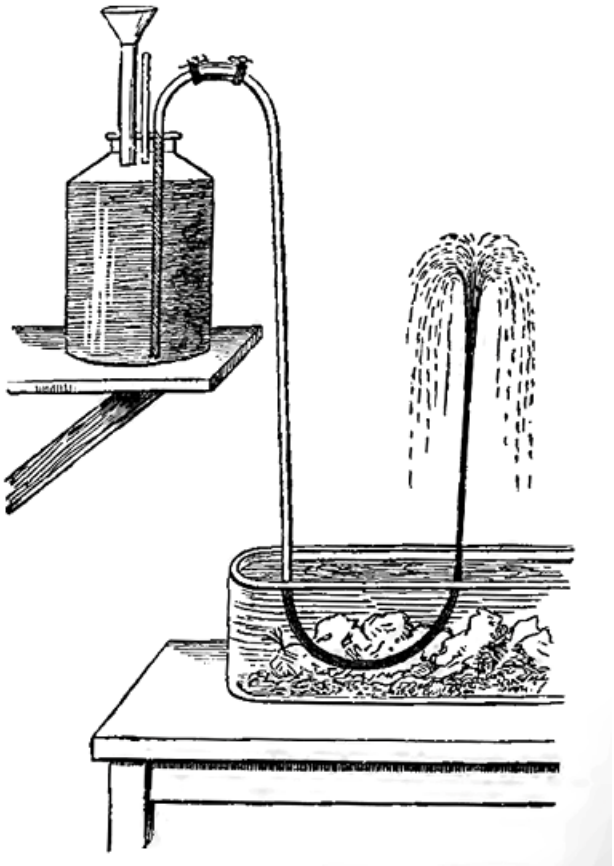


Figure 9: Taylor's Fountain Aerator.

taken from the tank into a jar situated higher than the tank, and then siphoning it back into the tank:

"Another means of promoting circulation is that of having syphons, which may be made to gently pour in the tank a fine stream of water from a jar placed above. If the current is made to flow a few inches through the air, it will mechanically entangle some of it and thus convey it to where it is required. But the ingenuity of a really careful aquarium-keeper will soon suggest to him various simple means of this kind, by which additional aeration can be obtained if required. The water referred to is of course taken from the tank into which it is made to run."

A variant on the second method placed the siphon tube down into the water in a U-shaped bend and then exiting some distance from the water surface. Depending upon the height of the jar, a fountain of some strength was produced, aerating the water as it fell back into the tank (Figure 9).

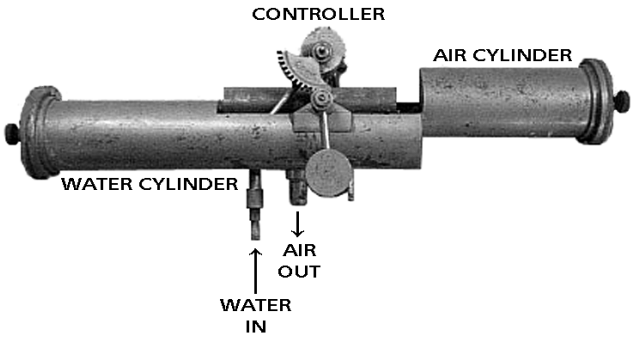


Figure 10: K.D.A Air Pump.

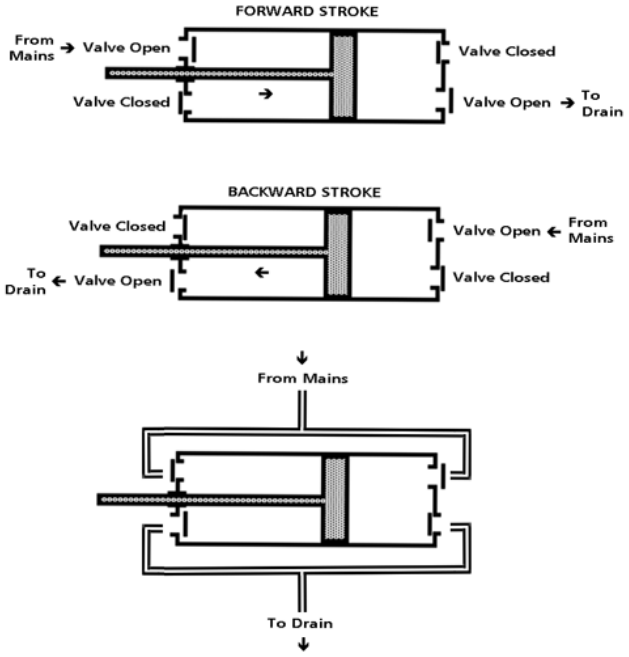


Figure 11: The Water-Driving Principle of the K.D.A. Pump.

The KDA (Kindelsche Durchlüftungs Apparat) air pump was introduced in 1908 (Figure 10). This device was a double piston water pump where both pump chambers were driven by water pressure through a common eccentric cam; this common drive allowed one piston to pump air while the other was refilling with air.

On the forward stroke, the entering water from the mains pushes the piston to the right, the water then going directly to the drain. On the backward stroke the procedure is reversed, this times the piston moving to the left (Figure 11). This, of course, accomplishes nothing more than moving the piston back and forth at the cost of the water usage. However, if one then connects an identical pump to the water pump - but one that uses air instead of water - then in effect we have an air pump feeding air to the tanks (Figure 12).

The device was characterized by an extremely low water consumption and high efficiency. The water consumption depended on the number of connected air outlets; only 1 liter of water in five hours was consumed using a single air outlet. Depending on the strength of the water pressure and the line resistance of the individual air outlets, at its fastest action it was claimed that a single KDA pump could power up to 60 air outlets.

The apparatus was relatively small, 13.8 inches in length, 4 inches high and 2 inches wide, and could be installed by anyone without needing any specialized knowledge. The only require-

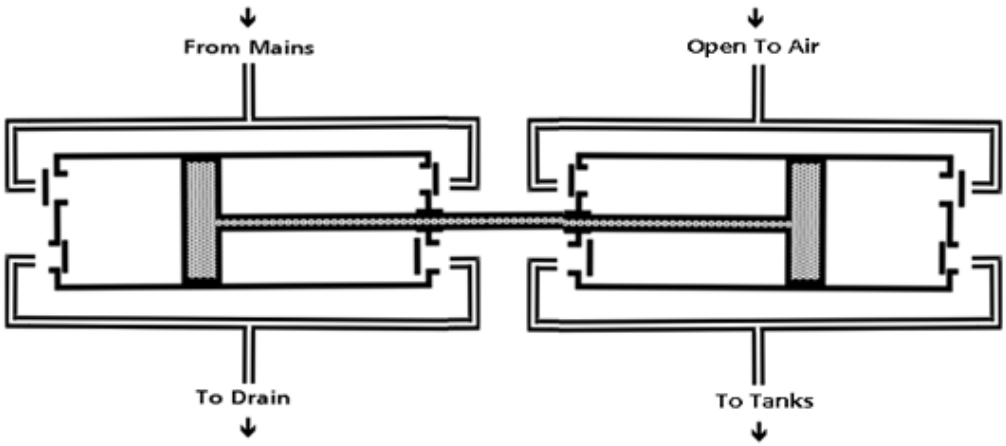


Figure 12: The K.D.A. Pump showing both pumps (water on the left and air on the right) connected.

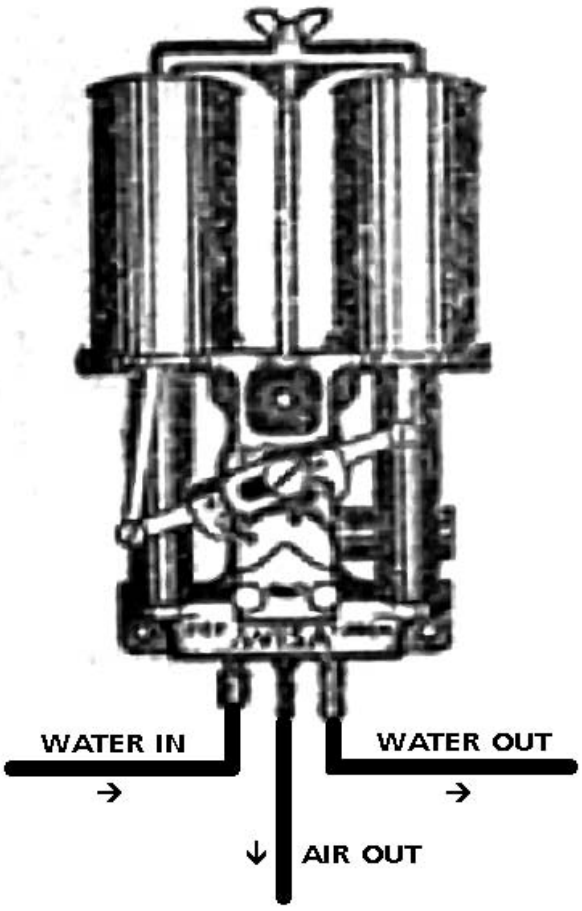


Figure 13: WISA Air Pump.

ment afterwards was that it had to be oiled from time to time. The device, moreover, had the advantage of shutting down automatically when the aeration had to be shut down or when there was an accidental obstruction to the aeration line; the operation of the pump automatically resumed when the problem was fixed, all this with great savings on water usage.

A very similar air pump to the K.D.A. was manufactured by Wisa (Figure 13). The principle was identical except in the case of the Wisa the two cylinders were situated vertically, side by side, rather than horizontally more or less in line. Whether one would choose the K.D.A. over the Wisa would probably depend upon the dimensions of the space available for installation.

Although the K.D.A. and Wisa pumps were decided improvements, being a double-acting pumps that provided air continuously where Harwood's pump was a single-acting pump in which no air was moved during the time the air chamber was replenished with outside air, Hurwood clearly gets the credit for inventing the first aquarium pump.

Lastly, it was very common for aquariums of the 1900's to be powered by air from an air tank, the air being replenished when necessary by a bicycle pump (Figure 14)

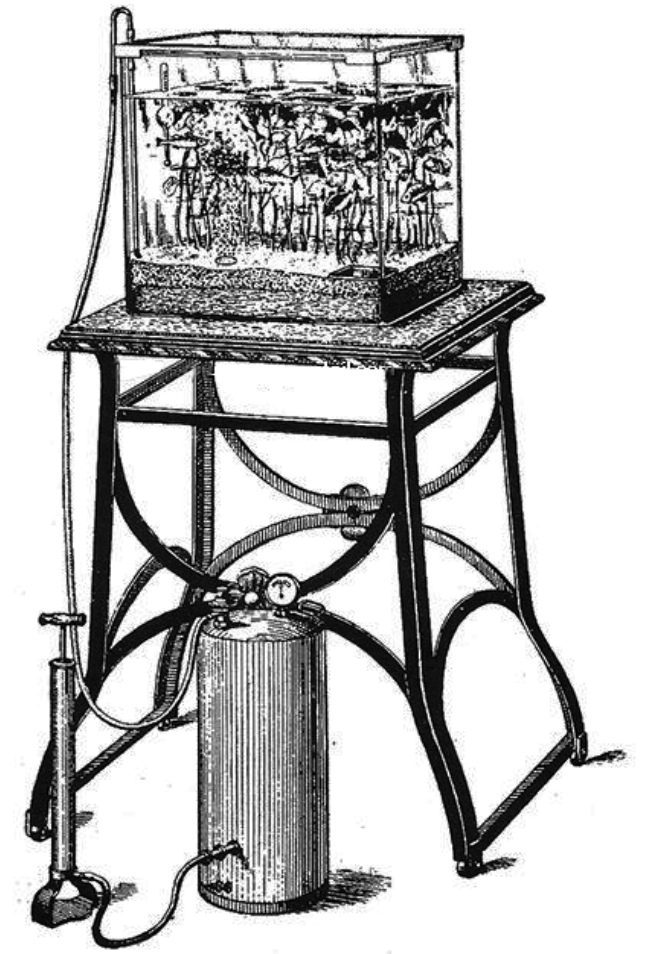


Figure 14: Air Tank with Bicycle-type Pump.

THE ORIGINS OF THE CICHLID HOBBY

By Albert J. Klee, Ph.D.

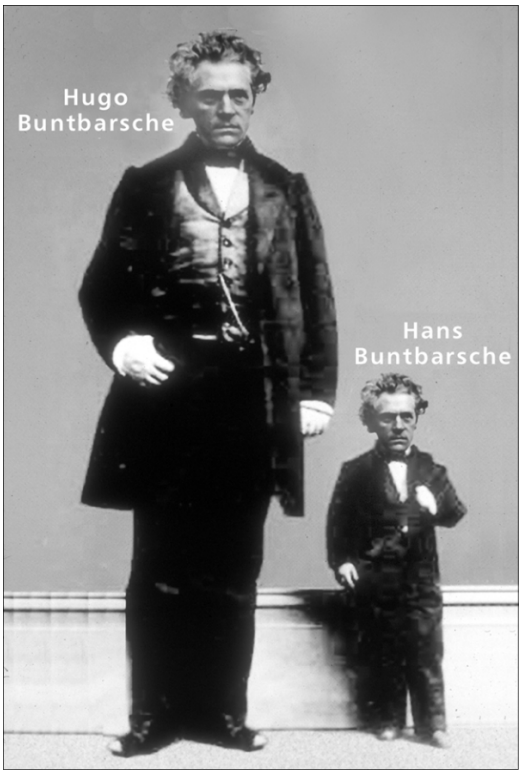
(Buntbarsche Bulletin, No. 227, pp. 28-33, April 2005)

The story starts in the year 1853 in the small Bavarian town of Buchstahude, Germany, when Fräulein Elise Eingemachte, an Editor's assistant who was carrying a box of umlauts to the printer, bumped into Emil Buntbarsche, a plumber doing maintenance work on the Flügelhorn that was played by a member of the Königliche Musik und Pumpernickel Gesellschaft, an organization that had a rehearsal hall in the same building. As a result of the collision, umlauts went flying all over the place and Emil, who was a real gentleman, helped Elise gather them up and return them to the box. Emil, who hadn't had a date since the fall of the Habsburg Monarchy (he was one of those German hippies known locally as a "flowerkraut"), chatted up Elise and soon they were holding hands regularly on the Liebestrasse.

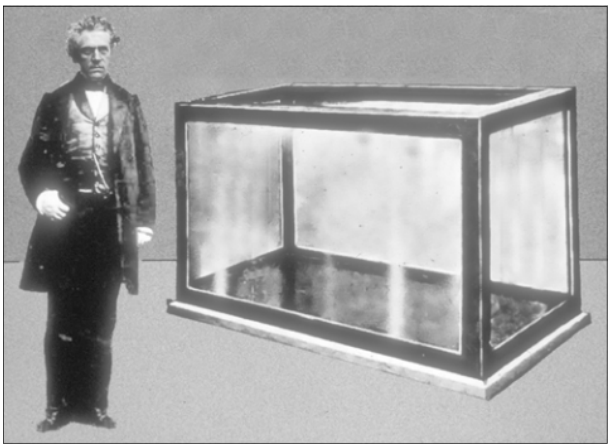
As a plumber, Emil had good connections so they were married a few months later and immediately tried to start a family. However, in their wisdom the Buchstahude Bürgermeisters had decided to make the sole road in town one-way only, so when Emil was finished with his day's work and tried to get home, he wound up in the next village located some forty kilometers away. Emil had to abandon his donkey and walk back, arriving home too late and too tired to do anything but have a quick supper of Krabbensalat, Schneckensuppe, and Schweinsmedallions. Fortunately, the Bürgermeisters reversed themselves and rescinded the law, and a year later the Buntbarsches were blessed by the arrival of twin boys whom they christened, Hugo and Hans.

Although the Buntbarsche brothers were rather undistinguished students (Hugo, for example, when asked why Buchstahude cows wear bells answered, "Because their horns don't work," and Hans thought that a Caesarean Section was a district in Rome), they did excel in natural history and even earned money after school by selling the rough bottom fish they found in the local river. For this they were paid daily, a remuneration known by the early Romans as "Karpe per diem." They devised a logo for their business consisting of two interlinked H's, and this was the very first Bismarck.

In addition to collecting carp, Hugo and Hans also netted smaller fishes such as Bitterlings, and also the complementary Dankelings, and



Hugo and Hans Buntbarsche. The brothers were identical twins, so the citizens of Buchstahude had great difficulty in telling them apart. The problem was solved when Hugo began to keep the larger cichlids, and his brother the smaller ones.



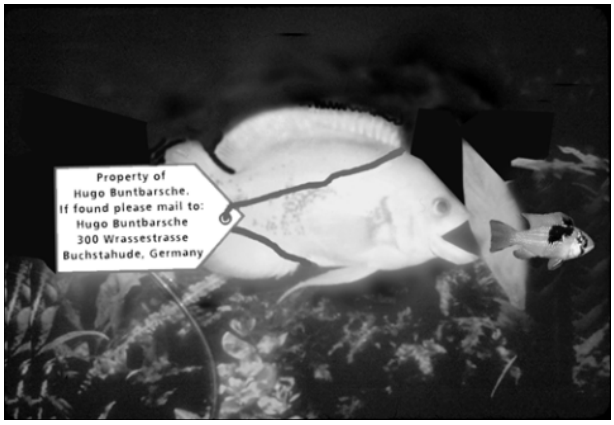
Hugo Buntbarsche and one of his smaller spawning tanks. When Hugo topped up his tanks, the water level in the Rhine dropped three feet.

this was the very beginning of the aquarium hobby for them. One of their uncles, Wolfgang Amadeus Buntbarsche, was an importer trading Hasenpfeffer and Kasespaetzle for items that were hard to come by in Buchstahude, such as frankincense and myrrh. Knowing that the boys were interested in keeping fishes, Wolfgang brought back a number of cichlids from Africa and South America, and from that day on the Buntbarsche brothers would keep no other fishes than those.

Their interest in cichlids, however, was quite different. Hugo, who stood 6 feet 7 inches in his Lederhosen, was only interested in the really big species. Hans, who only came up to Hugo's belt buckle, was interested solely in the dwarf species. (Since the brothers were identical twins, the only way the townspeople could tell them apart was by the size of the fish they kept.) Although Hans' equipment was, as befitting his charges, rather small, Hugo's on the other hand were immense. His filters, for example, were made to remove really large particles, such as gravel, dead sheep, and canoeists. Their enthusiasm for these fishes led them to establish, in 1889, the very first cichlid association in the world, the Deutsche Cichlid Gesellschaft (Author's Note: The Minutes of their first meeting are appended to this article).

On one occasion when he discovered some white spots on one of his Chanchitos, Hugo, who had some knowledge of English, exclaimed, "Ach, this is serious!" Hans misunderstood what his brother was saying and recorded it as "Ach, thee op thirius." Later, a Prussian microbiologist who had trouble with his vowels and thought that a diphthong was the lower part of an abbreviated bathing costume, changed it to "ichthyophthirius." Thus was born the first known aquarium fish disease. Savvy cichlid fanciers still refer to it as "Ach," rather than the more plebeian "Ich" favored by less enlightened aquarists such as guppy fanciers and, of course, killifish enthusi-

Hans Buntbarsche adjusting the pH in one of his dwarf cichlid aquariums. His tanks were so small that water changes involved eyedroppers and pipettes. Hans only used the finest Kölnisch Wasser (Cologne Water) for his fish. The fish shown here is the very rare *Apistogramma ottovonbismarcki*.



One of Hugo's large cichlids feeding on his brother's *Apistogramma*. Hugo was a careless aquarist and was forever losing his fish. As a consequence the local ASPCA required him to provide them with tags containing his return address. This happened so often that the local fishermen demanded that the postage was prepaid.

asts. This is not surprising, since the former chose that specialty because it was the only fish they could breed, and none of the latter have been known to respond to any external stimuli whatsoever without large doses of peat water in their morning coffee.

One day when Hans was out netting daphnia for his dwarf cichlids, Hugo set out to feed his own fish and discovered that he was plumb out of his own fish food, i.e., Bratwurst and Rotkraut. Glancing over at the biggest cichlid in his collection, *Boulengerochromis microlepis*, he noticed that it was heavy with eggs. As this was an emergency, he immediately fed it most of Hans' prized *Apistogramma* collection.

When Hans returned home and found out what Hugo had done, he completely lost it and grabbed his father's service revolver and shot Hugo right between the eyes. This created a hole from his forehead to the back of his head about three-quarters of an inch in diameter, but fortunately for Hugo did little harm since the brain is divided up into three parts: the left, the center, and the right and, as is well-known, cichlid fanciers do not use the center portion of the brain for anything of any consequence. Hugo, therefore, did not miss it in any way, the only aftereffect being that, when the wind blew in from the North it made a whooshing sound as it traveled through the hole, causing Hugo to ask if there was a polka band practicing in the vicinity.

Over the years the Buntbarsche brothers developed many new strains of cichlids, some of which are popular even to this day, such as the "Inherit the Earth Meeki," sundry genetic variants of *Pelmatochromosome*, *Chichlasomas* in

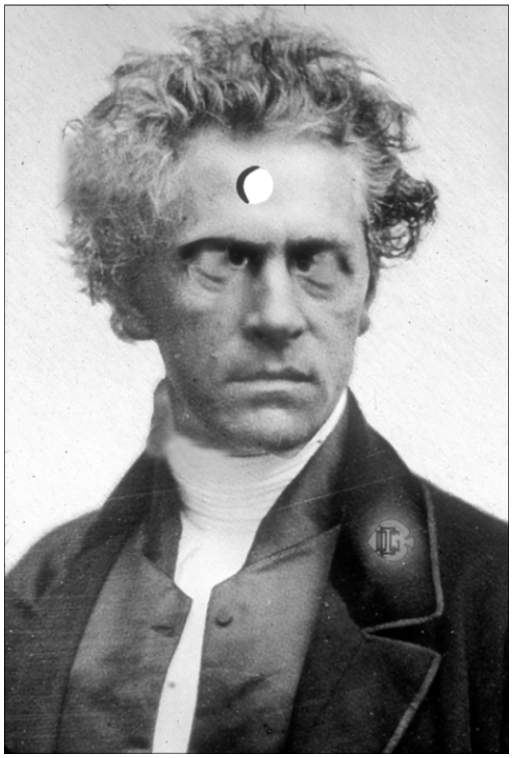
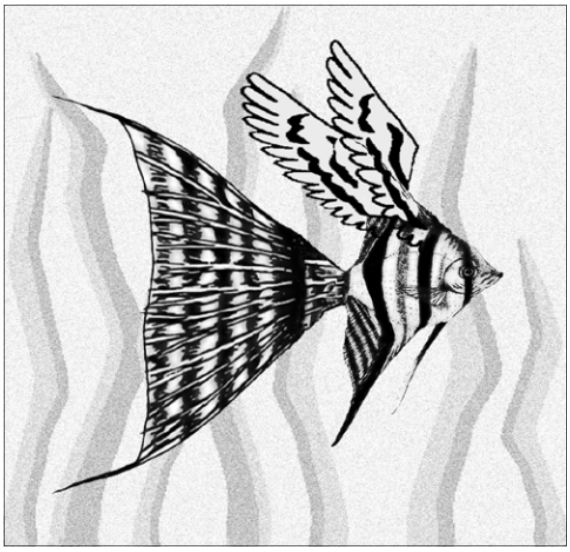


Figure 5: Hugo Buntbarsche after being treated at the Buchstahude Medizinisches Institut für Gestörte Liebhaber von Cichlids (Buchstahude Medical Institute for Disturbed Cichlid Fanciers) for the .44 caliber pistol wound inflicted by his brother.



Hugo Buntbarsche developed many specialized strains of cichlids, the most famous being "Der Fliegende Engelfische." Hugo was not satisfied that his Angels were so slow moving, so he set out to remedy the situation. At the time, the "Fliegende Engelfische" could outswim any tetra known to the hobby by a margin of ten to one, and his cat went meshuga trying to catch one.

numerous, long-lasting flavors, and the very aggressive *Terrorphyllum scare*. They developed special foods for cichlids, such as the Apristograham cracker, and also developed an interest in their diseases, being the first to develop a vaccine against the dreaded, "Cichlid Cell Anemia."

(The following is from *Der Buntbarsche Tagesbericht*, Band 1, November 1889. The author hopes that readers may overlook any minor errors that may have occurred in translation. AJK)

Minutes of the first meeting of the Deutsche Cichlid Gesellschaft, Buchstahude, Germany, October 10, 1889.

Last Thursday evening, just after the conclusion of the featured program, "Convict Cichlids, Three Stripes and You're Out," a sudden storm knocked out all power to the meeting room, plunging it into darkness just as Hermann Groschnoz was admiring the latest trophy he won (and one more to hang with his other *Tropheus*), taking First Place in the South American Class for his "Bandido Chanchito." With the light suddenly extinguished, Herr Groschnoz inadvertently lost his grip on the trophy (a replica of a Valkyrie holding a spear in one hand and a Firemouth cichlid in the other), and the pointed end landed in the vicinity of Gertrude Gummiknüppel's more

Not to be outdone by his brother, Hans Buntbarsche developed a number of *ramirezi* strains, one of which was his "Alpen Ram." It proved to be a nuisance to other fish as it was always butting into their conversations. Moreover, the fish were hard to feed, as they would only eat fresh Edelweiss.

than ample backside or, more precisely as Herr Doktor Präsident Ottoclave described it, “Wo die Sonne nicht scheinen.”

Gertrude, our Refreshment Committee Chairman (known affectionately as “Strudels und Noodles”), was at the time bent over trying to extinguish an extensive field of candles on her 60th birthday cake, a double German chocolate with extra cream, that she had so thoughtfully brought to the meeting to share with all of us. Upon being struck by the trophy, Gertrude, whose hands were still fastened around the cake plate, cried out ”Ach, mein hinteres Ende!” and straightened up rapidly, tossing the cake onto the head of Gottfried Gansburger who, at the time, was attempting to light an eight-inch, Weimar Republic Commemorative cigar. Unfortunately, the cake was liberally laced with rum and promptly exploded upon coming into contact with Gottfried’s cigar lighter. His eyebrows were removed during the detonation and pieces of cake were scattered everywhere. One large piece bearing the legend, "Glücklicher Geburtstag, Gertrude," fell into the formidable frontage of Fräulein Katharina ("Die Cupcake") Kantilever, who, upon thinking that her brother-in-law was taking untoward liberties, hollered “Nehmen Sie Ihre Hände aus meinem Büstenhälter!” and lashed out with a half-filled bag of extra hard Pfeffernüsse.

However, in the dark her aim was off and she accidentally struck 97-year old Adolf Edelweiss, our resident expert on *Hemorrhoidichromis* and *Bananacara* species, on the back of his head. Herr Edelweiss's false teeth immediately flew out and upwards, fastening themselves onto Gustav Geschaftig, right in the middle of what can only be described with some delicacy as his “Frucht des Looms.” Gustav, who at the time thought the problem was only a burned out light bulb, was on a ladder screwing in a replacement. Yelling “Gott hilft mir!” he dropped the box of light bulbs he was holding and they exploded as they hit the floor. Oberbürgermeister and part time constable, Heinrich Haberdasher, a specialist in Kerosene *Lamprologus*, thought that Napoleon’s troops were once again invading peaceful Buchstahude and, drawing his weapon, fired several rounds from his 1873 Mauser pistol. Fortunately no one was injured, but a stray bullet passed through several of the 100-gallon tanks holding the larger cichlids entered in the show.

The floor of the meeting room quickly filled with aged, conditioned water to ankle level and Frieda Fratzsaddle, who had had been celebrating her recent divorce from her fourth husband with a fifth of Old Granddad (“Alte Grossvater”) became confused, thinking she was on a sinking ship. Her ecumenical cries convinced all present to join hands and sing the only Calvinist hymn she knew, “Näher mein Gott zu Ihnen” (“Nearer My God to Thee”). Although the lights came on shortly afterwards, it took some time before sundry indignities were forgotten. The fish thrashing on the floor were carefully sorted out from pieces of glass, false teeth, and birthday cake, and a motion to adjourn was made, seconded, and passed.

Respectively submitted,
Lotte Kasebier, Sekretär.

A SHORT HISTRIONICS OF THE AQUARIUM HOBBY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Message 1046, July 21, 2003)

The earliest record of fish keeping is found in Egypt where, along with Mesopotamian graffiti and Hittite expletives, pictures of well-known African aquarium fishes are found carved on the sides of tombs. The instructions for keeping these fishes were written in a script based upon aquatic plants and known as Egyptian hyacinths. These earliest of all fish keepers lived in the Sahara desert, so although there was little water to be had, there was plenty of sand to cover the bottom, the middle, and the top thirds of their tanks. There was, in fact, only enough water to allow rubbing each fish once a month with a damp rag. Fish keeping at the time was fraught with many problems; the tombs leaked, it was hard to see through the marble sides, and the climate was such that the Egyptian aquarists had to live elsewhere, requiring a long commute from Nubia just to feed their fish.

The next record of the aquarium hobby is found in ancient Greece, where Socrates devised the first practical method for filtration, which involved poring aquarium water through discarded hosiery remove food particles. This was known as the "Sockratic Method." The members of his combined aquarium society and school of philosophy were called "Tetrahedonists," and they practiced their oratory by tossing Barbs at one another. Socrates' specialty was Discus, but his wife kept throwing them away.

Next on the scene were the Romans. The first killifish society was established by the brothers, Rivulus and Remiss, the latter so named because he forgot to put covers on the tanks and the Rivulus jumped out. Later, Neapolitan aquarists combined their hobby with their love of cooking and made famous such dishes as Brine Shrimp Scampi and Neon Tetrazzini. These early Italian aquarists were in the habit of drinking much vino when they were building their aquaria and their tanks invariably, especially those built in Pisa, leaned to one side.

A British publican, Fillup Gosh, actually invented the first straight-sided tank by first devising a rectangular commode for use under a Queen-size bed. The Queen, however, found the right-angled corners too uncomfortable to use so Gosh decided to offer his containers to aquarists. They were sold with a guarantee known as a "30-day Warrington." (It has sometimes been argued that Nathaniel Ward invented the aquarium; however, his was a sad case and he took a job with the British Civil Service and became a Ward of the State.) The hobby in England at that time was a favorite of female aquarists but was constrained by the strict moral codes of the day. Victorian ladies could not, for example, raise either their skirts or the water levels in their tanks without undergoing social opprobrium. Male aquarists, on the other hand, met nightly in local pubs and got tanked. After Gosh's death, his career suffered a dramatic decline.

Although Gutenberg had long since invented movable type and the bible, the world was now entering a time of great inventions and discoveries. With the advent of the Industrial Revolution, people stopped reproducing by hand and started reproducing by machine. Cyrus McCormick, for example, invented the McCormick raper, which did the work of a hundred men. Louis Pasteur discovered a cure for rabbits and, at the American Museum in New York City, Barnum displayed the famous musical insect known as the humbug

and also the first Beleaguered whale. Barnum was a very rich man and could afford a Butler. William Damon, who also worked for Barnum, circumcised the world, looking for new species of marine fishes for the Museum.

The greatest of the early American aquarists was Hugo Mullet, who was born in Germany in 1846, supposedly on his birthday. He had to leave Germany in a hurry when he was found defacing the currency, an offense known as "Deutschmarking." Mullet settled in Cincinnati and bred goldfish, a corruption of the German word for the then very expensive "geltfisch," itself derived from the Hadassic plankton feeder, "geltfilterfish." Unfortunately, Mullet could not spell Cincinnati properly, often leaving out one of the n's, a condition known as "enervation." He was therefore forced to move to Brooklyn where correct pronunciation was unheard of. Mullet was a snappy dresser and when he strolled by at the Packer Collegiate Institute where he was employed as an aquatic cosmetologist, the girls would say, "There goes that striped Mullet!"

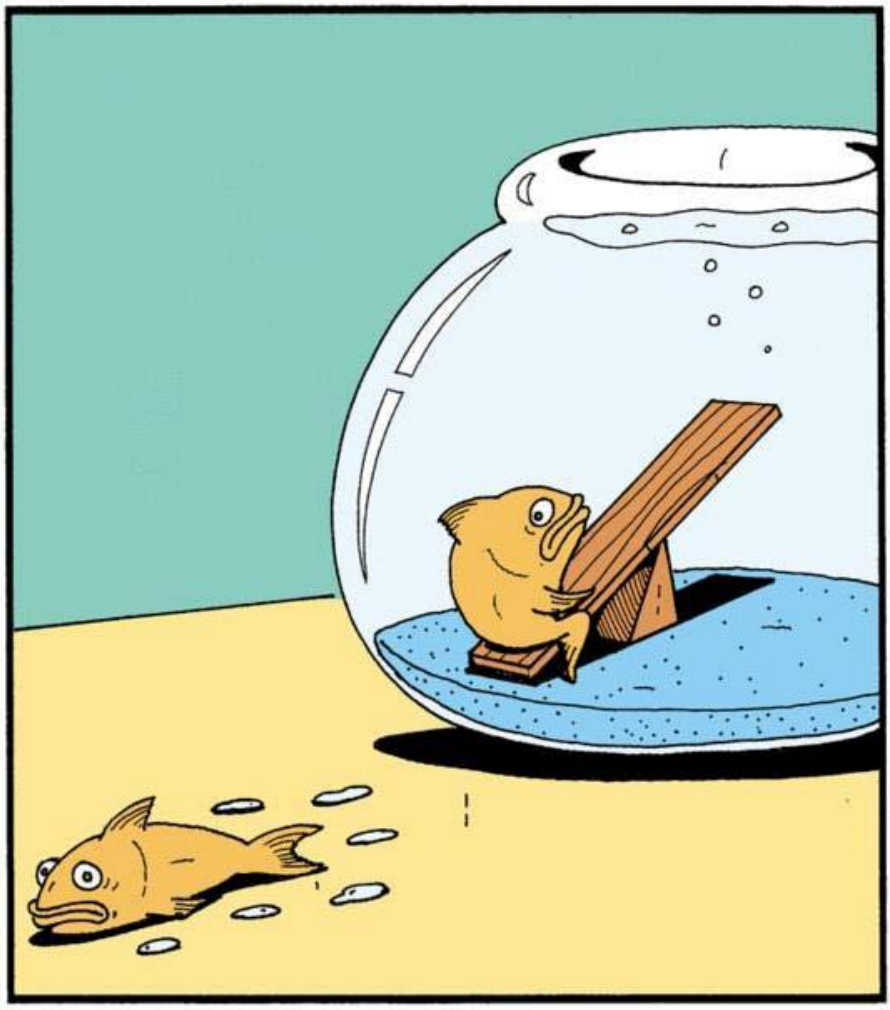
One of our first aquarium club organizers was Phosgene Smith who founded the New York Aquarium Society. Smith had a very poor understanding of geography, so the club actually met in New Jersey and held its monthly bowl shows in Omaha, Nebraska. He had a hard time on the road when checking into motels, as no one would believe a name like "Smith" on the register. What made it all the more difficult was his insistence on asking for three-hour rates. In any event, his book, The Home Aquarium…Wherever It Is Located," set down some of the basic principles of fish keeping that aquarists follow today, such as wearing rubber-soled shoes when transferring electric eels and eschewing pianos as aquarium stands regardless of the number of tanks they will hold. Smith, by the way, loved playing with his instruments and kept a spinster in his attic just for this purpose.

A famous aquarist of the day was Richard Dawn, who imported many of our most popular aquarium fishes. Two of his many catfish introductions included the Corydormouse, named for its prominent whiskers, and Lawncareria, prized for its ability to keep aquatic grasses under control. Other introductions included the unfortunate Hapless Chromis, the singing catfish Doras dayi, the predatory Belly Knee Sox, a number of Labeos whose names were on everyone's lips, and both Hemigramma and Hemigrampa species. Dawn was a very energetic aquarist, most likely stemming from his habit of eating overactivated charcoal. Dawn died in 1929 and is still dead.

One of the most influential pre-World War II aquarists was William T. Inners. Inners was half English, half Irish, and half Scotch, but he mostly drank the latter. Inners lived in Philadelphia, the home of Benjamin Franklin who in the early days of the American hobby discovered electricity by rubbing together two electric eels, one positive the other negative. (It is mistakenly thought that Franklin invented electricity "while flying a kite" but this was a transcription error, and as it is well known that he liked his ale, it should have read, "while high as a kite.") Inners was a printer, often typecasting most of the well-known aquarists of his day. The Neon tetra, Hyphenated Innersi, is named after him.

Inners was one of the earliest photographers of tropical fish, his most famous being of a Glue Bularis, which, unfortunately, stuck to his lens. He published a very popular magazine called "The Aquarium," but it was hard to read because of all the watermarks. Inners was also a prolific writer, his most famous book being "Erotic Aquarium Fishes," containing innovative ideas such as mentholated breath mints for Firemouth cichlids, Docksid-

ers for Walking catfish, tarnish removers for Silver Dollars, turn signals for Head-and-Tail -Light tetras housed in very short tanks, tiny pliers for removing the thorns from Rosy Barbs, and small waterproof microphones for Talking Catfish wanting to break into show business. After his death in 1969, however, he wrote very little.



THE ORIGIN OF THE PLASTIC BAG IN THE AQUARIUM HOBBY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Message 4804, April 14, 2006 & Yahoo Message 4808, April 15, 2006

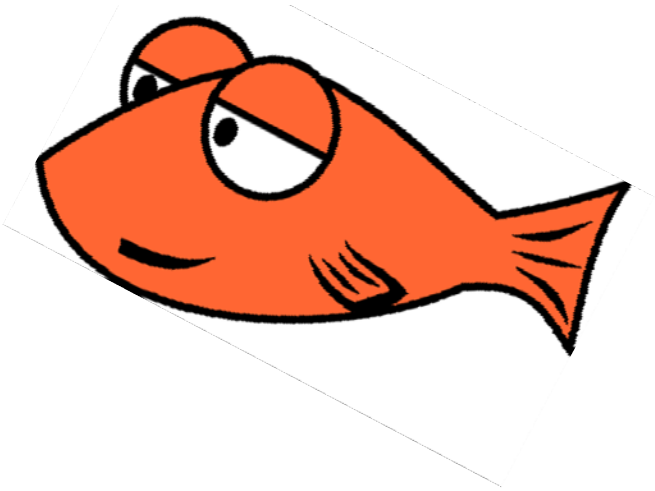
In the late 1940's a fellow by the name of Algernon Fiddle was getting married and picked up his Tuxedo at the rental store. On his way home he stopped off at a friend's house where he saw some broadtail guppies his friend had recently developed. Offered a number of pairs for the taking, the problem was that there was no suitable container available. The quick-thinking Fiddle took the plastic garment bag off his Tuxedo and tied off the slit end provided for the coat hanger hook. Voila! The transportation problem was solved and Fiddle made it home with his guppies intact, although the same could not be said for his Tuxedo since his friend kept white angora cats and, without the plastic garment bag for protection, the Tux was coated with white cat hair giving Algernon the appearance of a moldy prune at his wedding. (His normally wrinkled physiognomy unfortunately added to the effect.) Suffice to say that the honeymoon was not without some sharp words from the bride.

The idea was quickly taken up by a local pet shop who ordered a thousand bags from the garment bag supplier, the only stipulation being that the bags be only 12 inches long. The supplier at first thought that the bags were destined for a re-make of the Wizard of Oz but that misunderstanding was soon cleared up. Improvements soon followed, notably the removal of the legend, "Dry Clean Only" from the bag since customers who dutifully followed the instruction found that their fish shrank significantly and were hard to see.

P. S. I am surprised that you folks think this is just a "tale." Algernon Fiddle was an important figure in the history of the hobby. He was the first to invent a form of the undergravel filter, although he carelessly omitted the holes in the tubes that ran under the gravel so the filter didn't do very much. He also devised the very first frameless glass aquarium but the Elmer's glue he used made for a very short tank life span (a matter of a few seconds, actually). Sadly, Fiddle came to an untimely end when, standing in his bare feet in a puddle on the floor, he attempted to rearrange the inside filter in a tank containing his pet electric eel.

Fiddle's experiments with electric eels were legendary, by the way, as he ran all of his heaters, pumps, and lighting fixtures off that single tank although there were quite a lot of pyrotechnics in his fish room before he learned to use a step-down transformer to get the voltage nearer to 110. The first time Fiddle connected an incandescent lamp to the eel tank it was so bright that a passing steamer though it was the Barnegat lighthouse and it ran aground in Fiddle's front yard with a cargo of Vietnamese potbelly pigs.

In any event, use any of this material as you want. To quote from Jane Austin's Pride & Prejudice: "For what do we live, but make sport of our neighbors, and laugh at them in our turn?"



MINI-MEMOIRS of a FISH FANCIER

BY Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Message 784, March 26, 2003 & Yahoo Message 832, April 4, 2003)

The story starts in the mid-60's with two other people, Barry E. Franz and Samuel F. Wineberg. Barry was an industrial engineer at the Proctor & Gamble HQ in downtown Cincinnati, and Sam was a CPA residing in Fairfield, Ohio, a community a bit farther northeast. Both were avid aquarists and we three were old friends living within a 30-minute drive from each other. Barry was a little younger than I, Sam a bit older.

Barry was a marketing specialist and wanted to get into some aspect of the fish business where he could apply his talents without the restrictions imposed at work (P&G at the time was almost as fussy as IBM, i.e., dark suits, tie, no short sleeve shirts, and certainly never, never appear in the hallways sans jacket!). He tried to interest Sam and me in the hardware side of the fish business but both of us, having our own business qualifications (I, for example, at the time held the position of Adjunct Associate Professor of Information Sciences in the Graduate Business School at Xavier University in Cincinnati) thought it didn't have the proverbial snowball's chance in you know where to succeed.

However, about this time Jim Crawford (then Editor of *The Aquarium Journal*) told me that the San Francisco Aquarium Society (SFAS) was thinking of getting out of the publishing business. The IRS had questioned the tax-free status of their brine shrimp operations that was supporting the magazine since the *Journal* was operating at a loss. The SFAS, therefore, was willing to give the magazine away free to anyone they thought could sustain it as a viable operation. Barry jumped on this and suggested that we take up the SFAS on their offer.

Sam and I also liked the idea so in the summer of 1965 I went to San Francisco accompanied by my wife, Joy, and I made the pitch before a special committee of the Society. The SFAS was interested in one thing and one thing, only; the continuation of the AJ as a publication of quality content in the spirit of its long history. Consequently, they had three main criteria: (1) Did the applicants have the necessary knowledge of the aquarium hobby to carry on the AJ's traditions? (2) Did the applicants have the necessary business acumen to manage the magazine as a business, and (3) Did the applicants have sufficient capital to ensure that the magazine would survive financially?

Jim Crawford, who was pushing as hard as he could for me to take over the AJ, thought the decision was in the bag and even printed the cover of the August 1965 issue with the subtitle, "New AJ Publisher." I went back to Cincinnati and reported to Sam and Barry that it looked as if we were going to be in the magazine business. However, at the last minute, TFH Publications made a counteroffer and the SFAS decided to give the AJ to them.

With regard to the third criterion, there was no way Barry, Sam, and I could compete with a multimillion-dollar corporation. Jim was devastated but I was a bit more philosophic about it. After all, at least we had tried. (I am not going to discuss what TFH did with the AJ or what the members of the SFAS thought about it. You are all familiar with the former, and there are still those who were members of the SFAS at that time around to speak to the latter.)

Coincidentally, just after we were informed of the Society's decision, we learned that *Tropicals Magazine* also wanted out so Barry and I traveled to Chicago to discuss buying the magazine. Since Barry and I had not fallen off the turnip truck on the way to Dogpatch, we "examined the books" and quickly concluded that the stiff asking price wasn't worth the subscription base. We returned to Cincinnati and, after a lengthy deliberation, the three of us decided to start from scratch; we each ponied up some coin of the realm and formed a Subchapter-S corporation as a first step in the publication process. The first issue of *Aquarium Illustrated* appeared in January 1966 with me as Editor and Barry as Managing Editor. The duties were split three ways as follows: Sam was responsible for distribution, billing, payments and subscriptions; Barry was responsible for sales and advertising; and I was responsible for production. The first issue carried on its masthead such aquarists as Cook, Kelly, Maier, Schofield, Walker, Turner, Wolfsheimer, Nieuwenhuizen, and Stratton, and professionals including Miller, Rosen and Cohen. Others, like Loiselle, were added later on. (This issue also contained the first in a series some of you may heard of called, "A History of the Aquarium Hobby in America.")

This was a fun time in the hobby for me. I was the first aquarist since Roth and Innes to actually do the layout on a national fish magazine, the paste-ups and the preparation of artwork and prepress on the photographs. One of the first things I did was to build a table in my basement (right alongside 120 fish tanks!) 16 feet long where I laid out the assembling of each issue of the magazine on a production-like basis. Lordy, we had fun with that mag! Sam and I were happier than two guppies in a tank full of daphnia.

However, it is necessary for a little digression (mathematicians, as I told the AKA last year, are fond of tangents) since it is of some historical interest that will be new to the group. Those sixteen feet of table space with its hot waxer, light box, and other publishing paraphernalia of the time, was in use only every other month. One day I got the idea that we might also publish something to fill in the gap, and what I came up with was to be directed at fish hobbyists, a one-pager, printed on heavy stock and with spot color, that had some space at the bottom where a pet store could stamp its name, address, hours, etc., and hand out free to its customers to encourage them to keep coming back to the store.

I broached the idea to Barry and Sam. The latter was enthusiastic but Barry was dead set against it, maintaining that it would never work. Argue as we did, Barry was unmovable. Sam and I then asked Barry if it was OK with him if we embarked on the project as a joint venture that did not involve *Aquarium Illustrated*, and he agreed. Thus was born *The Aquarist's Notebook*. I put it together and got it printed, and Sam handled distribution and billing. As it turned out, it was highly profitable and involved relatively little work on our parts. We published it monthly for six years, producing 64 separate issues over its life. The first issue appeared in June of 1967, and the last in December of 1972. I mention this up because some of you may have copies of *The Aquarist's Notebook* in

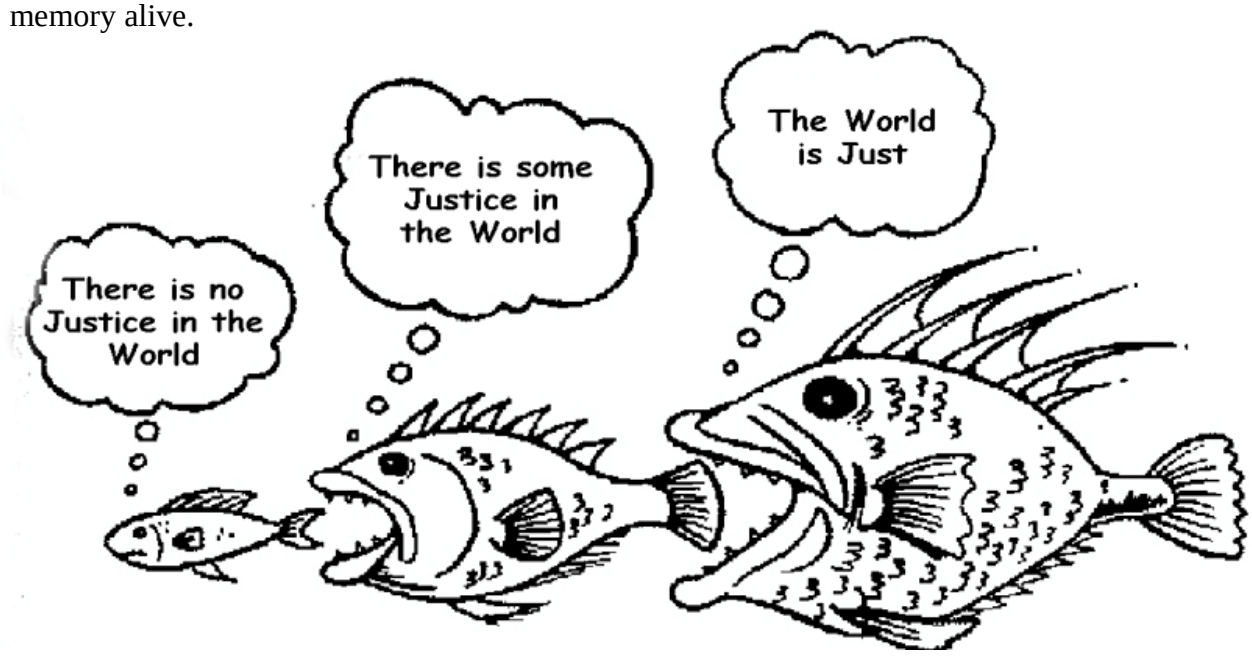
your possession and as it carried no publisher's identification other than its name and a post office box in Fairfield, Ohio, its origin remained a mystery until now. Just to keep the historical record up to date, in 1969 Sam and I also published a compilation of some the best material from *The Aquarist's Notebook* and it called *The Aquarist's Annual* (52 pages and again, no publisher's identification other than its name and a post office box). Although we didn't lose any money on the project there wasn't much interest in it among our pet shop clients, and so there were no repeat issues. So if you have a copy, that's another mystery solved!

By the way, Sam and I established a partnership that existed solely on a handshake. The only paperwork we ever did was the yearly partnership return to the IRS required for tax purposes. He was a remarkable man, so unassuming that no one would ever believe on first meeting him that he was a pilot on the Pacific front during World War II. Sam wrote the "About the Author" section to the revision of my history that Lee is publishing, and would not let me give him any credit in the book for it. He passed away a short time ago, but forty year's of friendship keep his memory alive.

By way of a quick review, the Pet Library series was conceived by Earl Schneider (and owned by Hartz Mountain, the pet conglomerate)) with the intention of breaking the hold TFH Publications had at the time on the low-priced end of the pet book market. To this end it was highly successful, and after the Pet Library series was introduced, TFH left this area of the pet publishing market.

I was asked by Earl, who was the editor of the series (a distinguished aquarist himself and writer par excellence who, by the way, should feature significantly in any post World War II history of the hobby in this country when it is written), to do three things: to participate in writing some of the titles, (2) to assist in finding and recommending authors, and (3) to lend my name and assistance in helping to promote the series. This I did, suggesting prospective authors, writing two or three of the booklets myself, and participating in two trade kickoff meetings, the first one being held in Chicago and the second shortly afterwards in New York City; for PR purposes, in each case I represented the fish authors.

Although it may seem strange perhaps that I did not write the killifish booklet, to me this



was an opportunity to open the field to young people with talent and Bruce (and John) filled the bill to the proverbial "T." (He also met the "young" criterion as well; it may surprise some, but Bruce was only seventeen years old when I invited him in 1961 to join the AKA Charter Committee. In those days, Bruce was like a younger brother to me and I often slept in a cot in his bedroom whenever I went to New York on business. This is as they say, however, another story.) In any event, this is why I wound up writing about guppies and catfishes instead of killies or any of the other fish groups I may have had a stronger interest in.

There is an amusing story concerning the Pet Library series sales campaign. Hartz Mountain provided racks to the pet shops to hold the booklet for display, and carefully designed the size of the booklets so that the competing TFH publications would not fit the racks. TFH countered this by sending thousands of their booklets back to the bindery and had them cut down so they could fit. However, after the trimming they looked positively awful and actually increased the sales of the Pet Library booklets!

Up to this time I had been the proverbial "babe in the woods" when it came to the ins and the outs of the tropical fish industry. Other than what I had gleaned by chatting with advertisers such as Alan Levy or a few industry-savvy friends like Earl Schneider, my contacts had always been almost exclusively hobbyists and/or ichthyologists, my interests being solely with the non-commercial side of things, although I did have a fair knowledge of, and many contacts in, the import/export business, both in this country and abroad. This was to change drastically with my editorship of *The Aquarium*, and I became acquainted with practices and personalities that considerably darkened my perspective on human nature.

I mention this in passing because there is an age-old paradox that has plagued historians ever since recorded time, that of separating a person's character from his or her achievements or abilities, We know, for example, that Coleridge was a drug addict, Poe was an alcoholic, and Byron was accused of incest. Furthermore, a part of a person's character may have a bearing on or connection with the subject at issue, while other parts may be totally irrelevant. Anyone writing about the post World War II history of the hobby will have to resolve such issues, but as this is meant to be a narrative dealing with events, not personalities, I'll move on.

Well it was time for me to fulfill my part of the bargain and endeavor to implement the operational model discussed previously. I was surprised both at the format change when I saw the first issue (I liked the old *The Aquarium* format much better) and how much I missed the control over the layout that I had in *Aquarium Illustrated*. One problem that cropped up right away was that, being a monthly, the deadlines for each issue were short and therefore there was no way I could be sent the galleys, check them for errors, and then return them to New Jersey in time to meet the printing deadline. Since neither John Hayes (nor later Sig Albert, who replaced John for a short while) knew very much about aquarium fishes, few of the errors that left my desk or those introduced in typesetting were caught in the galleys. Understanda-

bly, the appearance of these errors in the publication was a constant source of irritation to me.

It took a couple of issues to work out a reasonable modus operandi and to build up the staff. As with *Aquarium Illustrated*, I assembled a distinguished group of aquarists and professionals as specialist editors and consultants and won't bother to list them here. As for the content of the magazine, the Willingers were true to their word and pretty much left me to set tone, tenor and policy. Early in the game Alan Willinger suggested to me that the magazine was following the lines of *Aquarium Illustrated* and catering disproportionately to advanced hobbyists, so I did an analysis of content and came to the conclusion that he was absolutely right. TA was not AI, nor was it ever meant to be, so after identifying eight basic categories within the aquarium hobby and using a two-dimensional matrix taped to the wall of my office, I worked out a scheme whereby at least one article for each of the categories would appear in the magazine within any two-month publication period. This solved the problem.

By the end of the second year (1969), the history series had been completed and it was clear that the editing of the magazine was becoming more and more of a burden. In addition to editing, writing and dealing with the spate of author correspondence, I had a full-time job, was teaching graduate school part-time, was writing and producing *The Aquarist's Notebook* and traveling on a frequent basis between Cincinnati and New York in addition to the rather extensive travel my own professional life was demanding.

It is important to remember that at the time there were no home computers to assist with the editing nor was there an internet to facilitate communication. Today, of course, the situation would be vastly different but in 1969 things were still done the hard way. One wag once characterized writing in this way: "Writing is easy. All you have to do is stare at a blank sheet of paper until drops of blood form on your forehead." Well, there are many similarities here to editing part-time, long distance! Nevertheless, I had three more years to go.

Then in the Spring of 1970 an event occurred that further complicated the situation, i.e., I was offered the opportunity of returning to school in the Fall for my PhD, all tuition paid, on full salary, and sufficient time off to attend classes. Accordingly, I asked the Willingers if they would consider releasing me from the editorship of *The Aquarium* later in the year. While they were mulling that one over, other things were happening in New Jersey. The various TFH enterprises distributed products at this time that were in direct competition with those manufactured and sold by Metaframe, e.g., filters and other aquarium-related items. *The Aquarium* and TFH were competitors, therefore, in a much broader sense of the word, not just as magazines. In the Fall of 1970, just about when I was starting school, TFH attempted to initiate a new ploy, that of loading *The Aquarium* with advertising for these competitive products.

There was no way Metaframe could respond in kind. Aquariums, Metaframe's major product, were fast-becoming an undifferentiated commodity (like electricity) and thus the profits were small. Although there was considerable profit in items like filters, the competition was keen. If the introduction of a new filter bombed, then one suffered a loss for the year and had to wait until next year's trade show to try again. TFH, on the other hand had a steady income from its vast publishing empire, something Metaframe did not have.

The Willingers were aghast and tried to refuse the advertising. However, the lawyers told them that this was illegal - if you accepted advertising from one, you were bound by law to accept it from all. The Willingers were infuriated (and I couldn't much blame them) and decided to turn *The Aquarium* into a house organ where the only advertising that appeared was Metaframe's, which was legally permissible. This they did, starting with the February 1971 issue of *The Aquarium*. I was now the editor of a house organ, an intolerable situation for me. Few people want to read a national tropical fish magazine that mentions only one manufacturer's products. One reads a magazine for its editorial content, sure, but one also reads it to be informed of new products and to learn more about and to be able to locate existing ones. For me this was a deal-breaker, and the Willingers acknowledged it. However, they asked me to stay on for a "few months" longer as a favor, saying that something significant was going to happen in the near future.

The "something significant" turned out to be that the well-known toy maker, Mattel, was negotiating in secret to buy Metaframe. The Willingers had always treated me fairly so I agreed to continue as editor, although those "few months" dragged on to December 1971 when the last issue of *The Aquarium* was published. Because they had no need for a house organ, especially one devoted solely the aquarium hobby, immediately after Mattel purchased Metaframe they discontinued TA.

The announcement in the last issue stated that "Publication of *The Aquarium* magazine in its present format will be suspended with the December 1971 issue," suggesting that the magazine would reappear in the future in some other reincarnation ("...a novel, exciting, magazine for the hobby...") The subscribers were offered a choice; either a prorated share of their subscription returned or their subscription transferred to a planned, "novel, exciting, magazine for the hobby." Since I had no prior knowledge of the wording of this announcement, having seen it for the first time only after receiving the final printed issue myself, I was rather astonished.

It remains a mystery as to what was behind this wording and I can offer only one possible explanation. It might be that Mattel was considering publishing a new magazine that would deal not only with the aquarium hobby - which now they were part of - but also with other areas in which Mattel was involved. The powers behind Mattel at the time, Ruth Handler and her husband were fascinating and somewhat erratic characters in their own light, and it is not improbable they might have been considering such a project and were merely being careful not to burn any proverbial bridges.

Thus ended the final chapter in the long, thirty-nine year history of *The Aquarium* magazine.

"The Worldly Hope men set their Hearts upon Turns Ashes - or it prospers; and anon, Like Snow upon the Desert's dusty Face, Lighting a little hour or two - is gone."

(Rubáiyát of Omar Khayyám)

THE MEN WHO PRECEDED THE AQUARIUM HOBBY

BY Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 10, 2012)

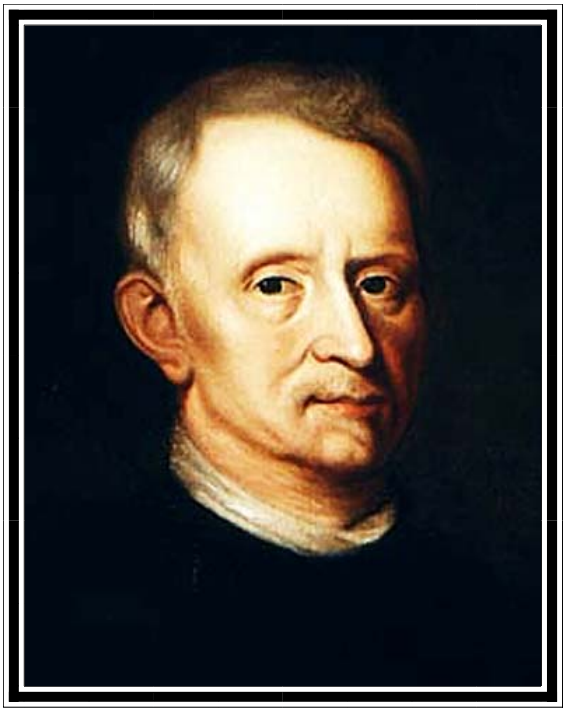
The Victorians were faced with a very formidable problem in their fish keeping, i.e., how to keep their animals alive in an aquarium without aerating or changing the water. In their search for a solution, they referred to the prior research that demonstrated that plants produced oxygen and absorbed carbon dioxide, while animals absorbed oxygen and produced carbon dioxide in a sort of counterpoise between the two kingdoms. Indeed, the requirement for plants was mandatory for the Victorians when determining who was first to "invent" the aquarium.

Aquarium historians, although alluding to some of these precursors to the aquarium hobby, have only provided sketchy information about their specific contributions or have not mentioned them at all. In this paper, I propose to fill this shortfall and to introduce some new names heretofore not previously acknowledged in aquarium hobby history.

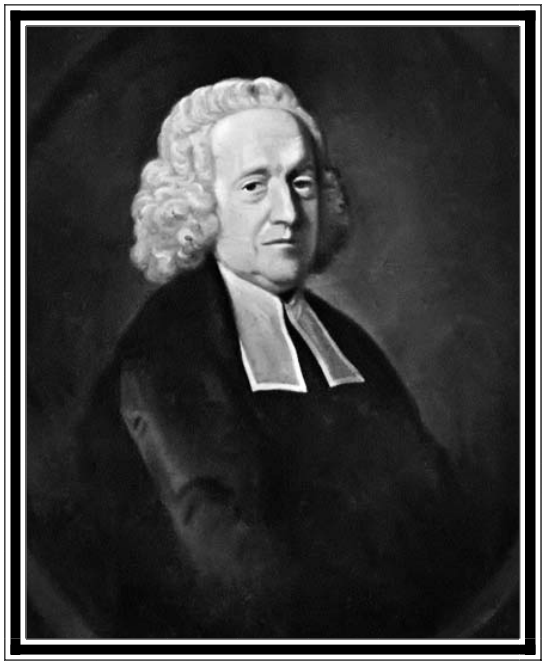
JAN BAPTIST VAN HELMONT (1580-1644)

Perhaps the first experiment designed to explore the nature of photosynthesis was that reported by the Jan van Helmont, a Flemish physician, philosopher, mystic, and chemist who introduced the word "gas" - from the Greek word chaos - into the vocabulary of scientists. Van Helmont lived and worked during a unique period of history - the dawn of the scientific revolution. As Europe began to shrug off the old-fashioned superstitions of the Middle Ages, scientists learned how to conduct experiments and make rational observations, rather than believing in religious phenomena to explain the world around them. However, the clash between science and faith eventually caused difficulty for van Helmont. He was interrogated by the notorious Spanish Inquisition for giving scientific explanations for supernatural events.

During the early 1600s, van Helmont was embroiled in a controversy over a pamphlet he had published on curative ointments. He was condemned for heresy by the General Inquisition of Spain, a special committee set up to punish those who contradicted the Catholic Church. Van Helmont was also denounced by the University of Louvain's medical and theological faculties. Eventually, he was detained and interrogated, then kept under house arrest for years. Perhaps because of this experience, van Helmont published little of his work. On his deathbed, he gave his writings to his son to edit and publish.



Jan Baptist van Helmont (1580-1644)



Stephen Hales (1677-1761)

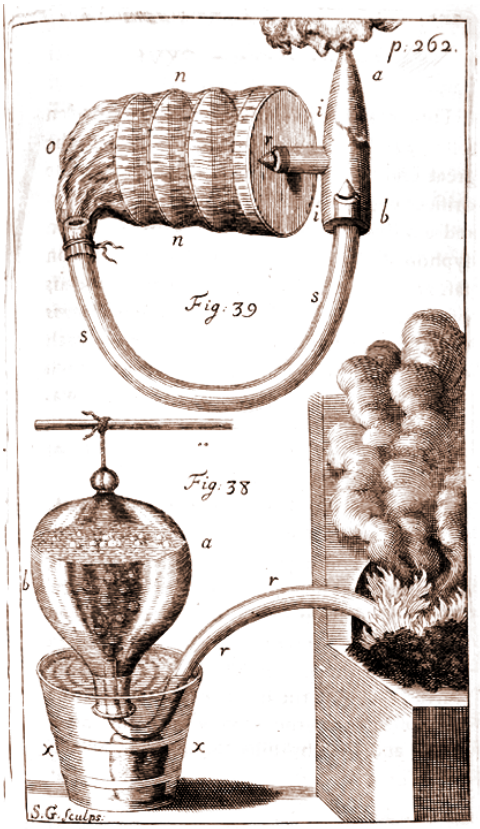
In 1643, van Helmont He performed an experiment to determine where plants get their mass. He grew a willow tree and measured the amount of soil, the weight of the tree and the water he added. After five years the plant had gained about 164 lbs. (74 kg). Since the amount of soil was basically the same as it had been when he started his experiment, he deduced that the tree's weight gain had come from water. Since it had received nothing but water and the soil weighed practically the same as at the beginning, he argued that the increased weight of wood, bark and roots had been formed from water alone. However, this "deduction" is incomplete, as a large proportion of the mass of the tree comes from atmospheric carbon dioxide, which, in conjunction with water, is turned into carbohydrates via photosynthesis.

Von Helmont did not discover photosynthesis, but this famous experiment with the willow tree provided a good hint for others to follow up. Van Helmont's experiments, by the way, were almost certainly inspired by Nicolaus of Cusa's 1450 book, "De Staticus Experimentis," in which he stated: "If a man should put an hundred weight of earth into a great earthen pot, and then should take some Herbs, and Seeds, and weigh them, and then plant or sow them in that pot, and then should let them grow there so long, untill hee had successively by little and little, gotten an hundred weight of them, hee would finde the earth but very little diminished, when he came to weigh it againe: by which he might gather, that all the aforesaid herbs, had their weight from the water."

STEPHEN HALES (1677-1761)

During the 1600s, naturalists made significant progress in describing and illustrating plant anatomy, but it is Stephen Hales - a British clergyman - who is generally considered to be the founder of plant physiology and a pioneer of quantitative physiology. He was born in Kent, England and studied theology at Cambridge, but also read mathematics, physics, and botany. He became a clergyman but also devoted much of his time in scientific pursuits particularly in the conduct of experiments in plant physiology. From his first experiments in 1724, he was soon recognized as England's foremost living scientist, Newton having died three years earlier. His most important work, "Vegetable Staticks," published in 1727, was in plant physiology. He suggested that plants derive something from the atmosphere, a guess that future researchers have proven correct and has become an essential component of the process of photosynthesis in plants.

He observed that the volume of air just above the water surface decreased when a plant was grown in a closed atmosphere and concluded that air was "being imbibed into the substance of the plant." He also noted that light enters leaf surfaces and flowers and may play a role in plant growth and development. In



Some of the equipment Hales constructed to perform his plant experiments.

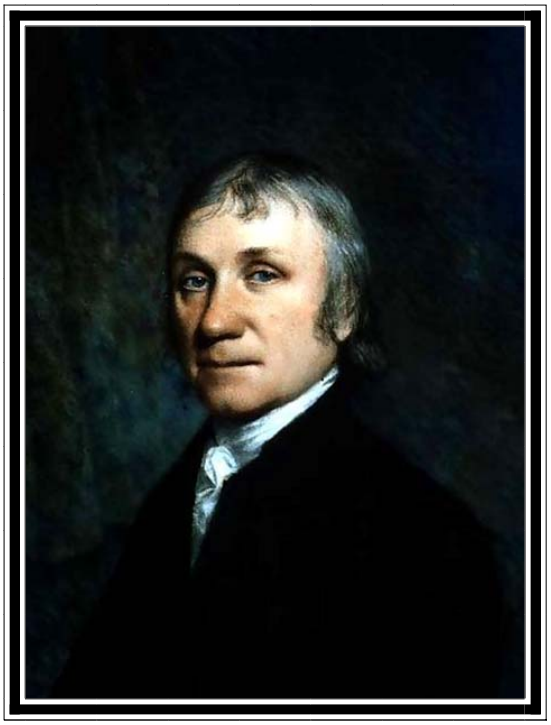
addition, Hales developed instruments and techniques for the quantification of plant processes.

JOSEPH PRIESTLEY (1733-1804)

The first evidence (1772) that gases participate in photosynthesis was reported by Joseph Priestley, an English theologian, Dissenting clergyman, natural philosopher, chemist, educator, and political theorist.

There is a historic dispute about who discovered oxygen. Most credit Priestly alone or both Priestly and Scheele. Oxygen was discovered for the first time by the Swedish chemist, Carl Wilhelm Scheele, in 1772. Joseph Priestly, an English chemist, independently discovered it in 1774 and published his findings the same year, three years before Scheele published. The French chemist, Antoine Lavoisier, also discovered oxygen in 1775. He, however, was the first to recognize it as an element and coined its name, “oxygen” - which comes from a Greek word that means “acid-former.”

Of all the achievements reported in Priestley’s great paper the most surprising was the discovery of the “restoration” of air by vegetation. Considering the “consumption of air by fires of all kinds, volcanoes, animals breathing, and so forth,” Priestley was convinced that there must be some provision, by God in nature, for remedying the injury which the atmosphere receives … “In what manner the process in nature operates, to produce so remarkable an effect,” Priestley wrote, “I do not pretend to have discovered”, but vegetation did restore bad air. He had not yet recognized the agency of light in the process; he didn’t understand that plants used the



Joseph Priestley (1733-1804)

Jan Ingen-Housz (1730-1799)

"fixed air" in the atmosphere in a complex process of photosynthesis. He had, however, started a program of investigation that would involve numbers of chemists and plant physiologists for a number of years.

Priestly knew that if a burning candle is placed in a sealed chamber, the candle soon goes out. If a mouse is then placed in the chamber, it soon suffocates because the process of combustion has used up all the oxygen in the air — the gas on which animal respiration depends. However, Priestley discovered that if a plant is placed in an atmosphere lacking oxygen, it soon replenishes the oxygen, and a mouse can survive in the resulting mixture. Priestley thought (erroneously) that it was simply the growth of the plant that accounted for this. He did, however, conclude that plants reverse the effects produced on the air and thus become the chief means by which the purity of the atmosphere is maintained.

JAN INGEN-HOUSZ (1730-1799)

Ingen-Housz was a Dutch physiologist, biologist and chemist. Ingen-Housz was also a proponent of inoculations as a means of inducing protective immunity and was the first to describe Brownian motion.

Jan Ingen-Housz discovered photosynthesis, the process by which plants utilize energy from sunlight and from atmospheric carbon dioxide to synthesize carbohydrates, although there is some controversy over whether the honor should go to Priestley. All life forms on Earth depend on photosynthesis, either directly or indirectly. In 1779 he discovered that the effect observed by Priestley occurred only when the plant was illuminated. Scientists knew that the flame of a candle in a sealed jar would eventually burn out; likewise, a living animal would die in a sealed container. They explained this as the "good air" being used up.

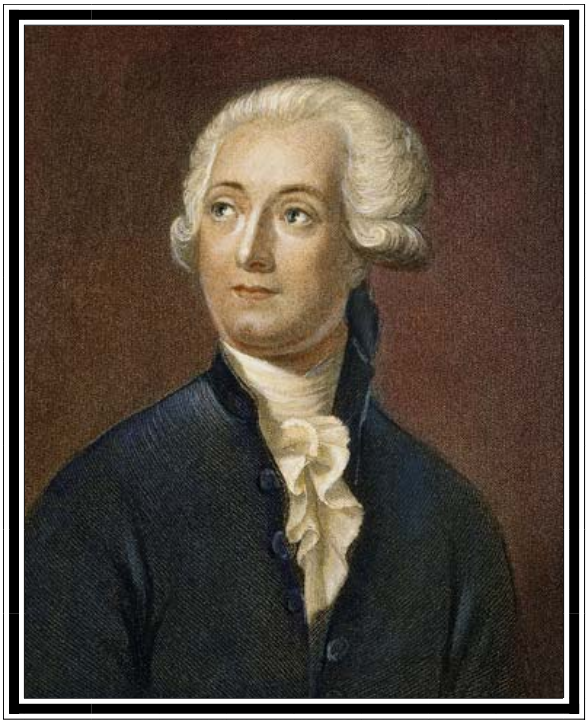
In the 1770s, while studying various gases, Priestley showed that plants could restore the fresh air in the containers by removing the "bad air" (now called carbon dioxide) and replacing it with "good air" (now called oxygen) such that the air could once again support a burning candle or the respiration of a living animal. Ingen-Housz extended these studies to show that the release of oxygen required light in the visible range of the spectrum and that only the green parts of plants possessed this capability of restoring the air. These findings laid the foundation or scientific understanding of the process now termed photosynthesis.

ANTOINE-LAURENT LAVOISIER (1743-1794)

As Ingen-Housz was performing his experiments, the celebrated French chemist (and

Revolutionary) Lavoisier disproved the phlogiston theory, first stated in 1667 by Johann Joachim Becher. The theory postulated the existence of a fire-like element called "phlogiston," which was contained within combustible bodies and released during combustion. The theory was an attempt to explain processes of burning such as combustion and the rusting of metals, which are now collectively known as oxidation. Lavoisier conclusively demonstrated that candles and animals both consume a gas in the air which he named oxygen. This implied that the plants in Priestley's and Ingen-Housz experiments produced oxygen when illuminated by sunlight.

Considered by many as the founder of modern chemistry, Lavoisier was a powerful figure in the deeply unpopular Ferme Générale, 28 feudal tax collectors who were known to profit immensely by exploiting their position. He was branded a traitor by the Assembly under Robespierre during the Reign of Terror in 1794. He had also intervened on behalf of a number of foreign-born scientists including mathematician Joseph Louis Lagrange, granting them exception to a mandate stripping all foreigners of possessions and freedom. Lavoisier was tried, convicted, and guillotined on 8 May in Paris, at the age of 50.



Antoine-Laurent Lavoisier (1743-1794)

Lavoisier's importance to science was expressed by Lagrange who lamented the beheading by saying: "Cela leur a pris seulement un instant pour lui couper la tête, mais la France pourrait ne pas en produire une autre pareille en un siècle." ("It took them only an instant to cut off his head, but France may not produce another such head in a century.") One and a half years following his death, Lavoisier was exonerated by the French government. When his private belongings were delivered to his widow, a brief note was included, reading "To the widow of Lavoisier, who was falsely convicted."

JEAN SENEBIER (1742-1809)

Jean Senebier was a Swiss pastor, botanist and naturalist who wrote many works on vegetable physiology. Though others had shown that a great part of the substance of plants must be obtained from the atmosphere, no progress was made until bubbles of gas were observed on leaves when they were submerged in water, which Joseph Priestley recognized as oxygen. Ingen-Housz proved the simultaneous disappearance of carbonic acid; but it was Senebier who clearly showed that this activity was confined to the green parts, and to these only in sunlight, and first gave a connected view of the whole process of vegetable nutrition in strictly chemical terms.

The growth of plants is accompanied by an increase in their carbon content and Senebier discovered in 1782 that the source of this carbon is carbon dioxide and that the release of

Jean Senebier (1742-1809)

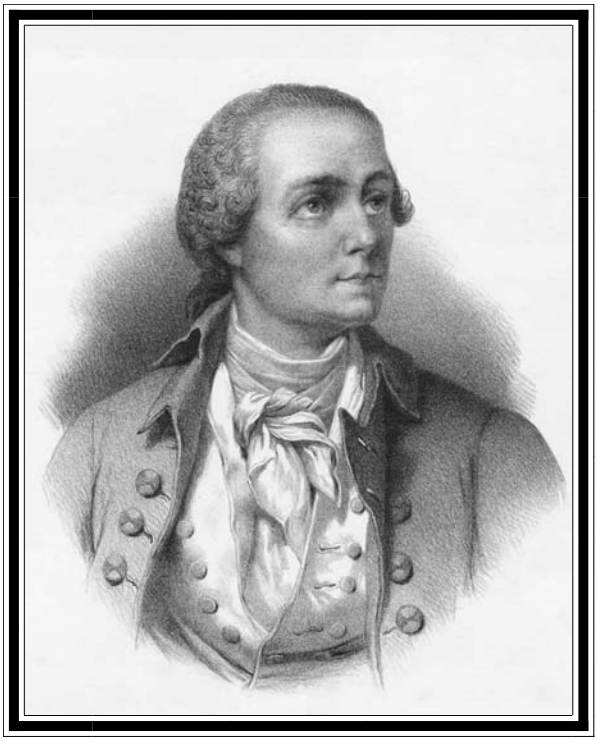
oxygen during photosynthesis accompanies the uptake of carbon dioxide. Senebier concluded (erroneously as it turned out) that in photosynthesis carbon dioxide is decomposed, with the carbon becoming incorporated in the organic matter of the plant and the oxygen being released.

Ingen-Housz considered Senebier's *Mémoires* to be "a copy of his own work from the evidence of the planning and sequence of the experiments performed, the eudiometric units used and the terminology." However, the acknowledged repetition of one scientist's experiments by another is not plagiarism.

NICOLAS-THÉODORE DE SAUSSURE (1767-1845)

De Saussure was a Swiss chemist, botanist and student of plant physiology who made seminal advances in phytochemistry. De Saussure sustained and added to the discoveries of Ingen-Housz and Senebier and proved that the green parts of plants take up and decompose a substance of the air at the same time that they assimilate water. His experiments on carbon assimilation are numerous and precise, and were presented with great perspicuity in his "Recherches Chimiques sur la Vegetation" published in 1804.

De Saussure found that the decomposition of carbon dioxide by green plant parts was a process necessary for the continued life and growth of the plant, but in addition he found that the carbon dioxide content of the atmosphere surrounding a plant might be increased, by artificial means, up to the point where it actually was injurious to the plant. Large quantities of carbon dioxide in the air were favorable adjuncts only if the plants were in condition to assimilate rapidly. After determining the amount of carbon appropriated by a plant, de Saussure found that the plant increased in weight by an amount out of proportion to the quantity of carbon fixed. Consequently, although he was of the opinion



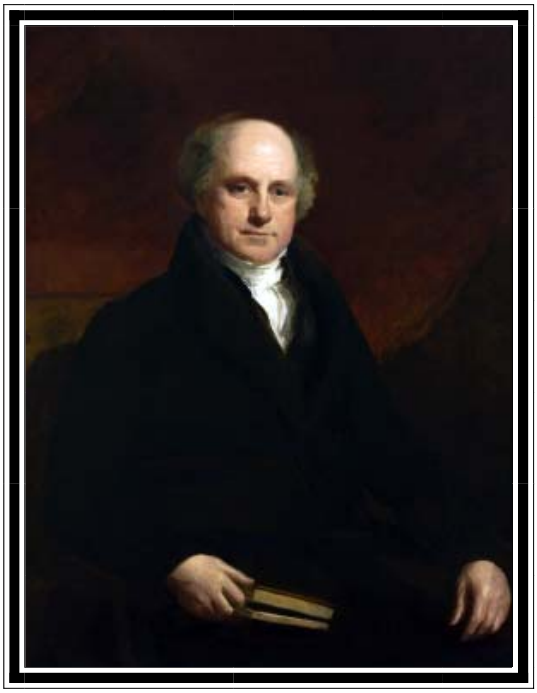
Nicolas-Théodore de Saussure (1767-1845)

that the great mass of the vegetative body was built up from the components of the atmosphere, it was clear that a part of the vegetable mass was derived from the fixation or utilization of the soil solution.

DANIEL ELLIS (1772?-1841)

Ellis - an army surgeon who later turned his career to a study of agriculture - was a contributor of articles on "Vegetable Anatomy" and "Vegetable Physiology" to the Encyclopaedia Britannica, 1815-24, In 1807 he published "An inquiry into the changes induced on atmospheric air by the germination of seeds, the vegetation of plants, and the respiration of animals," that summarized in some detail the prior work on photosynthesis and animals and discussed his own experiments on the changes in air from plants and animals. Ellis took issue with Priestley's conclusion that plants reverse the effects produced on the air: "However much, therefore, we may be disposed to admire the beautiful provision which this supposed reciprocity of action would establish between the functions of animal and vegetable life, we must suspend out belief in its truth until better proofs are brought forward than these experiments afford." Daubeny was later to prove that Ellis was wrong.

Ellis was one of the first to mention the requirement of oxygen in the water for the survival of fishes in a section of his book titled "Of the Changes induced on the Air by the Respiration of Insects, Worms, Fishes, and Amphibious Animals": "The same necessity of fresh air in the water in which they live, is required by aquatic animals. Zoophytes, according to Mr Davy, require the presence of air in the water in which they grow, and they act upon it like fishes The animalcules in pepper water remained *in vacuo* twenty-four hours and, being afterwards exposed a day or two to the open air, Mr Derham found some of them dead and some alive. Mr Ray remarked, that fishes cannot live in water without air: they will live in a vessel of water with a narrow mouth for months or years; but if the vessel be stopped, so as wholly to exclude the air, or interrupt its communication with the water, they will be suddenly suffocated. Dr Priestley confined several small fishes in a vessel, containing three pints of rain water, that had been previously well boiled to deprive it of its air, and they lived only between three and four hours. Mr Davy introduced a large thornback [i.e., a type of ray found in the coastal waters of Europe] into a jar containing three cubic inches of water, which had been deprived of its air by distillation through mercury: he was very quiet for four minutes and a half, but then began to move about, and, in seven minutes, had fallen on his back, but still continued to move his gills. In eleven minutes, he was motionless, and when taken out, after thirteen minutes, he did not recover."



Daniel Ellis (1772?-1841)

Charles Giles Bridle Daubeny (1795–1867)

CHARLES GILES BRIDLE DAUBENY (1795–1867)

Daubeny was a physician, chemist and botanist. One of his more important papers was published in 1836, "On the Action of Light upon Plants, and of Plants upon the Atmosphere," in which took a systematic survey of the leading facts ascertained by Priestley and Ingen-Housz, Senebier, Ellis, and especially Saussure's findings that the green color of plants - supposed to be connected with the decomposition of carbon dioxide - is produced most rapidly under the action of violet rays.

The careful series of experiments by Daubeny disproved the latter's findings. Where Priestley saw a counterpoise to the effects of animal respiration in the process of plants decomposing carbon dioxide and giving out oxygen, Ellis, however, did not and by a series of experiments attempted to establish his opinion. Daubeny showed that these experiments were flawed and agreed with Priestly. He also concluded that as a very small portion of a tree or shrub generates a very considerable quantity of oxygen, the action of plants in absorbing carbon dioxide and releasing oxygen serving as a complete compensation for reverse action of that of the animal kingdom.

Daubeny was a contemporary of Charles Darwin, a passionate scientist and a very wealthy man. In 1849, the Duke of Devonshire invited him to join a party of eminent botanists and horticulturists at Chatsworth House to come and see his *Victoria amazonica.* This was the first time that the Victoria water lily had flowered in England. As soon as Daubeny saw it he stated that he simply must have one and he returned to Oxford to build the Water Lily House and the tank (the building was 36 by 30 ft.; the tank, located in the center, was 27 by 21 ft. and was 12 ft. in depth). He suc-

Daubeny's study at the Daubeny Laboratory, Magdalen College, Oxford.

cessfully grew and flowered the Victoria in 1851 and then charged the people of Oxford a shilling to come and have a look. Unfortunately, the people of Oxford not only stayed away but also wrote aggrieved letters expressing their concern at paying to see just one single plant!

CONCLUSION

Based upon the work of these men who preceded the aquarium hobby, the goal finally was reached: "…the popular notion of an Aquarium being in all probability derived from those antiquated glass vessels of globular shape and narrowed upper extremity (upon which it would be well if the Legislature imposed a heavy tax as a prevention of cruelty to animals) in which gold and silver fish have been imprisoned, and the water has been changed at more or less irregular intervals! My present purpose is to show…what those experienced in these matters are perfectly well aware of, that the water of a well-managed Aquarium needs to be changed no more than does the soil of one's garden in which are grown vegetables and flowers" (Hughes, 1874).

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SOME NOTES ON FÉLIX DUJARDIN

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, November 17, 2012)

If you Google the phrase "In 1838, Félix Dujardin noted owning a saltwater aquarium, though he did not use the term," you will come up with about 35,000 hits. You'll also come up with 239 hits in French containing the phrase, "En 1838, Félix Dujardin annonce détenir un aquarium d'eau de mer, bien qu'il n'utilise pas encore ce terme," which is simply a translation of the English term.

Whoever came up with the term apparently didn't know that much about the aquarium hobby, since the term "aquarium" (in the fish tank sense) didn't come into being until about 1852 (Klee, 2012), so of course Dujardin didn't use the term. Furthermore, although the remark is tantalizing to the aquarium hobby historian who is trying to pin down "firsts," it leaves one wanting. One does not know what sort of aquarium was used, what animals and plants were contained within or where the original reference might be found for the statement.

Félix Dujardin.

In my paper, "Who Invented the Aquarium" (Klee, 2012), I quoted from an article written by the director of the l'Aquarium du Jardin d'Acclimatation (Rufz de Lavison, 1863) who included verbatim a note sent to him by Jean Louis Armand de Quatrefages de Bréau (1810-1892), a well-known French naturalist who maintained that Dujardin should be credited with the discovery of the marine aquarium. Quatrefages briefly noted that starting in about 1838, Dujardin had kept marine animals alive in jars containing water lettuce (*Ulva*) for long periods of time without resorting to either aeration of water changes. He specifically mentioned that he had observed living jellyfish in Dujardin's jars.

At the time covered by my Invention article, the explicit definition of an aquarium was "animals + no aeration or water changes" or implicitly, "animals + aquatic plants" since without aeration or water changes, the only way to keep animals alive in a container of water was to use aquatic plants. The term "animals" was deliberately vague. It is important to note that one of the requirements for being "first" was publication, a requirement that holds even to this day in this and other fields.

Quatrefages's description of Dujardin's accomplishment, however, does not satisfy the publication requirement. To see whether the claim is valid, therefore, we must examine

ZOOLOGICAL PAPERS OF FÉLIX DUJARDIN		
40.	"Observations sur les Eponges," *Soc. philom*., p. 81,1838. *L'Institut,* no. 234,1838. *Comptes-rendus,* VI, p. 676, 1838.	Marine sponges
41.	"Observations sur les Eponges et en particulier sur la Spongille ou Eponge d'eau douce," *Ann. sc. nat.*, (2), X, p. 5-13, 1838.	Freshwater sponge
42.	"Observations sur un nouveau genre de médusaire provenant de la métamorphose des Syncorynes," *Comptes-rendus,* XVI, p. 1132, 1843. *Ann. sc. nat*., (2), XX, p. 370, 1843.	Jellyfish
43.	"Mémoire sur le développement des Méduses des Polypes hydraires," *Ann. sc. nat.,* (3), p. 257,1845. *Comptes-rendus,* p. 1273, 1845.	Jellyfish
44.	"Mémoire sur la Comatule de la Méditerranée," *L'Institut, Journal des Académies et Sociétés Scientifiques de la France et de l'Étrange,* v3, no. 119, p. 268, 1835.	Echinoderm (Crinoids)
45.	"Mémoire sur un Ver parasite (*Albertia*) constituant un nouveau genre voisin des Rotifères et sur les Systolides ou Rotateurs en general," *Ann. sc. nat.,* (2), X, p. 175, 1838.	Rotifers
46.	"Sur les Systolides ou Rotifères," *Annales françaises et étrangerès d'anatomie,* III, pp. 85-88,1839.	Rotifers
47.	"Mémoire sur quatre nouvelles espèces d'Annélides marines dont l'une a le sang vert," *Comptes-rendus,* VII, p 648,1838. *Ann. sc. nat.,* (2), p. 288, 1839.	Echinoderm (Marine worm)
48.	"Description du *Rhipistes,* nouveau genre d'Annélide d'eau douce et de plusieurs Acariens marins et d'eau douce," *L'Institut,* no. 254, p. 316, 1842.	Echinoderm (Freshwater worm)
49.	"Note sur une Annélide (*Exogone pusilla*) qui porte à la fois ses œufs et ses spermatozoides," *Ann. sc. nat.,* (3), XV, p. 298, 1851.	Echinoderm (Marine worm)
59.	"Observations zoologiques. 1° Sur un petit animal marin, l'Echinodère, formant un type intermédiaire entre les Crustacés et les Vers," *Ann. sc. nat.,* (3), XV, p. 158, 1851.	Echinoderm

Dujardin's publications. Life is made easier here since a complete set can be found in Joubin's lengthy (61 pages) biography of Dujardin (Joubin, 1901).

Joubin lists 96 papers and classifies them so it is necessary only to examine his zoological papers that I have listed in the accompanying table. I have added the last column to identify what animals were being discussed in each.

Since it is Johnston's paper of 1842 that currently is the basis for the title of the first marine aquarium, sans fishes, it is necessary only to examine the six papers whose number I have boldfaced in the table. However, I did examine papers 42 and 43 since they relate to the jellyfish mentioned by Quatrefages.

Regarding the first paper (42), the following is my translation of some relevant parts:

"For several years I kept in a large number of jars of algae and marine animals from different localities, each of which is the subject in a series of carefully recorded observations.

"In July of 1841, in jars of seawater from the Mediterranean that I maintained since March 1840, I saw for the first time on the walls of a small neighboring zoophyte, Syncoryne, the formation of a filamentous stem, its thickness one-fifth of a millimeter and covered with a horny envelope, throwing off a few branches here and there, each terminating in a small club-shaped head. Around the bulge of the head were four arms arranged in a cross with perfect regularity and it is these that I propose to use the name of Stauridie for to designate the larva of the jellyfish."

Regarding the second paper (43), the following is my translation of the relevant part:

"As I related in a previous paper, in 1843 I was led to the comparative study of polyps and jellyfish by observing them kept alive for several years in a small jar filled with seawater. I dealt with any excessive evaporation and maintained the same specific gravity. The walls of these bottles were gradually entirely covered with small algae, infusorians, protozoa, annelids and polyps, and these animals became acclimatized, adapting themselves to these changes in the environment; under these conditions I have observed very young mussels keep the same size for three years."

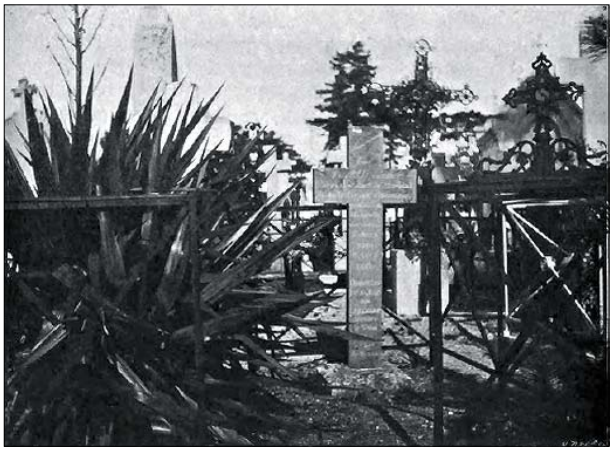
Thus we have from Dujardin himself the fact that he kept marine aquaria (sans fishes), but since both of these papers were published after 1842 it is necessary to example the six boldfaced papers in order to determine priority.

Publication 40 is quickly dealt with since it is a short note stating "…that these ambiguous beings [i.e., sponges] that wandered far from the plant kingdom to the animal kingdom, are actually groups of animals…" No reference is made to keeping them in aquaria.

Publication 41 can also be discarded since it deals with freshwater, but I'll take a detour here because it is interesting in a historical sense. By way of background, Spongilla is a genus of freshwater sponges found in lakes and slow streams. They attach themselves to rocks and logs, and filter the water for various small aquatic organisms such as protozoa, bacteria, and other free-floating pond life. The also tend to cover the cases of caddis-fly larvae. The following is my translation of the relevant portion of the paper:

"The Spongilles gathered from the Seine in the following October exhibited the same phenomena, especially in that the filaments were more clearly flagelliform. In May, as the water began to deteriorate by putrefaction, I developed doubts about the existence of these filaments in very fresh Spongilles. I thought there could have been monads producing filaments or at least altered sponges so I resolved to wait until spring to study Spongilles again since I was sure to find nascent cases on the larvae in the caddis fly pond. One should be aware how quickly sponges corrupt the water in their jars and the difficulties I encountered in keeping them alive for even five or six days, so I could not help but be surprised hearing Mr. Gervais announce that he revived dried Spongilles by placing them in water. I often saw all my Spongilles dead within twenty-four hours, thereby losing the opportunity to observe them. I finally was

Dujardin's home (left), next to the church of Saint Helier.



The tomb of Félix Dujardin.

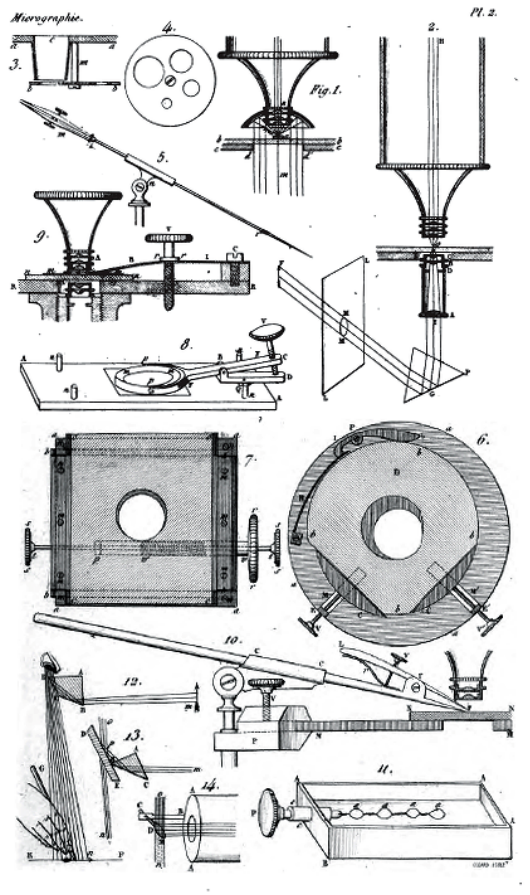
able to keep them using only two or three caddis fly cases that hosted the Spongilles. The Spongilles would them emerge in each jar filled with water and lots of aquatic weeds, They were placed in shallow bottles at home because in the pond where they live, they always chose their habitation site on the cases of the caddis fly larvae that were near the surface."

I find this interesting since this shows that Dujardin was one of the first who kept a freshwater aquarium (sans fishes). However, as I have shown in my "Who invented the aquarium?" paper, des Moulins preceded him by eight years for this honor. This leaves papers 45 to 47. Paper 45 can be ignored since Quatrefages states that Dujardin didn't start his aquaria until 1838 and Quatrefages should know as he was a close friend; indeed, Quatrefages, Dujardin and Louis Michel Français Doyère (a French zoologist, 1811-1863) formed a small group in which they discussed their scientific observations, exchanged information about their current work and discussed their future projects. Curiously, in every one of their letters they included in large print a sort of password for authentication, i.e., "we will see"! Unfortunately, Doyère fell out of favor with Quatrefages, whose relations with Dujardin then chilled and later was further stressed by a dispute over priority in later years. Quatrefages, however, always defended Dujardin when it came to considering who was the first to maintain a marine aquarium.

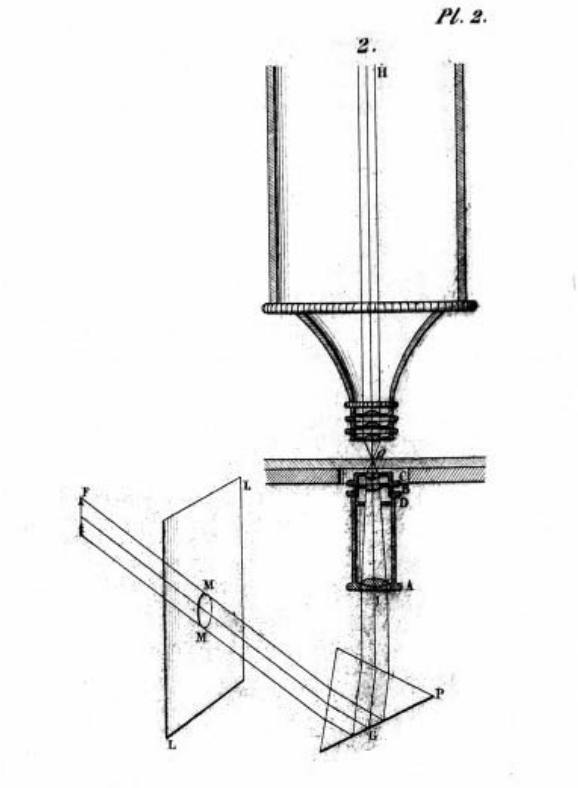
I have examined papers 45, 46 and 47 but find no discussion of keeping the animals concerned in aquaria; their contents generally describe new species, document anatomical details or devise new classifications.

Dujardin is primarily known for his work with microscopic animal life, and in 1834 proposed that a new group of one-celled organisms be called Rhizopoda (meaning "root-foot"). This name was later changed to Protozoa. In 1835, he disproved Christian Gottfried Ehrenberg's hypothesis that microorganisms have the same organs as the more complex animals. Also in 1835, he was the first to describe protoplasm, the jellylike material in animal cells which he called "sarcode," from the Greek word meaning "flesh" (Hugo von Mohl is credited with introducing the name protoplasm for it in 1846). This substance, now called cytoplasm, was later found in living plant cells. Although the term protoplasm is rarely used any more in a strictly scientific sense, many of the notions associated with the term have survived. He also considered the then disputed question whether sponges were animals or plants, and concluded in 1838 that they were animals, which is what they are considered today.

It is interesting to note that both Dujardin and Warington were interested in microscopes and made improvements to them, Warington even inventing a microscope that bears his name. Among his improvements to the microscope, Dujardin was the first to use an achromatic substage condenser and in 1843 wrote a book, "Nouveau manuel complet de l'observateur au microscope" [New Complete Manual for the Microscope Observer]. Warington's object was to provide an arrangement whereby the compound microscope could be brought to bear upon living objects in an aquarium, when these might be either in contact with one of the glass sides or be not far removed from it. This he accomplished by making use of the body of a Student's microscope, with the grooved limb in which it slides, and attaching the latter by a strong cradle-joint to a tubular stem that could be fixed at any height upon the edge of the table that supports the aquarium, by means of a clamp with a binding screw.

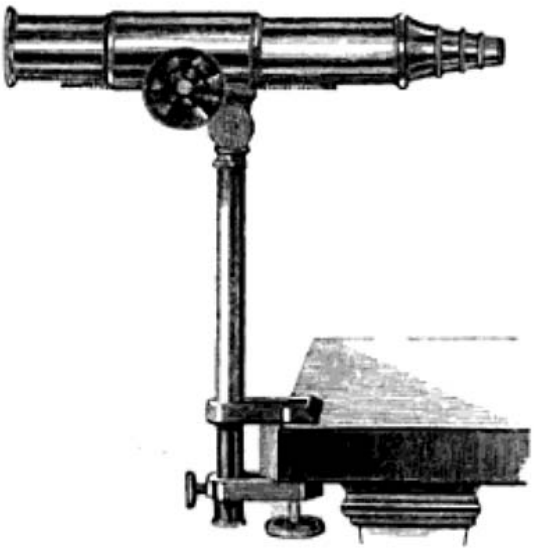


A page from Dujardin's "Nouveau manuel complet de l'observateur au microscope."



Dujardin's achromatic substage condenser.

Dujardin's education at the École Polytechnique was in mathematics, not zoology, a subject that was later self-taught. His criticism of Ehrenberg's theory earned him many insults and the disdain of famous men in the field who objected to this unknown young man who attacked the universally accepted and officially taught ideas of the day. The fact that he was proven right only added to the discomfort of this ménage of self-centered and pompous academics. Having neither an important academic position nor fortune, he was forced to write in journals in order to implement his small salary to support his family and raise his two children.



Universal Microscope, arranged for viewing objects in an aquarium.

For about nine months in 1849, Dujardin spent the time away from his family in order to complete some of his research in peace and quiet. His biographer (Joubin) writes:
"Seeking quiet and not to be disturbed by any annoyances, he settled on the outskirts of Rennes in a little old house, then in the countryside, one rather more like a farmhouse than a dwelling for a scientist. He had a fairly large garden, a large room on the ground floor and a fairly large kitchen. Living there as a hermit, he probably felt that the kitchen and its dishes were completely useless, so he transformed the ground floor into an aquarium; plates, glassware and jugs used to contain cultures where he had (the word is his) infusorians and rotifers, were sorted out so as to have each species in its own tank. All of this was in admirable order; his notes, veritable journals of the aquarium that unfortunately I found only in fragments, attest to the meticulous care with which these vessels were numbered and the experiments conducted. Nevertheless, Dujardin, jealous guardian of the sanctuary, sometimes consented to let in a few neophytes; the Canon Hodé [a vicar of the parish of Saint Helier, frequented by Dujardin; he also had a passion for the natural sciences] was among them and it is from him that I have these details. He was not alone. I have already stated that Dujardin held a deep place of affection for his family in his heart. A niece told me that when she was six or seven years old, she sometimes was allowed to accompany her uncle into the mysterious kitchen when she was a good girl, but could not let go of the hand of the scientist who ensured that an indiscreet finger, dipped in one plate and then another, never came to affect the purity of these so painstakingly selected cultures."

During his entire life, Dujardin endured the greatest of difficulties - jealousy and injustice. The construction of experimental apparatus, the purchase of books and the publication costs of his work absorbed most of his income. Nevertheless, when at a distance of century and a half we take a detailed look at his work, one recognizes all the scientific progress for which we are indebted to him. He not only was one of the greatest scholars of his century, but a man in the highest sense of the word.

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AQUARIST EXTRORDINAIRE—PIERRE CARBONNIER

by Albert J. Klee, Ph.D.

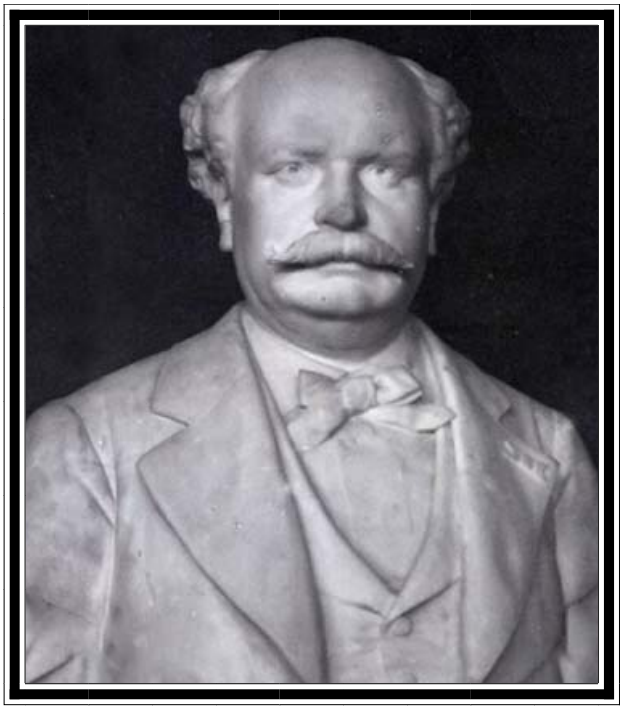
(Aquarium Hobby Historical Society, Yahoo Files, December 15, 2012)

Pierre Carbonnier was born on August 7, 1828 in Bergerac, the son of Pierre and Marie Andrieu. The third child in a family of 12, he married Josephine Flusin Zelie in Paris in 1857. He began his career in Marseille where he occupied himself with fish farming, befriending some well-known naturalists along the way. His "Guide Pratique du Pisciculteur" ("Practical Guide to Fish Culture") was published in 1866 and soon he acquired a respected name of his own.

He settled in Paris in 1855 and founded one of the oldest retail houses in Paris marketing fish, aquarium plants, aquariums and outdoor pools. He also built a fish farm on the Quai de Mégisserie. In 1869, Carbonnier began raising exotic fish, notably the Paradise Fish (*Macropodus opercularis*) brought from China in 1869. In 1874 he imported all sorts of anabantids including different species of gouramis such as the giant gourami (*Osphronemus goramy*) and the banded gourami (*Trichogaster fasciata),* the betta (known in France as the poisson combatant), the Climbing Fish (*Anabas scandens*) and the Spanish Killifish (*Valencia hispanica*), breeding most of them and writing about his experiences, mostly in the *Comptes rendus de académie des Sciences* (*Proceedings of the Academy of Sciences*) and the *Bulletin de la Société d'Acclimatation* (*Bulletin of the Society of Acclimation*). The latter was formed for the purpose of acclimatizing, domesticating and breeding newly introduced exotic animal species, either useful or ornamental, and later the goal of protecting these exotic species and their habitats was added as well. It is considered the oldest association for nature conservation in France.

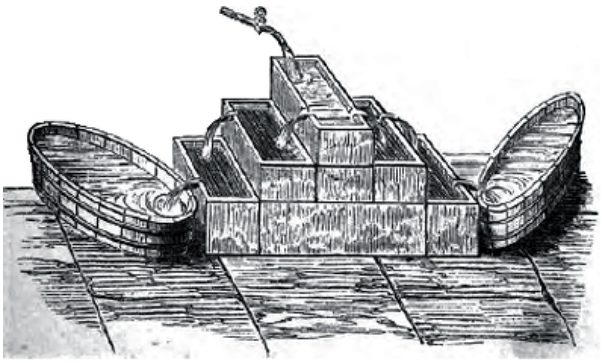
He also bred sunfish and blue gills imported from New York, the catfish *Corydoras paleatus* imported from Argentina, the Canadian Silver Bass [i.e., the freshwater drum, *Aplodinotus grunniens*] and goldfish such as the telescope.

For his work in improving the fish population in Spain, he was awarded the Order of the Knight's Cross in 1870 and becames the "Chevalier de l'Ordre de Charles III d'Espagne." At the International Exhibition of



Pierre Carbonnier (1828-1883).

Note: Any text in square brackets, whether in the text, bibliography or appendices are explanatory notes or updated scientific names provided by the author, not Carbonnier. Fish names and identifications have changed radically since the 1800's, and customs, terminology and situations might not be easily understood today.



An illustration from Carbonnier's 1864 book, "Guide Pratique du Pisciculteur."

river and maritime industries opened at the Palais de l'Industrie in Paris in 1875, he won the Gold Medal for his studies of freshwater aquariums and introduction of exotic fish species. In 1878 he directed the Aquarium du Trocadero, which was one of the main draws of the Exposition Universelle (the Third Paris World's Fair), which celebrated the recovery of France after the 1870 Franco-Prussian War. As a result, he was made a Chevalier of the Legion of Honor.

Carbonnier was an avid naturalist and a good man, noted for his kindness and dedication and who treated his fish with fatherly tenderness. His articles - models of keen observation and judgment - on the transport of live fish and on the reproduction and development of the nest-building fishes have repeatedly drawn the attention of aquarists, naturalists and scientists alike.

CARBONNIER'S HOME AQUARIUM

The last chapter in his Guide Pratique du Pisciculteur concerns the home aquarium. As it is quite lengthy, I have reproduced it (translated) in Appendix I. It is interesting to note that Carbonnier was aware of the origin of the word "aquarium" from the world of gardening (for further details on this subject see my article,

The "Maison Carbonnier" from a wood engraving by E. Chevalier in an article in *La Chasse Illustrée*, 1874.

Carbonnier (center) and two Russian aquarium pioneers, Solotnizki and Merschinski.

"Who Invented the Aquarium?" in Klee, 2012). He also advocated partial water changes and provided information about aquarium construction and their costs in his time, how many gallons of water were required per fish, what fish to include in the community tank and what to avoid.

Carbonnier claims the credit for inventing the flat-sided aquarium, pointing out that he built the first flat-sided tank ten years before the book was published, which was in 1864. Even allowing that he actually wrote the text two years prior to its publication in 1862, this would mean that he built the first such aquarium in 1852. However, Warrington provided a sketch of his flat-sided aquarium in a January 1852 gardening publication (Klee, 2012) and so clearly has publication priority. This was a somewhat obscure publication, so I conclude that Carbonnier was not aware of it at the time.

BREEDING FISHES

Carbonnier is probably best known in the aquarium hobby for his work on breeding the Paradise fish and the South American catfish, *Corydoras paleatus*. Because this is seminal material, I have placed his first articles on both in Appendixes II and III, respectively.

In the course of doing the research for this article I frequently came across the following two quotes (or modifications of them): **"The paradise fish is a true aquarium staple, having famously been introduced to the hobby by a French soldier named Gerault way back in 1869. Of the initial 100 specimens shipped, 22 survived and were successfully bred later that same year by another Frenchman, the Parisian Pierre Carbonnier,"** and **"First European import: 1869, France, by Gerault, a French officer. He was ordered to bring 100 *Macropodus opercularis* to France by the French consul in Ning-Po, Simon. 22 fish survived the trip, and 17 were delivered to the famous breeder Pierre Carbonnier in Paris, who bred them in the same year."**

The problem with these statements is that Géraud was not a French soldier but an officer aboard the steamship *Empress*; 22 fish were shipped, not 100, and all 22 survived the trip. Only 17 of the fish were *Macropodus opercularis*, however; among the other five included two types of anabantoids, (including the betta) and a loach; and it was Eugène Simon, the French consul, who was responsible for bringing the fish to Paris (Géraud was not "ordered to bring 100 fish to France"; he only assisted Simon during the trip). The true account of how the Paradise fish got to France can be found in Appendix II.

Another error I came across involved Paul Carbonnier, who assisted Pierre Carbonnier in the importation of many of his fish species. Paul Carbonnier has often been described in the British and American scientific literature

as Pierre Carbonnier's "father." The problem is that someone (or more than one and it was copied) translated the French word "parent" as the English word "parent" (in his article, "Nidification du poisson arc-en-ciel de l'inde," for example, Carbonnier refers to "mon parent, M. Paul Carbonnier") and since it is clear that Carbonnier's mother was not involved in this assistance, "parent" was reduced to "father."

However, "parent" in French can also mean family member, relative, relation or kinsman as well. In point of fact, Paul Carbonnier was really Carbonnier's nephew; indeed the term, "mon neveu" ("my nephew"), was used later in the cited article.

In any event, Carbonnier reported additional observations on the spawning of the Paradise fish the following year in "Nouvelle note sur un poisson de Chine appartenant au genre Macropode" ("A new note on a Chinese fish belonging to the genus *Macropodus*").

One species he bred might just be one of the earliest of the exotic killifishes bred in the hobby, i.e., *Valencia hispanica*, and since it is short I reproduce here (translated) his observations in their entirety from his 1881 paper, "Reproductions de poissons exotiques":

"A few years ago, one of our colleagues in the Société d'Acclimatation, Mr. Graells, a Spanish naturalist, notified me of the existence north of Barcelona, in freshwater pools where sometimes the Mediterranean ebbs, small fish from 2 to 2-1/2 inches long of the genus *Cyprinodon*, and I thought its study could offer a great scientific interest.

Valencia letourneuxi

"I then wrote to Mr. Ventrillon, the French designer attached to the great industrial firm, l'Espagne of Spain, directed by our colleague, Dr. Joseph Muntadas, if he would be so kind as to bring me some of these small fish on his next trip to France.

"In September of 1878, Mr. Ventrillon arrived in Paris with eight Cyprinodons but three died shortly afterwards. I had only four males and one female fish, which during the summer of 1879 provided me with fourteen small fry. These in turn have reproduced a few months ago and my group of fish now is thus increased by fifty new specimens similar to those which I have the honor to place before your eyes.
"I reserve for a future communication, to acquaint you with the singular mode of reproduction of this interesting species, until I have followed up and observed them again."

Unfortunately, Carbonnier died less than two years later before he was able to provide the promised details.

Another article I have added to the Appendices (Appendix IV) is Carbonnier's account of the importation and breeding of the Giant Gourami, *Osphronemus goramy* ("Le Gourami et son nid"). I do this because its spawning differs somewhat from that of the Paradise fish and Carbonnier describes it in minute detail; also, it is an example of the interest the *Société d'Acclimatation* had in importing tropical fish and exploring the possibility of adapting them to the climate of France and/or its colonies. Carbonnier discusses this issue and offers his opinion on the probability of success.

Anabas testudineous

Lastly I include a portion of the note Carbonnier sent to the Society ("Importation de poissons exotiques: Anabas, poissons combatants [i.e., bettas], gouramis") regarding two of three shipments made to him of *Anabas*, the Climbing Perch:

"The first shipment consisted of forty-four Anabas collected in the waters of Calcutta by Monsieur Paul Carbonnier, and he reported no loss during its journey to Wales. Having been entrusted then to the care of Mr. Ozias, the second engineer aboard the *Hoogly*, forty-two of these fish arrived alive and I have not had a single death since. In his letter, Monsieur Paul Carbonnier writes that he often encountered these fish in numerous groups, several hundred meters from the river, crawling on the ground and doing well in overland travel.

"Some travelers have even claimed that these fish climbed up trees, but this needs to be confirmed. Nevertheless, on the ground they employ some very singular motions; the posterior part of the body and tail follow a sequence of movements, the consequence of which is to propel the body forward. Its huge gill covers, open at this time, are armed at their base with strong sharp serrations firmly inserted into the ground to prevent any movement backwards. It uses both pectoral fins to maintain its balance; seals do not crawl better on the ground than this fish. But what is most remarkable about them is their method of breathing, in which they seem to take only atmospheric air. In water, its mouth is always closed except to eat and the gill covers, which have a thin membrane lining the inside of the body, move only slightly. Every few moments the fish rushes to the surface to renew the air bubbles that are transported to its pharyngeal cells; in this it behaves like the Gourami, Macropode and the Arc-en-Ciel [i.e., *Trichogaster fasciata*], a breathing pattern I described to the Academy of Science in a note of February 1874. The Anabas reaches a weight of 14 to 17-1/2 ounces and is very good to eat. In India, the natives give the flesh of this fish high marks.

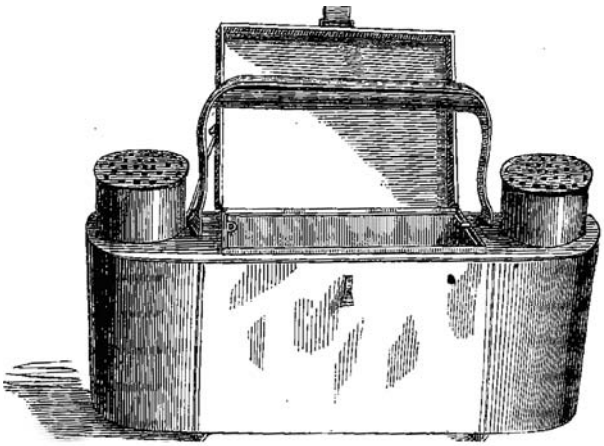
"The third introduction was an experiment. Twenty-two Anabas and six Gouramis were sent from Calcutta to Wales by Monsieur Paul Carbonnier to me in a transparent container; the water was not changed en route and no one cared for the fish during transport. Ten Anabas and three Gouramis arrived live in Marseille on August 1 and in the same container were the skeletons of those who died en route. This is important since it provides evidence that all fish belonging to the labyrinthiforme group can take in oxygen for breathing directly from the atmosphere. Those who died on route from Wales to Marseille probably died of hunger. What makes me certain that this is the explanation of what happened on the way to Marseille is that it corresponds to that of our valued friend, Monsieur Chevalier."

TRANSPORTING FISHES

Early on Carbonnier was not only receiving shipments of fish from contacts in China and India, but was importing the as well. The following is his note to the Société d'Acclimatation ("Du transport des poissons," 1871):

"I take this opportunity to let you know of the promising success I have achieved in sending freshwater fish of our country to America, Egypt, and Algeria.

"A few weeks ago, the two sons of the President of Republic of Peru told me that of a hundred fish that I had sent the previous year, thirty-eight had arrived alive and had



Carbonnier's apparatus for Shipboard transportation.

been bred in quantity. In exchange for this activity an hoping to bring to France a new species of fish, I always look for some kind of reciprocity.

"For a long time I did not receive anything in return. However, three months ago, Mr. Godillot, a merchant in New York to whom I had sent some of the interesting Macropodus that I'll take the opportunity to report on soon, promised to try shipping fish from North America.

"Finding in Mr. Godillot a Frenchman devoted to his country, I sent him transport instructions together with a special device. This device left Le Havre on the transatlantic liner St. Lawrence on August 8th, and was sent back to me on the same ship a month later.
"Starting out from America with about fifty fish, twenty-eight arrived alive. I still have all of them, and I must add, that under the influence of a lot of suitable food, the abdomen of a number of females is inflated, which makes me hope that I will be able to breed them.

"You can count on this species Messieurs, as the climate of New York differs little from that of our country, What is unfortunate is that these new minnows are not likely to exceed the size of that of a gudgeon, but judging by appearances, they should make excellent fries. I have just been advised by Monsieur Godillot that he will be sending me a new species in the same device. [Note: The "minnows" sent from New York were *Fundulus* (probably *heteroclitus*). In France, it was common for the local minnows to be fried up as a meal.]

"The issue of transport of live fish is quite complex. When it comes to sending them over large distances, there have been so many failures proceeding by trial and error. Nevertheless, the results can help point us to the correct way to ship fish. Here are some of the conclusions that can be made.

"If one keeps fish used to living in strong light for several weeks in dark containers, fungal threads grow and cover their scales and fins, killing them in a few days.

"On the other hand, fish living in deeper waters, or living mostly hidden under stones, transport very well in the dark, especially when the water is changed twice a week. This change of water is most necessary because without light, it becomes polluted in a few days. At 68 to 77 degrees, microorganisms abound in forty-eight hours in less well-lit waters.

"Well nourished, healthy specimens, 2 to 2-1/2 inches in length should be selected for transporting. Prior to this, keep them in pure water so that they finish digesting all their food (twenty-four hours is usually enough time). If the travel does not exceed one month, withhold any food during this time. Each fish must have at least a quarter of a gallon of water, renewed when possible. Lacking special equipment, glass and terracotta vases with large openings covered with a cloth that permits air to pass through are preferred for the air breathing fish; for the others any container may be used.

"There are cases, in long voyages, for example, when feeding becomes necessary, and one is sometimes advised to provide farina or hard egg yolk. One must be careful using these materials, since I am sure was the main cause of our failures. A fish in such a greasy container from the flour and egg yolk, will died asphyxiated in less than a day.

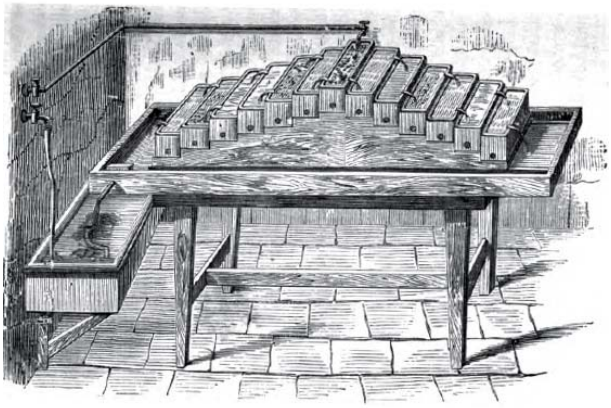
"Despite the restrictions aboard ship, there are always resources that can be taken advantage of, e.g., flies, mites, cheese, small bits of meat; this is the kind of food that should be given. It is essential that all food uneaten by the fish is removed a few hours later.

"It is through these means and these special precautions, such as my instructions, that I have succeeded and have the honor to provide you with an example of the arrival of an American fish in France.

"The device I built for the transportation of live fish over long distances is made of tin in the form of a basket slightly compressed on its two lateral faces, It is 16 inches long, 6-1/4 inches wide and 6 inches high, and contains about 2.6 gallons of water. A hinged handle placed in the upper part allows easy handling. It is very portable and one person can easily carry it around.
"On the upper side there is a frame 8 inches long by 6 inches wide, containing a pane of glass. The glass is held in place by pins and can be removed to allow cleaning of the insides or extra ventilation for the fish. A hinged, polished tin lid covers the whole transparent portion of the device; when open it serves as a reflector and can be tilted at different angles to provide varying amounts of light to shine on the surface of the water.

"At each end of the apparatus there is a wide-mouth bottle with a lid pierced with ventilation holes. One of these openings is used to introduce water and fish; in the lid of the second neck is welded a cylinder wire mesh, 5 inches long, with a hole at its base. This cylinder is designed to hold charcoal, immersed in the water, to maintain it in a good state of purity. To protect the fish from the rough surface of the wire, a perforated partition was established in the interior.

"A small zinc armature, fixed to one side of the device, prevents rusting of the tin, and at the same time neutralizing or considerably slowing the production of microorganisms. The physiological cause of the slowdown that



Another illustration from Carbonnier's 1864 book, "Guide Pratique du Pisciculteur."

I have often seen in the growth of microorganisms in an environment where there is a low emission of electricity and a little hydrogen production, deserves the attention of qualified specialists.

"These are the basic details of the conveyance; it facilitates continuous monitoring of the fish and provides the necessary hygienic conditions that they require during the transport."

Carbonnier provided much practical advice in this short note regarding preparation of the fish before shipping, feeding them (or not) during transit and how much water was needed per fish. His observations on the differences in transporting fishes that lived in well-illuminated waters versus those that preferred darker were unique. Carbonnier was innovative at the time in the use of charcoal to purify the water when artificial aeration was not available, and although the purpose of the zinc in his device was primarily to stave off the rusting of the tin, he observed that it also reduced the population of harmful microorganisms. He was also careful in protecting the fish from the rough wire mesh used to hold the charcoal. In the long run, of course, it was the so-called "German shipping can" (so-called because the original concept was developed by Frank Buckland) that won out over Carbonnier's design.

SPECIES	MOST LIKELY DEPTH RANGE OF THE FISH, METERS, AT VARIOUS TEMPERATURES							
	25 DEGREES		20 DEGREES		15 DEGREES		10 DEGREES	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Ablettes.....	0,80	1	0,50	1	0,25	0,75	0,10	0,75
Aloses.....	1,50	2	1	2	1	2	0,50	1,50
Anguilles....	1	2	1	2	0,75	1,50	0,50	1,50
Barbeaux....	1,50	2	1	2	0,75	2	0,50	1,50
Brèmes.....	1,50	1,75	0,75	1,50	0,50	1,50	0,25	1,50
Brochets....	0,50	2	0,25	1,50	0,25	1,50	0,25	1,25
Carpes.....	0,25	2	0,25	1,75	0,25	1,50	0,25	1,50
Chevannes...	0,50	1,50	0,10	1,50	0,10	1,50	0,10	1,50
Chabots.....	1	1,50	1	1,50	0,50	1	0,25	1
Épinoches...	0,25	1,50	0,25	1,50	0,25	1,25	0,25	1
Goujons.....	1	1,50	1	1,50	0,50	1,50	0,25	1,50
Loches.....	1	1,50	1	1,50	0,50	1	0,25	1
Lottes.....	2	3	2	2,50	1,25	2	1	2
Perches.....	0,50	1,50	0,25	1,50	0,25	1,25	0,25	1
Saumons....	0,50	1,50	5	10	1,50	3	0,50	1,50
Truites.....	0,50	1,50	5	10	1,50	3	0,50	1,50
Tanches.....	0,50	1,50	0,50	1,50	0,50	1,25	0,50	1
Vairons.....	0,75	1,50	0,50	1	0,25	1	0,25	0,75
Vandoises...	1	1,50	1	1,50	0,50	1	0,50	1

Carbonnier's table showing the preferred water depth of various species of fishes as a function of water temperature.

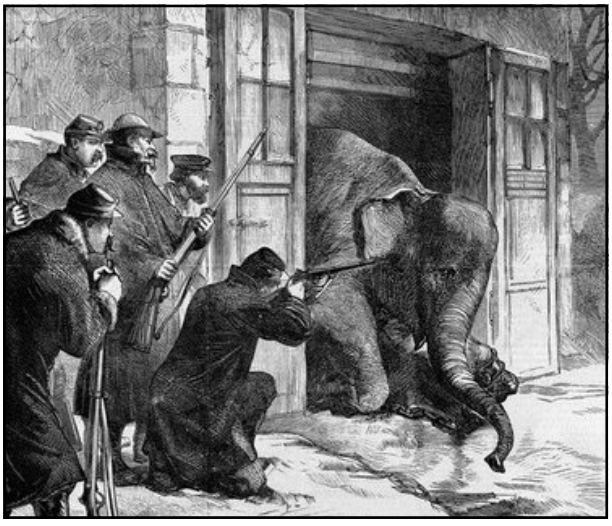
THE EXPERIMENTER

Over the years, Carbonnier put together a table showing the range of depth a particular species of French fish would be found as a function of the temperature of the water. He used this information to explain the spawning and post-spawning behavior of fish in his 1873 article, "De l'influence de la pression extérieure sur la vie des poissons" ("The influence of external pressure on the life of fishes"). This was also published in the Danish journal, *Nordisk Tidsskrift Fiskeri*, a year later ("Om det ydre tryks inflydelse paa fiskens," 1874).

THE FRANCO-PRUSSIAN WAR

In his "Le Macropode de Chine" ("The Macropode of China"), published in 1872, Carbonnier describes the terrible times he experienced during the Franco-Prussian War. Often referred to in France as the War of 1870 (actually July 1870-May 1871), it was a significant conflict between the Second French Empire and the Kingdom of Prussia aided by various German states. The war and its resulting German victory brought about the unification of Germany and the shifting of the balance of power in Europe. In France it led to the downfall of Napoleon III and the end of the Second French Empire, followed by the French Third Republic, which continued resistance in the war with newly formed armies, and ended with the Paris Commune uprising of 1871.

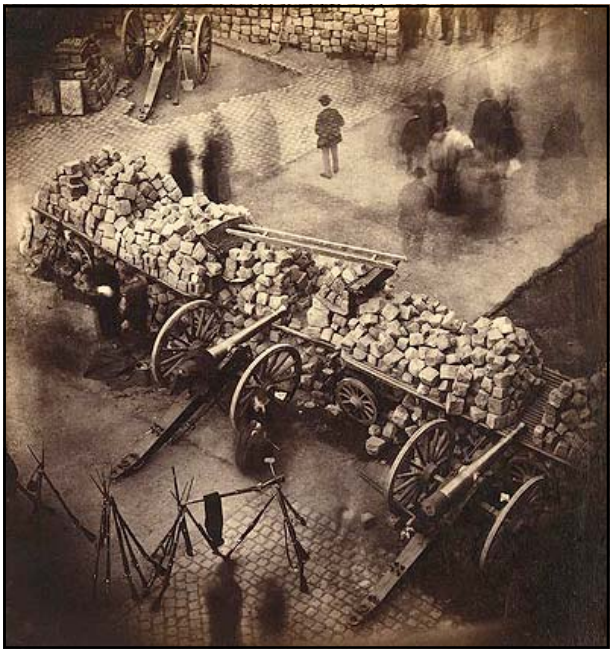
The Siege of Paris (19 September 1870 – 28 January 1871) brought about the final defeat of the French Army. The bombardment lasted 23 days, usually two to five hours each night. Dogs, cats and rats were frequently eaten. The animals of the zoo were added to this diet, including Castor and Pollux, the two elephants that



Parisians shooting an elephant for food at the Jardin des Plates, Paris, in 1871

were the pride of Paris. Only the lions, tigers, and monkeys were spared; the big cats for the difficulty of approaching them, and the monkeys because of "some vague Darwinian notion that they were the relatives of the people of Paris and eating them would be tantamount to cannibalism." On 18 January, with Paris starving, German troops occupied the city and the new German Empire was proclaimed at the Palace of Versailles.

The Paris Commune was a government that briefly ruled Paris from March 18 to May 28, 1871 and included a high proportion of skilled workers and several professionals, but also anarchists, socialists and Marxists. It was not surprising therefore that many of its decrees were controversial. Carbonnier, of course, was certainly not a fan of the Prussians, but he wasn't particularly fond of the Commune, either. The following are excerpts from his article:



Barricades set up by the French during the siege of Paris, 1871.

"When the bad times came and the Prussians enclosed us in their circle of iron and fire, I had in my possession, in addition to my twenty adult pairs, about seven to eight thousand fry of various ages. But, alas, this unexpected success came with terrible worry and suffering! I will not attempt to tell you the whole story; suffice it to say that water was more essential for me than any other element, followed by gas since in my shop all the lighting and heating was supplied by gas. Soon both the water and gas supply was cut off and all winter long I had to send my students to the Seine to bring back water for fish. I had to burn everything in sight to revive and save them from freezing. In the seven days of the week, four days was spent in this ceaseless work; the other three I spent on the ramparts when I was called to duty.

"But despite all my efforts, I could not supply the fish with sufficient food; in vain I shared my meager portion of horse meat with them. My losses were large and the mortality struck both the slow and the young mercilessly, but the strongest of them resisted everything and

The Rue de Rivoli after the Siege of Paris, 1871.

Pierre Carbonnier, 1828-1883

when the day of deliverance came - when I was finally able to feed them sufficiently - they were, so to speak, resurrected and I wound up with about two thousand strong and healthy fry.

"Along came the Commune, this time to satisfy their dual desire of ordering me to comply with the orders of the insurgent government, and to take away my students, exposing them to the dangers of a new siege, I left Paris, and taking with me my aquatic family, I settled in Champigny, where I have, or rather had, a property.

"Alas! The Prussians had passed through there. My fish farm was destroyed and the trenches of my formerly flowing fish ponds were all dry. In addition to the loss of fish and fences, the house was riddled with shell fire. I saw shell pits and mounds of rubble at every step. It was gloomy evidence of the furious struggle that took place within this narrow valley; this now was my new surroundings.

"However, here in solitude and among ruins is where I settled down. My fish were my only companions. I devoted four and half months in rearing and breeding them, and I went back to Paris in August, this time with six hundred adult pairs, all similar to these I have honor to show you, and six thousand youngsters of various ages. You see, gentlemen, when I persevere, I am sufficiently well rewarded with success.

EPILOGUE

My examination of the life of Pierre Carbonnier proved valuable in that it filled the gap in the early history of the hobby that started with the abatement of the aquarium fever in England that started in the 1860's and ended near the turn of the Nineteenth Century. Not only did he breed a host of anabantids, such as *Colisa lalia*, but he also bred very dissimilar fish, including *Corydoras*, *Umbria* and *Valencia*, describing in detail what he did and what he observed. He also imported the Glass fish *Pseudambassis ranga* and the cyprinid *Nuria danrica* (formerly *Esomus dandricus*). He described in detail the construction of an octagonal aquarium and devised a successful method whereby fish were transported over great distances by ship. He was an experimenter and amassed data that was of great interest to, and much in demand by, his colleagues. He won medals for his studies of freshwater aquariums and introduction of exotic fish species and for the direction of a public aquarium that was the main draw at the Third Paris World's Fair in 1878.

Pierre Carbonnier died in 1883. His life was an interesting and fascinating one, deserving of more than just a few words about his work with *Macropodus* and *Corydoras*. He did exciting things in his day and I very much would have liked to have met him. I would, however, have pleaded "prior engagements" in 1870 and 1871!

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APPENDIX I: THE APARTMENT AQUARIUM, FROM THE "GUIDE PRATIQUE DU PISCICULTEUR" ("PRACTICAL GUIDE TO FISH CULTURE") 1864.

"An aquarium is the name given to a tank or basin, a kind of breeding ground of small dimensions, in which plants and aquatic animals such as fish live and thrive.

"The aquarium is specially designed to place before the eyes of the observer the phenomena of vegetation in water, the reproduction and development of fish, their manners and their habits. Its shape, therefore, must not be distorted if the many details useful to know about the animal and plant life that grow within are not to escape these observations. For the same reason, it must be constructed of transparent sides and contain a sufficient amount water.

"It is no longer just a heated greenhouse where horticulturists or amateur gardeners cultivate their flowers, or something designed to grow a profusion of the beautiful tropical plants known as the water lily. The lily, in these conditions, is at once a welcome surprise for the visitor's eyes, and escaping from the water surface of the basins from which it grows is beneficent moisture that cools the air in a greenhouse that is too dry. It is undoubtedly through this that the aquarium has become a piece of luxurious, leisure time furniture, taking its place next to the elegant plant stands in the living rooms in the apartments of the rich.

"For a long time now, those who study the habits of fish are increasingly attracted to observe them directly, and looking for a different or unusual kind of recreation they have in their possession spherical glass vases filled with water containing a few goldfish that pass their lives in a continuous and tiring circular motion. The shapes of these vases do not lend themselves to making these observations either easy or comfortable. It can easily be imagined then, according to the fish or plants they contained, that they were seen in unreal ways, their shape shortened to view or contorted unpleasantly. Without running the risk of comparison one could say that what was seen was only a caricature of the plant or fish.

"Aquariums today have flat surfaces; consequently they depict an accurate view of what they contain from the outside. It was about ten years ago that we built the first flat-sided aquarium for Baron Heurteloup, and without wanting to suggest that the English have copied us, since they have constructed similar aquaria, we claim the honor of this modest and useful invention, an honor probably very small, but not a frivolous one.

"Allow us to point out that our work in pisciculture on occasion led to improvements, principles that today are recognized throughout the practice, and that never, not even in the course of this little book, have we ever claimed anyone else's' legitimately acquired priority. We remind our readers that we have never neglected the opportunity to give credit to these humble scholars, skilled illustrious practitioners or modest researchers. However, that we claim our rights to take credit for the invention of flat-sided aquaria, both with regard to the idea and for the details of its construction, is a small matter of pride that when the claim is examined it will be found in our favor because we are truly the inventor of these aquariums.

"Although the Chinese had a lot of time to learn about and use these kinds of vessels, they did not use them for the study of aquatic plants or fish; the dimensions and shapes of their aquariums were in no way suitable for this purpose. They were used instead to enhance the decoration of their strange architecture, both outdoors and indoors. This is, without doubt, because the goldfish, which comes from these distant countries, is so easy to breed in almost any container.

"Aquariums that are built today vary in the form and details of the arrangement of their component parts, but first and foremost they all have straight and transparent sides. Those established in the zoological garden in the Bois de Boulogne present to the curious observer the most beautiful of these designs.

The octagonal aquarium constructed in Carbonnier's Paris shop.

People who visit there for the first time are amazed by this little miniature sea, populated by small aquatic meadows and forests that appear to be unconcerned being the subject of this intense curiosity. For many people the desire to have such an object of their own in their home for recreation is natural. We will soon show that to carry out this desire is neither difficult nor expensive. The only problem we might face in the installation of the aquariums in question is the lack of an exposure to direct sunlight, because without this warmth the underwater plants will not grow or multiply.

"The most widely adopted shape for aquaria is the rectangular one, the octagonal shape being preferred by those who desire more elegance and richness of detail.

"The figure shows the aquarium model built by us, which is located in the center of our store. Its dimensions and capacity are as follows:

Diameter, 39 inches;
Height 24 inches;
Weight of the tank with the rock and water, 1280 pounds;
Tank capacity, 130 gallons.

"The base is formed of a thick slate plate with eight small copper columns attached. They form the sides of the octagon and hold the thick glass that is the walls. They are held in place to the bottom plate and to the glass panes all the way up to the height of the columns using water-proof putty. A circle of polished copper provides a strong and elegant border at the upper part, strengthening the whole construction. A rock rises from the middle of the basin, forming a sort of cave where the fish can seek shelter from any bright light or other stimuli that affects their behavior. Various aquatic plants grow in small cavities outside the rock cave. The whole is supported by a strong wooden table.

"Most aquariums are much less elaborate than the model described above, and their capacity varies from 2-1/2 to 50 gallons. If the buyer doesn't find anything to his liking among those that we have in our store, at his request we custom manufacture one. The bottoms are cast iron, slate or glass, depending on its use. In those designed to contain sea water, contact of the water with metals such as iron or copper must be avoided since their oxidation has the most serious consequences on plants, fish and other marine organisms. The means of production that we use allows us to price these tanks at 1 to 1-1/5 francs per liter of capacity [about $3.4 to $5 per gallon in today's currency].

"It remains now to provide some background before stocking the aquarium with plants and fish, and to discuss the care required to achieve the desired results. They will pertain especially to fresh water, for which we believe hold no secrets.

"Those who prefer a show of flowering aquatic plants rather than that provided by moving creatures, no doubt have in their possession an aquarium used only for such culti-

vation, oblivious to the pleasure experienced by others who contemplate and follow the development of living beings that can also live in the same environment. It seems that nature does not separate two major relationships from each other, that is to say, that of aquatic plant life and aquatic animal life. In fact, these two provide essential elements for each other, and if this balance is not maintained, they both suffer.

"Air, as everyone knows, is necessary both for animals and plants. Animals consume oxygen and release carbon dioxide; plants, on the other hand, absorb carbon dioxide and give off oxygen. What happens in our atmosphere has its equivalent in the aquarium so it is necessary therefore to establish and maintain an environment that caters to both plants and living creatures.

"The number of living creatures we introduce must be proportionate to the capacity of the aquarium; one can, on the other hand, never introduce too many plants. When the water doesn't contain what is needed for the plants, they just borrow it from the atmosphere. It is not the same for fish; their makeup does not allow them to utilize the air we breathe. From time to time, during storms or when the atmospheric pressure decreases, we see them move up to the surface in the layer that has more oxygen, but this only happens when there are too many in the aquarium, or when they are not accustomed to living in stagnant waters. In the latter case, it is not necessary to keep plants in the tank.

"We have found that to live and thrive in an aquarium, a fish 1.2 to 1.7 inches in length needs 0.26 gallons of water. An aquarium of 26 gallons capacity, therefore, can hold a sizeable population of fish, permitting us to observe the differences in the customs and habits of many different species, along with studying the reproduction of our freshwater snails.

"It would be unwise to mix fish in the aquarium whose manners or habits differ widely. Some are too aggressive, such as pike, perch, eels and sticklebacks. They should always be separated from the more harmless species or they will pursue them continuously and when they can't kill and eat them, they will maim them by biting their tails and fins. In this latter state, the unfortunate victims are no longer a object of study or recreation as their means of moving about are taken away; they are condemned to remain motionless, a pity.

"Among the fish that thrive in the aquarium and one easiest to maintain is the goldfish from China which, by its diversity of coloration, provides a most pleasing look at a single glance; others include the minnows, which like our birds, have the most beautiful colors during breeding and take the food presented to them from your fingertips just a few centimeters below the surface of the water; tench, which plow through the gravel, providing an opportunity for other fish to grab various organic materials that are trapped there as food; dace and bleak, who delight us in their rush to show how nature has been lavish in their favor, giving them very developed fins and an overall shape that allows them to go twenty times around the aquarium in a single leap; and bream, roach, bitterling, carp, loach, all fish of different forms and habits that live in perfect harmony and help to provide a varied and continuous interest in the aquarium. Regarding the stickleback and its mode of reproduction in the aquarium, we refer the reader to what we said on page 148.

"The introduction of plants in the aquarium can be done in several ways: the most common is to leave them in the pots in which they were grown and set them on the bottom of the tank, covering and filling the gaps between them with coarse sand or gravel, thus forming a single united dome from which new growth emerges.

"Another is to place a bed of peat a few centimeters thick at the bottom of the tank, and cover it with a thick layer of gravel 2 or 3 centimeters deep in order to prevent the earth mixing with the water and disturbing its transparency.

"Plants that can be grown in the aquarium are numerous: we recommend preferably the water lily, iris, reeds, water sensitive (which floats on the surface), water crowfoot whose many branches provide a most beautiful effect, umbrella palm, *Valisneria* and rosoli (also called the flycatcher because it asphyxiates flying insects that land on the flower, then closing and reopening after the insect moves no longer; fish frequent the vicinity of the plant, in the hope that it will give them the opportunity to grab an easy prey). [Carbonnier is talking here about semi-aquatic plants in aquariums that are half-filled, permitting then to grow out of the water and to flower.]

"The presence of various snails in the aquarium is necessary. They feed on the plant detritus that may corrupt the water and thus serve to maintain its purity. Most of them constantly crawl on the walls of glass and scrape off the algae that develop there; in this way, through the tireless work of these scavengers, the glass retains its transparency.

"In a well populated aquarium, the show is very entertaining. We can see water beetles walking during the day at the water surface in an inverted position to hunt small animalcules; the snails coming up from time to time to the surface to breathe, then dropping to the bottom; the clams in which you can try making fake pearls, as is done in China; and to vary the show already so varied, we can easily add Lilliputian freshwater shrimp, salamanders and turtles to this population, and many other animals it would be too long to list.

"To sustain life in such a large population does it require continuous and meticulous care? No. We can find no evidence that this is needed.

"A bird raised in a cage often flies around terrified, colliding against the bars of its prison, scattering the millet and hemp which is their food over the furniture of the apartment. It requires more care and presents more liabilities than the many residents of an aquarium. In an aquarium the animals live calm and quiet lives satisfied with little, almost nothing, and can be maintained without food for several months.

"In an aquarium where the fish have sufficient space and where the vegetation is abundant, it is necessary to renew the water only partly, once a week. As do the majority of animals, fish react badly when there is a large change in temperature or in their environment, and the entire renewal of the water where they lived for eight days would lead to these changes most of the time. The tank can be emptied easily, in whole or in part, by means of a small rubber tube used as a siphon and, in the latter case, it has the advantage of sucking out the water from the depth deemed best, that is to say, depending upon how far down in the aquarium the tube is placed we can siphon out water from the bottom, middle or top. During cold weather, the fish are in a kind of torpor, so a water change is not necessary more than once a month.

"Many people feed the fish in an aquarium with bread or bread crumbs or even bits of unleavened bread or wafer; this, however, has dire consequences. Some of this food remains in the water and sooner or later decomposition takes place, imparting a sour taste to the water and clouding it. Food ingested by fish and then discarded in its droppings have the same effect, but to a lesser degree. Experience has taught us that meat, especially cooked, minced beef, is the most suitable food in all respects. Furthermore, it does not disturb the water before or after it has been digested by the fish. They eat better and require smaller amounts, and their droppings provide food for the snails. Be assured that this is what happens. When an excess of droppings accumulate on the bottom of the tank and cannot be removed by siphoning out with the rubber tube, one must use the curved pipette curve shown. A few pinches of ground beef thrown on the surface of water is enough food for all of the inmates for a week. A good routine precaution to take is to avoid feeding the fish the day before a partial water change.

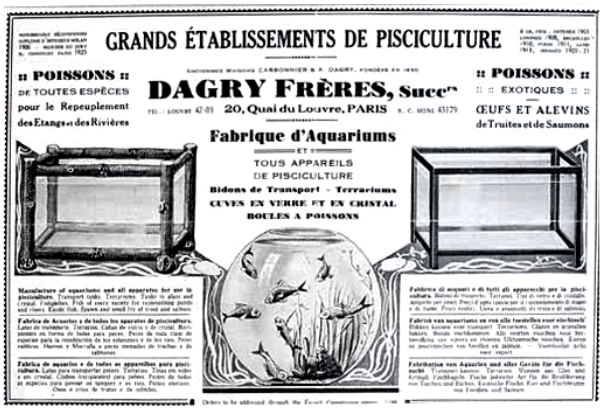
The photographs on this page are of the Dagry House, the successor to Carbonnier's establishment. In 1930, the year shown, it manufactured home aquariums, terrariums and fish farming equipment, and it also sold exotic fish, fish for stocking fish ponds, and reptiles. The store still exists to this day.

(Photographs were taken by A. Lemaitre, courtesy of Association d'aquariophilie et de terrariophilie at aquarium32.com and Jacques Teton.)

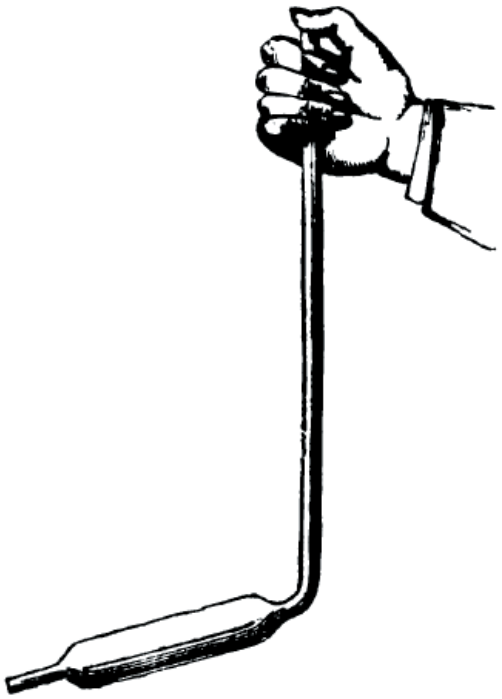
In the foreground is the Proprietor at the time, Henri Leveaux.

The same shop inside. Various models of aquariums line the shelves. Below these are tropical fish and at the bottom are cold water fish. At the right is a circular aquarium with a fountain.

Examining a new importation of fish. Shipments at this time were carried out in large tin cans wrapped in wicker.



The shop's outdoor display.



The device used by Carbonnier to siphon uneaten food and detritus from the bottom of a tank.

"Small bloodworms that the fishermen use as bait, such as flies and the red worms found in lettuce are much sought after food for fish. Indeed, they snap up and digest all kinds of vegetable and animal material that can pass through their mouths; our only decisions are in the choice of the quality and quantity of their food.

"The last tip that we have to offer in the installation and maintenance of aquariums in an apartment is that you do not expose them to bright light. Most freshwater fish avoid bright light and moreover, it tints the water greenish, masking problems inside the tank and preventing seeing what is going on. The recess of a curtained window exposed to the light for a half-day is the best location in an apartment for an aquarium. You can enjoy the enchanting spectacle of an animated world amidst picturesque vegetation. The learning gleaned and the entertainment experienced goes on without ceasing."

APPENDIX II: "RAPPORT ET OBSERVATIONS SUR L'ACCOUPLEMENT D'UNE ESPÈCE DE POISSON DE CHINE" ("REPORT AND OBSERVATIONS ON THE BREEDING OF A SPECIES OF FISH FROM CHINA"), 1869.

"On July 8, our indefatigable colleague, Monsieur Simon, Consul of France in Ningpo, arrived in Paris, bringing from these distant lands a number of fish still unknown to most of our naturalists. It is, however, not the first time Monsieur Simon showed his devotion to science and to our Société d'Acclimatation, and for this he certainly has earned his award of the title of Honorary Member.

"It is necessary to appreciate how much greater the difficulties are when transporting fish as opposed to plants and terrestrial animals; suffice it to remind one on this subject of the numerous persistent and almost fruitless attempts made in recent times to transport the Gourami from the island of Réunion to France.

"It is only fair to say that Monsieur Simon had in this difficult task Monsieur Géraud, an officer aboard the Empress who was bright and eager to help. It is to them that we owe two of the new acquisitions that have enriched the science of ichthyology and from the following facts I have every reason to believe that the domestication of the fish is now a reality.

"Starting on July 9, Monsieur Simon, building upon my practical knowledge as a pisciculturist and as an observer, had been kind enough to collect some of these fish for me. Of the about one hundred that he had taken at the beginning, there remained only twenty-two. Enclosed in glass jars with a capacity a bit over one and a half liters, Monsieur Simon provided them during the voyage with crushed vermicelli, which resulted in making the water a milky white.

"As such a regime would certainly be sufficient to kill the most robust fish of our country within a quarter of an hour, the possibility

of returning them to health by placing them in a suitable medium seemed good.

"From July to August I kept seventeen individuals of 7 to 8 centimeters in length, all belonging to the same genus, that of *Macropodus*, but they are a species completely unknown so far. The dorsal and anal fins are very long and tinted with the most vivid of colors. The scales, of all shades of the rainbow, provide vertical stripes of yellow, red and blue, and they are streaked from head to tail with stripes that change color. Added to this is a graceful, softly rounded, long forked caudal fin, that expands like that of a peacock's tail, so it is not surprising that I thought it should be given the name of Paradise Fish because it is among fishes what the Bird of Paradise is to birds.

"Of this group there are twelve males and five females; the latter are smaller and less brightly colored. Two other fish belong to the same genus but are different species, identified as fighting fish or bettas [at this time the betta was known as *Macropodus pugnax*].

"Their size is about that of our Epinoche [i.e., stickleback]. They are a pale gray, unremarkable at rest, but when something excites or irritates them they expand their fins, straighten up and instantly become an iridescent color. The eye is like a green azure fire, all fin rays become purple-red mixed with blue and green, and each scale is a small shining pearl. Its appearance is really indescribable; it must be seen to get an adequate idea.

"I still have another pair of fish from the same source, but like our Misgurn or grand eloche [a loach, i.e., the weatherfish, *Misgurnus fossilis*] it offers nothing of interest in particular; also included is a number of goldfish with a double caudal fin, an anomaly I frequently encounter and quite common in our country. I have recently given three specimens to the Zoological Gardens.

"The seventeen in the first group of fish came from rice fields in Guangzhou. When they were handed to me on July 10, most had clipped, worn fins, and their bodies were covered with fat, dirty pustules that would have inevitably killed them before long, and so the first order of business was to get rid of them. The task was not easy, but here's how I did it.

"In an aquarium containing about 70 liters of water, I placed clumps of aquatic plants, choosing a sedge with rough foliage, i.e., *Carex*, mixed with filamentous plants. I put in my fish and gave them food from the red worm jar. To get to the worms that were located at the bottom of the aquarium, the fish were forced again and again to pass through the aquatic plants, which in three or four days stripped by rubbing all of the material with which their bodies were contaminated, and I soon had the satisfaction of seeing their colors reappear and their fins reforming and growing rapidly.

"Ten days passed thus, during which my fish swelled visibly. The females especially took on an extreme amount of weight, which I attributed first to the abundance of food, but it was only the prelude to spawning. In fact, the morning of the eleventh day I noticed, not without surprise, a big change in the appearance and behavior of my fish. In the males, the edges of the fins were yellowish blue, and the extended spines of each pectoral fin were saffron yellow. Their fins spread like a wheel similar to the peacocks and pea hens of India, and with their vivacity, jerky leaps and display of their bright colors they tried to attract the attention of the females. The latter did not seem indifferent to this display and they swam slowly to the males and seemed to take pleasure being near them.

"Noting that the males and females were fighting and guessing that spawning would take place soon, I choose the strongest male and placed a female in a special aquarium with slate on three sides, illuminated by only a single glass pane and containing 40 liters of water.

"Ignorant of how spawning and fertilization would take place, I tried to ensure that the environment in their new would ensure success. I filled the bottom with sand, placed clumps of aquatic plants in the tank, and

placed a piece of slate leaned on one side of the tank to provide them with some shelter. "This all occurred on the morning of July 21; the water temperature was 72 degrees Fahrenheit.

"After taking ten minutes to explore their new home, the male came to rest against the transparent side of the tank, and at the surface of the water relentlessly absorbing and expelling air bubbles, he formed a kind of floating foam with a diameter first of 2 inches, then increasing to an area of 16 square inches. This was maintained without any absorption of tank water as a result of the secretion of a greasy mucus - the envelope of each bubble - produced in the mouth of the male.

"Then the male approached the female. I saw it expand its fins and bend them in an arc-like hoop. Then the female, who stood vertically with her head above the water, oscillated the lower part of her body in the semi-circle of the male who, bending and contracting his long fins, fastened to her side and, with obvious effort for at least half a minute, tried overturn her. Nothing is more graceful than the movements of these animals, dressed in their bright colors, dropping 15 to 20 inches down from the surface and then returning to the nest every ten minutes from 11:30 am to 3 pm. During the resting intervals, the male kept working on his foam nest, which at one point was a half inch thick at the center.

"However, until three o'clock this had, in fact, been nothing but a preliminary coupling. No doubt that the eggs in the female and the sperm in the males were not yet in a state that would induce any egglaying, but after 3 pm there were effective couplings. The male, pressing more forcefully against the shaking female, induced her first spawning. As the eggs were leaving they made almost immediate contact with the genitals of the male, who passed on his sperm to them. The actual coupling is in the middle of the water; the operation begins at the surface and ends before the fish have reached the bottom. They then separate and the eggs float up into the next.

"Starting with the first egg, I saw the male trying to eat all he encountered so, eager to save some, I collected one hundred to one hundred and fifty with a pipette and placed them in a bowl. Then seeing them still spawning, I left the eggs in the tank to see what would happen. Then, to my surprise, I found that far from devouring the eggs, the male harvested them in his mouth and placed then in the foam. Up to seven o'clock, I saw the same actions repeated: mating, spawning and egg collection by the male.

The Paradise Fish, *Macropodus opercularis.*

"When all was finished the male chased the female, who was pale and discolored, to a corner of the tank where she remained motionless. He then undertook the care necessary for the successful incubation of eggs, restoring the gaps in the foam that oc-

curred now and then, and taking a few eggs in his mouth where they accumulated in large numbers and placing them in less populated places. When the foam layer seemed too tight, he broke it up and immediately filled the new voids with new bubbles. He labored thusly for ten days without ceasing, without rest and without food.

"As for the eggs I had collected, they were stored in water whose temperature was maintained between 70 and 73 degrees. I examined them under a microscope twenty-four hours after spawning, finding they were transparent on one side; the other had two small spheres, nested one inside the other, and of a different color.

"Re-examined forty-eight hours after spawning, I saw the heart beat of the embryo, so they had indeed been fertilized. Finally, after sixty to sixty-five hours, the hatching began. What happens in this case is that the embryo undergoes two transformations before reaching the perfect state. Immediately after hatching, it is a true tadpole. The tail is well formed, but the head, trunk and yolk sac are enclosed in a sphere. It swims in this state and the eyes are visible, but there is no distinct mouth. It does not form until the second or third day. Five days later, eight days after birth that is, what was in the remainder of the sphere is reabsorbed, and the little animal is fully formed.

"Throughout these transformations, the male continues to provide the embryos with the same care he has given to the eggs. He swims in pursuit of those who escape from the foam, inhales them into his mouth and brings them back into the protective shelter. I saw him, most likely saving his strength, collect eight or ten in a single hunt and saw no injuries or any damage to the fry. This lasts until the number of repairs to the nest tries his patience, and he signals the end of his task and abandons his offspring to themselves.

"This transport of eggs to a foam floating on the surface and the mode of incubation is quite different from that of he fish in our climates, and may be shared by several other Chinese species. It is said that the ability to collect the sperm in great abundance by damming steams with weirs and mats is the means implemented by the Chinese who make a trade of stocking rivers and lakes with these fishes. So far I find this somewhat difficult to believe.

"My seventeen Chinese fish, reduced to sixteen by the death of a female and in which consists of twelve males and four females, provided me with six broods in three weeks. Some of them even started for the third time eight days apart, an astounding fertility. In five days the abdomen of the female, flat and compressed after spawning, bulges again; spawning seems to be intermittent in this species and is repeated every eight days during the summer.

"My difficulty slowing me down now is the kind of food to give these 6 to 8 mm in length fry, since they refuse all food not moving. In vain I tried flour, egg yolk powder, crushed meat, flesh, fish, beef liver; nothing worked. They would eat live prey, but newly-born Daphnia are four times too large for them.

"This caused me to lose a thousand fry, but I still have many that are strong and I count on the fertility of my females. I am experimenting with patience and courage and do not despair of success in breeding them. The rearing of this fish may not be easy but. be that as it may, it is quite remarkable."

APPENDIX III: "MŒURS D'UN POISSON DE LA FAMILLE DES SILURES, LE *Callichthys fasciatus, CUV.*" ("CUSTOMS OF A FISH FROM THE CATFISH FAMILY, *Callichthys fasciatus, CUV.*"

"I have in my possession a number of individuals of the species from the river Plate called Callichthys fasciatus, Cuv. [*Corydoras paleatus*]. This species is characterized by two barbels at each angle of the upper lip, two rows of broad and strong scaly plates that

cover the flanks and intercept the lateral line, and two dorsal fins, of which the second (adipose) is furnished like the first with an osseous ray. These fishes, as I have ascertained, frequently take in a provision of air at the surface of the water; but their most interesting peculiarity consists in their mode of copulation and reproduction.

"At the moment of fertilization, the female brings together her ventral fins, after the fashion of two open fans united by their edges, and thus forms a sort of cul-de-sac, at the bottom of which the aperture of the ovaries opens. The male sperm is contained in a sort of membranous sac, and a few moments afterwards it arrives at the female's opening where the eggs find themselves bathed in a liquid very rich in spermatozoids.

"Each such union consists of five or six eggs, which the female retains for a few minutes in the pouch thus described; then she quits the bottom to search for a favorable spot for their development, her choice leading her in preference to a well-illuminated part, such as the glass wall of the aquarium, or a stone submerged in the water. With her mouth, she cleans a place at least 4-6 inches below the level of the water; then, applying her abdomen to this substrate, she opens her sac and the eggs, which are adhesive, are attached.

"All the eggs being deposited, contact with the male recommences; the positioning of the eggs follows one another forty or fifty times in the course of the day. I estimate the total number of eggs released at about two hundred and fifty. I should note that the spawnings I have observed always started between 9 and 10 am, and terminated about 2 pm.

"At the moment of deposition the eggs, arranged in groups of from three to five, are of a milky white coloration but slightly transparent. Afterwards they become yellowish, and at the moment of hatching, i.e. from the eighth to the tenth day of incubation, they become blackish; this latter coloration is due to the pigment spots which cover the body of the embryo.

"At the moment of their birth the fry are globular in shape. At first one can only distinguish the four barbels; the umbilical vesicle, which is semitransparent, is not very large. The fry holds itself in a normal position, not lying upon its side like that of most other fishes. The tail and the other fins appear quickly. These latter developments last on the average three days, during which time the fry lead an independent and isolated life. When this period is past, i.e. from twelve to thirteen days after egg deposition, the youngsters collect together and move about the bottom of the aquarium. The growth of this fish is not very rapid; it does not become adult until two years after its birth.

Corydoras paleatus

"An interesting fact is the variation in the month of reproduction in our Callichthys. At La Mata it breeds during October and November. After arriving in Europe, a year passed without them producing young. In 1878, the spawning took place in August and September. This year (1880) they spawned in the month of June. Evidently there has been an adaptation

to our climate, the temperatures of which are the reverse of those of South America."

APPENDIX IV: "LE GOURAMI ET SON NID."

"In recent years, I have had the pleasure of describing for the Société d'acclimatation the curious and interesting habits of certain species of fish of the air-breathing order, labyrinthiformes.

"During breeding, the males use their bright colors to attract females, build a nest to house the eggs and provide attentive and efficient protection to their offspring during their embryonic development as well as after hatching. These facts indicate an instinct in these fish that is developed to the highest degree, revealing faculties hitherto believed only possessed by animals higher in the animal kingdom. These are the Macropodes [*Macropodus*] of China and Colises [*Colisa* species] of India.

"The study of a fish of the same family, the Gourami (*Osphronenus olfax*) [*Osphronemus goramy*], whose name has often been mentioned in this forum and in the Bulletin of the Society and that has made known to those who were unable to attend our meetings, gave me no less profound astonishment and admiration, and comparing my present observations with those I have already made with regard to the behavior of the Macropodes and the Colises, I am tempted to conclude that in all fish of this remarkable air -breathing order, nest-building is essentially based on the formation of an aggregate of air bubbles in which the male deposits or provides for the arrival of the eggs.

"I will not attempt to give you an analysis of what has been said and written about the Gourami or refute the many theories issued thereon by various authors; my role is more modest. They based upon observations with my own eyes and I will endeavor to give you the most accurate information. The five hundred hatched in my establishment in July last and whose current size varies from 1 to 2-1/2 inches, is convincing testimony as you can see from the specimens I now have the honor to present to you.

"The Gourami is a freshwater fish of India, remarkable for the uniqueness of its physiology, its size and the taste of its flesh. Many travelers report having seen them weight twenty pounds and more, and that their flesh was delicious. From recent and reliable information I have learned that in the markets of Calcutta where fish is sold live, its weight rarely exceeds 9 pounds. Gouramis are found in freshwater in the Netherlands East Indies, China, Réunion - where it was naturalized in the last century - and in French Guiana, where it was imported later.

"The body of the Gourami is slightly discoid, that is to say high and laterally compressed; the snout is at an angle exceeding 90 degrees, the mouth is thrust outward; the lower jaw extends a little more than the upper and in the male becomes thicker with age. In the course of the first year, the latter is pointed and the lips project slightly.

"At birth the dorsal and anal fins extend beyond the caudal fin, the latter being short and rounded. The rays of the dorsal fin can fold into and disappear entirely in a furrow that extends over the entire length of the back, which allows the fish to pass easily through the branches of aquatic plants. This character is less apparent in the anal fin.

"The ventral fins are reduced to the first ray, which develop into a long filament that extends the length of the body, and is endowed with an extreme flexibility. The fish can position them forward, backward and sideways, an organ certainly of touch and of great sensitivity.

"Metaphorically speaking, for me the Gourami is a great coliseum, whose development changes according to the areas inhabited. As for color, I never saw a more variable fish. The bottom of its dress is brown, the fins are darker. Greenish blue stripes crisscross his body transversely, but in winter they are not seen. Ordinarily this fish is dull and earthy,

but with the approach of the warm season and the time comes for spawning, it takes on a wedding dress that is second to nothing, including that the Macropodes of China.

"Cuvier assumed that the pharyngeal cells observed in the fish from this family were designed to store water, dripping it on the gills to keep them in a state of moisture favorable to the oxygenation of the blood coming from the heart. I was able to demonstrate that out of water, these fish do not live longer than the carp and tench of our country, and that the cells in question are reservoirs of air that the animal is obliged to renew at the surface to maintain its respiration in stagnant waters. (See the *Proceedings of the Academy*, February 16, 1874.)

"When the oxygen in the air contained in these reservoirs is absorbed, the Macropode expels the old bubble and immediately takes in another at the surface. The Gourami and Anabas reject the old air bubble before taking in another; Colise Arc-en-Ciel [*Trichogaster fasciata*] sometimes expel the old bubble through the mouth and sometimes through the gills.

"It is now amply demonstrated that all fish air-breathing labyrinthiformes can draw on the oxygen they need to breathe either from the external air or from the water.

"This has greatest importance in relation to the ease of transportation of these animals. Indeed, one simply puts them in a large container filled two-thirds and it need not be renewed. It is this knowledge that allowed us to transport them successfully in the same water for more than five weeks; without this ability, they never would have survived crossing the tropics. Forty-four Gouramis arrived in Paris in the same water (the Ganges), and only two were dead.

"But why is it that the many attempts that have been made over the last century to introduce the Gourami in France did not succeed? The reason seems to me very simple. Importers, believing that they were doing the right thing, completely filled their water jars and stretched a canvas or something similar over the surface of the water in order to prevent a fish that sometimes leaps more than 10 inches high from jumping out; also, any abrupt replacement of a large part of the water where there is a large difference in temperature can also contribute to any failure to bring them back alive.

"This method of breathing is, I believe, an insurmountable obstacle to the acclimatization of the Gourami in waters that may freeze over.

"In 1873, the first two shipments of these fish were sent to me from India by Paul Carbonnier; the individuals shipped being too large, however, they died during the crossing of the Red Sea.

"On December 11th the same year, Dr. Danion, a doctor on one of the Messengers ships, brought me seventeen live fish that had been entrusted to him by my nephew [i.e., Paul Carbonnier]. I introduced them at the next meeting on the 12th [i.e., a meeting of the Société d'Acclimatation], without providing a name since I wanted make sure in advance that I actually had Gouramis [Gourami was the common name given at the time to *Osphronemus goramy*, named by Lacepede in 1802; we sometimes refer to it today as the "Giant Gourami"].

"Monsieur Autard Bragard, who a few months ago brought back several specimens of this species that were deposited in the Museum, recognized mine to be young Gouramis. Drawings that Monsieur Mesnel had made of this fish for the magazine *Pittoresque* [*Picturesque]*, and illustrated in the work of M. Millet in *les Merveilles des fleuves el des ruisseaux* [*The Wonders of Rivers and Streams*], reduced my suspicions to certainties, and at the next session in December 1870 I had the pleasure to announce that we had seventeen Gouramis living in Paris.

"Therefore, I made every effort to acquire new shipments. Our illustrious President, Mr. Drouyn Lhuys, arranged for me to travel by express on the Paris-Lyon-Méditerranée route with all of the containers I had designed for

transport and, with the help of many engineers on the ship the *Courier*, the Company was rewarded for their dedicated efforts since one hundred and eleven Gouramis were alive in Paris in 1874.

"Now, gentlemen, I found it difficult to keep these fish alive in our relatively cold climate and to breed. This part of my work will, I hope, be less boring. If I have put three years of tireless study and breeding into this species, I have been richly rewarded: first by finally achieving success, and then by the opportinity to describe the scientific discoveries that allowed me to do so.

"In the spring of 1874, I noticed that the shape of my fish had changed; the body elongated a bit as did the height proportionally. The head ended in a blunt tip and the lips – especially that of the males – swelled significantly. Some of them had become almost completely discoid. Finally, as regards their coloration, these younger fish were quite different. I did not think that at this size they would breed, but after reading the memoire of Baron Roujoux in the Bulletin of August 1801 where he said that the Gourami can reproduce while being small, and noting that those of Guadeloupe [a small French island in the Caribbean] resulting in a degenerate race whose individuals became become smaller and smaller with time, the thought of a possible breeding scheme came to me with the aim of improving the species by careful selection. To this end, I isolated several pairs of fish in different aquariums, but the results were negative.

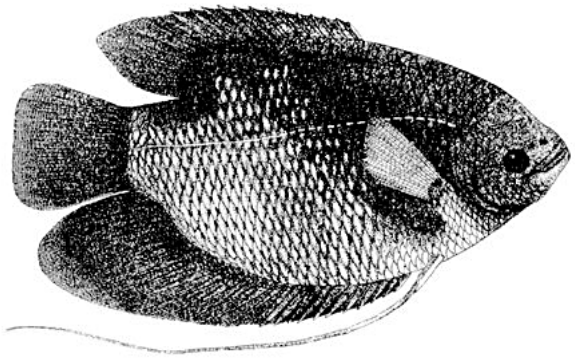
"In the spring of 1875, I placed them all in a 13 foot diameter pool where the water was maintained during the summer at a temperature of 68-72 degrees Fahrenheit; the fish broadened out a bit, but did not spawn.

"I had known that whenever a young fish is starved for about three or four weeks, the skeleton is formed and it cannot grow any larger no matter what food regime is then offered. Such was the case of my Gouramis who had gone without food during the long trip.

"Finally, in October 1875, the temperature fell significantly so I decided to collect my fish and bring them back to Paris. I found more than twenty-two alive, the others dead from causes that I could not determine, and last spring, no more than fourteen individuals were left. This time, if I were not to lose the species, I needed to try an experiment, i.e., to raise the water temperature to a level favorable for breeding. In the month of June, I placed my fourteen Gouramis in a 53-gallon aquarium and, using a gas heating system, I maintained it at a constant temperature of 77 degrees Fahrenheit.

"Within a short time the fins of male fish were the most vivid of iridescent colors; the throat became blue, the stripes took on a green tint and the anal fin took on a blue-steel coloration bordered by an orange line throughout all the twists of its serrations. The

THE GIANT GOURAMI (*Osphronemus goramy*)



dorsal fin, blue-steel like the anal fin, and had a border across its length of a white stripe. The two ventral fins, black at their base, were the most beautiful reddish orange along the rest of their length.

"The males, nine in number and adorned with bright colors, pointed their ventral fins forward, constantly copying each other and flaunting their beautiful costumes.

"It was a combat zone in the rivalry for the possession of a female. The females, five in number, nestled in the bottom of the aquarium, watching the fight and waiting impatiently for the final result. If one of them dared to enter this arena, she returned bruised.

"The females had nothing in common at this time with the males who leapt out of the water; if one of them picked up air at the surface, the others would simultaneously rush to the spot.

"On June 27, the lips of the most beautiful male were swollen beyond measure. I also noticed that all the other males seemed to recognize defeat because no one dared approach him. The iridescence colors had disappeared in the losers, and he alone, by his brightness and vivacity of movements, seemed to assert his supremacy. All the females now had recognized their master, because they did not take their eyes from him and sought his company from the rest. Among this group of females it was not difficult to distinguish his favorite, although at first glance her abdomen did not seem more swollen than that of the others. I saw the male pay her more attention, bending around her with more elegant curves of his body.

"On June 28, the male began constructing a foam nest in one corner at the surface of the water. Ready for anything, I had prepared a variety of materials which I suspected he might need. In a few hours the nest reached a considerable size, 6 to 7 inches in diameter and 4 to 5 inches in height. The next day the nest was scattered about, the froth floating to and fro over the surface of the water. I suspected that during the night a great struggle took place and I immediately took the opportunity to remove all but the two breeders. My idea paid off and soon a new nest was built, constructed partly with materials from the old nest and with new bubbles produced by the male.

"In the Chinese Macropode the male takes in the air bubbles and ejects them directly under the nest of foam; being impregnated with mucus supplied by the buccal membrane, they maintain their shape. The Gourami's mouth, however, does not appear to secrete as much mucus. It is part of the male's job to find the construction materials that may be at hand and then to collect those that seem to fulfill the requirements and bring them to the nest.

"To this end, he goes to the surface of the water, turning his back to the nest, and takes in atmospheric air, ejecting it in the form of gas bubbles. During this activity, any poorly constructed bubbles are destroyed; only those whose envelope has adequate strength are collected and deposited in the nest. By this time, the mucous secretion seems to be more plentiful and if the male is not successful in finding materials with which to bind the nest, then it descends to the bottom of the water in search of some aquatic plants, preferably confervae. This he takes in and chews for a few moments. These plants undoubtedly stimulate the buccal membrane that excites secretion, like in humans where the secretion of saliva and gastric juices is initiated by spices.

"By the evening of July 4th, a very large globular nest was floating in my aquarium. The male positioned himself below and watched attentively; he would not allow one finger to touch the glass and risked killing himself by rushing furiously headlong into it. Whenever the female approached, the male showed his satisfaction in his position below the nest by his display of splendor and bright colors. At one point, his body had acquired sufficient flexibility to clasp the female and lead her to the nest for the first spawning; other egg releases soon followed and were repeated nearly forty times in three hours.

"A colisa Macropode would have no trouble in collecting the eggs and put them in order in the nest. The Gourami, however, does not seem to know how to take them into his mouth and bring them to the surface. It uses an odder ploy, facilitated by the arrangement of its branchial (gill) lamellae.

"After each release of eggs, which are nearly the same density as water, they float to and fro in the aquarium. The male rises to the surface to obtain a goodly quantity of air and then lowers himself well below the eggs. Suddenly, by a violent contraction of the membranes of the mouth and pharynx, it forces the air within the mouth to escape through the branchial gaps, divided into tiny bubbles by the lamellae and fringes of the gills as it is sprayed out. The violence of the expulsion is such that it produces two jets of a blast of air that envelopes the eggs and carries them to the surface.

"Nothing is more curious than to see this maneuver of the Gourami male as it almost completely disappears in the middle of a veritable fog of air and when at last this is dissipated, air bubbles resembling thousands of tiny beads reappear, clinging to the rough scales and rays of his fins.

"I estimated the number of eggs that were deposited in the nest to be two or three thousand, from which I did not obtain more that 600 fry, most eggs being infertile.

"The initial incubation period is three days; after this period, a series of changes begin similar to those I have already reported for other species. The tadpole swims belly up and has the shape of a ball ending with a small tail. After an additional three days, that is to say six days after hatching, the embryonic period is now completed and a number of the bolder fry venture out and attempt to escape the paternal eye. The male pursues these fugitives and some are even sprayed by the jets of air because of their boldness. This brings them to the surface and back into the cradle of the family.

"The first appearance of young Gouramis takes place at the surface of the water, and at this age they already draw atmospheric air, the element indispensable to the existence of all the fish of this family.

"The father gives up his parental responsibilities after ten days after birth, letting them wander to suit their whim.

"Observing the development of the young Gouramis, one is struck by their rapid growth; in sixty days, mine reached an average length of 2 inches. It is true that in July and August this year the temperature in Paris was very high, but it is also due to the action of light on the development of the fish of this family, a fact to which I call the attention of naturalists.

"In their country of origin, where the length of the day is roughly equal to that of the night, it is normal and customary that fish growth occurs throughout the twelve months of the year. In our country, these lengths are not the same. When the length of night exceeds that of the day, there seems to be a complete cessation in their development.

"Those of you, gentlemen, who have raised Macropodes have observed this fact. During the winter days no progress is made in growth even though the water temperature is maintained at the same level as in the summer. But when March 15th approaches, a sort of awakening occurs and these fish grow more rapidly, continuing as the length of the

day increases and number of night hours decreases.

"After removing all of the fry and providing the necessary care for them, I soon saw the male get back to work. He build a new nest at four-week intervals but unfortunately, after an accident that caused the death of the female, the male suddenly abandoned his job and lost his breeding colors overnight. Fish of this family of air-breathers seem to feel strong ties to each other.

"I have observed several male Macropodes, whose females were jumping out of the aquarium, lose all their colors in a few hours; the same behavior seems to occur in the Gourami.

"Perhaps I have spent too much time in relating all these facts relating to the breeding and spawning of the Gourami, the hatching of the eggs and the various phases that follow. These facts, as I have reported them, have at the same time prompted the question that I now ask. Can these laboratory studies, as I may call them, be turned into practice. Is the Gourami likely to acclimate in our temperate countries?

"I hardly dare to share with you some thoughts about this question that came to me during the long and painstaking observations I made with this fish. I do not believe in the possibility of its acclimatization in our country. Regarding its necessity to breathe atmospheric air, it would be impossible to do so in our ponds or streams whose surfaces are likely to freeze in the winter. Together with the kind of asphyxia that I have seen in my aquarium experience when, during cold weather, air at a much lower temperature than the water in which it lived was taken in, these facts seem to discourage any attempt in this direction.

"Over time I have been able to observe the Gourami in the summer and in the beginning of inhospitable times. I saw that the fish can live, in a mild winter, in water of a temperature not lower than 50 degrees Fahrenheit. In one case, which unfortunately I cannot state is an exception, when a sudden lowering of the temperature brought the water down to 43 degrees, many fish died but others survived. Added to this is the fact that when the cold season arrives, the breathing of the Gourami slows down, as indeed happens in other fish. I have even observed several specimens that wound up in the mud remain there for several weeks in a state bordering on suspended animation.

"One word more, Messieurs, to describe the conditions under which I think breeding of the Gourami should be attempted: shallow water, but with a large surface area that is exposed to sunlight in the warm season and is therefore heated; a very active aquatic vegetation, giving rise to an abundant amount of oxygen adhering to its leaves that the Gourami eagerly takes up (and it is worth noting that, even under these conditions with access to oxygen of a high state of purity, the fish still goes up to the surface of the water to renew its oxygen reserves); and a bottom of mud or clay that allows it to sink into, providing a shelter against the adverse effects of temperature changes. Such conditions are those I think will be useful in testing out the Gourami set free in nature.

"About its food, it consists of plant debris and the various insects and small animals that live and grow in the water.

"It is here, gentlemen and honored colleagues, that I depart from my humble role of observer; it is now up to you who have given us so many examples of the practical sense you have made from the application of the general observations and results that our research and laboratory studies have provided. If my predictions are correct, one day is not far off when perhaps where we reach a goal most hotly pursued by our Company: the Gourami, a tropical fish living and thriving in the freshwaters of southern France and Algeria."

Emil Adolf Rossmässler, Father of the Aquarium Hobby in Germany

by Albert J. Klee, Ph.D.,

Aquarium Hobby Historical Society, Yahoo Files, January 5, 2013

Emil Adolf Rossmässler was born in Leipzig in 1806. His family, like many others, was struggling economically due to the Napoleonic wars. At an early age he developed an interest in science and a skill in drawing that was passed on from his father, an engraver. From his school days at St. Nicholas, the school of his native town, he acquired friends who had similar interests, among them Theodore Velcro, the son of a wealthy copper works merchant, who had a Herbarium and a Mollusk collection at his disposal. Theodore was his constant companion when they collected snails, mussels and plants. Emil lost his parents early on and was thus partly dependent on the altruism of relatives and partly on his own unskilled labor, such as the copying of correspondence, lessons and books.

On Easter of 1825 he entered the University of Leipzig. He would have preferred studying medicine but his uncle, who then was in *loco parentis*, found this to be too expensive and so Emil fulfilled a wish of his deceased mother and became a Protestant theologian. Finding his theological studies rather dry, being based mostly on the study of manuscripts and letters, he spent a great deal of his spare time studying botany, the tuition for which was supplied by a sympathetic professor. He was so successful in this field that by his second year he was teaching botany to pharmacy students.

In 1827 Rossmässler went to the Thuringian town of Weida to accept a teaching position, and happily remained there for 2-1/2 years. One fruit of this stay was some work with plants. In 1830 his treatise, "Contribution to the knowledge of the flora in Weida's Gross-herzoglich-Sächsische Neustädter circles," appeared in the journal *Flora*, and a year later in the same journal, "Plantae Lipsienses, Weidanae et Tharandtinae." He also provided input to H.G.L. Reichenbach's "Flora of Germany in dried specimens." The latter work was done so well that he was offered the post of professor of zoology at the Royal Academy of Forestry and Agriculture in Tharand (a town in Saxony), although he was asked to first acquire the necessary qualifications for the post.

Thus Rossmässler left Weida on Easter 1830 for his home town to prepare for his new teaching position, moving in June of the same

Figure 1: Emil Adolf Rossmässler (1806-1867).

Figure 2: The Four Seasons, by Emil Adolph Rossmässler, 1856

year to Tharand. His thesis was on the zoological spruce weevil that had just devastated Tharand's pine plantations. In 1882 he published his "Systematic survey of the animal kingdom" containing a collection of his drawings. In 1834 he did another on the insects of Tharand's forests. He prepared teaching guides for his students that contained drawings that lent clarity to the texts and afforded an opportunity to examine the extent of his knowledge. With particular zeal but also with great success, he took up the study of land and freshwater mollusks that he had started in his boyhood.

In September 1832 he spent several weeks in Vienna and there conducted research, collected, and recorded with untiring zeal. He returned with a storehouse of rich material that spurred him to a fruitful literary activity in the field of mollusks. "Diagnoses conchyliorum terrestrium et fluviatilium (in two volumes)" appeared in 1834, followed in 1835 by the first volume of his obra maestra, "Iconography of the land and freshwater mollusks," an outstanding feature of which was its many high quality drawings of hitherto un-illustrated European species. In the last plate of this volume he made his first attempt at lithography. Only the first plate of the second issue showed his drawings; all subsequent illustrations were his lithographs. He made progress in this art from issue to issue; thus the images of the last volume are the most beautiful.

In 1835 Rossmässler led an expedition to Trieste in the Karst Mountains, and afterwards went on to Carinthia in the Alps. In early 1837 he arrived in Berlin where he met the most important living naturalists such as Alexander von Humboldt, Von Buch, Ehrenberg, the brothers Gustav and Heinrich Rose and other well-known men who inspired him to think along new lines. After the uninterrupted publication from 1835-39 of the Iconography, the professor of mineralogy in Tharand retired due to age and illness and Rossmässler took over his position, including leading the mineralogical excursions of his pupils. This caused him to deal with geology in detail, processing the plant imprints of the Altsattel lignite basin from the rich fossil collections of the Heinrich Cotta.

Under the title: "Contributions to Fossilization," Issue 1 with 12 plates appeared in print in 1840. After the death of Prof. Raumer in the summer of the same year, he delivered lectures on plant physiology and therefore now felt once again stimulated to literary production in this field, an example of which was "The Main Things About the Internal Structure and Life of Plants," which was published in 1843 and that presented the most important scientific

knowledge in this area in a way understandable by the practical farmer. Despite this heterogeneous activity, in 1842 the eleventh and in 1842 the twelfth issues of Iconography appeared.

Politically, Rossmässler was quite active. In 1848, he belonged to the Funfzigerausschuss, a committee to set up a permanent committee of the Frankfurt pre-Parliament [the Frankfurt parliament was the first democratic one in Prussia, existing from 1848 to 1849 when the King took over again]. From May 1848 to June 1849 he was a deputy for Pirna in the Frankfurt National Assembly. He belonged to the moderate left factions, first with the German court, and later with the Nurnberger court.

In 1845 Rossmässler had converted from the Protestant to the Catholic faith and by 1846 his inclination towards the creation of the Ronge'schen Deutschkatholicismus - a schismatic sect formed in December 1844 by German dissidents from the Roman Catholic Church, under the leadership of Johannes Ronge - had been adopted formally. For religious reasons, he heavily criticized what was evil in the government at the time, in particular as a member of the Frankfurt Parliament where he was particularly active in the School Committees, and this made him unpopular with the Government. He was among a group of deputies who fled to Stuttgart in 1849 to establish a Rump Parliament until they had to give way because of the violence they encountered. Accused of treason, he was found not guilty. Therefore, in the summer of 1849 he retired at his own request with a little less than half of his previous income. Compelled now to write for money, he became a science writer for the people.

Besides his writings for the popular press, Rossmässler was advocate in supporting educational opportunities in the form of local galleries and museums, the formation of natural history societies in the form of "Humboldt associations," and to the creation of Workers' Education Associations. He was a founding member in 1861 of the Industrial Educational Association in Leipzig, and founded the German Workers Union convention which, after his death, became the Social Democratic Party. In 1865 he brought in the first woman member in his local Education Association. After a prolonged bout with kidney and bladder disease, Rossmässler died, surrounded by his family, on April 8, 1867.

ROSSMÄSSLER'S WORKS

In Tables 1 and 2 I have listed Rossmässler's most important works and also his contributions to the *Die Gartenlaube* (*The Arbor*) to

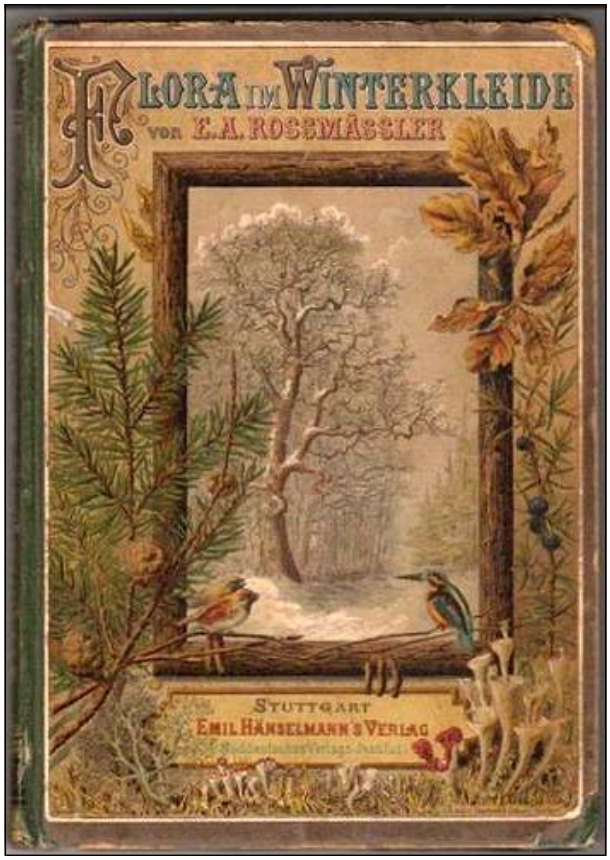


Figure 3: Flora in Winter Dress, by Emil Adolph Rossmässler, 1856

TABLE 1: PUBLISHED WORKS	
1832	Systematic Overview of the Animal Kingdom.
1833	Iconography of the Land And Freshwater Mollusks (3 volumes).
1840	Contributions to the Study of Fossils.
1843	The Main Things About the Internal Structure and Life of Plants.
1847	A Study of The Anatomical Characteristics of the Woody Parts of the More Important German Trees and Shrubs.
1850-1853	Man in the Mirror of Nature. (5 volumes).
1852	Popular Lectures in the Field of Nature. (2 volumes).
1854	Travel Memories from Spain. (2 volumes).
1856	Flora in Winter Dress.
1856	The Four Seasons.
1856	The History of the Earth.
1857	**The Freshwater Aquarium.**
1858	Water. Second reproduction edition in 1860.
1859	Man and the World of the Sea.
1860	Natural History Lessons.
1862	The Forest.
1860	The Natural History Lesson - thoughts and suggestions on a reorganization of the same.
1863-1868	The Animals of the Forest. (2 volumes, together with Alfred Brehm).
1856-1859	*Nature* (Journal published by Otto Ule and Karl Mueller).
1859-1866	*From the Home* (Rossmässler's own magazine).
1868	For Free Hours.
1868	Microscopic Views. (Collection of Rossmässler's lectures).
1874	My Life and Ambition. (Autobiography, published posthumously by Karl Russ).

show how his writing and his audience changed after leaving public office. I have also bold-faced the two entries that had a significant effect on the aquarium hobby in Germany. First, a few words about *Die Gartenlaube*, since Rossmässler published a great many of his popular articles there.

TABLE 2: ARTICLES in the *GARTENLAUBE* (*THE ARBOR*)	
1853	Spanish Travel Letters, I-VIII.
1856	Botanical Lectures for Women. First the Plant System.
	The Lake in the Glass.
	A Note.
1857	Hard and Brown Coal and Peat. First article.
	Hard and Brown Coal and Peat. Second article.
1858	The Avalanche.
	Hard and Brown Coal and Peat. Third Article. The Appearance of Coal.
	The Blackthorn.
	A Ruin of the House [an article about snail shells].
	Hard and Brown Coal and Peat. How was coal created?
1859	Pearls. First half - Interior construction and development of the pearl.
	Second half - Pearl luxury, pearl fishing, pearl trade.
	An International Congress of the future [on preserving the world's forests].
1860	On the marble deposits of Rübeland [noted for its caves, grottos and rock masses].
1862	The Rosenlaui glacier [located in the Swiss Alps].

Die Gartenlaube - Illustrirtes Familienblatt was the first successful mass-circulation German newspaper and a forerunner of all modern magazines. Its complete title translates into English as *The Garden Arbor - Illustrated Family Journal*, but throughout its history it was known simply as *Die Gartenlaube*. It was started in Leipzig, Germany in 1853 and although Brunner (Brunner, 2003) credits Rossmässler as being a co-founder of the magazine, the founders actually were Ernst Keil as publisher and Ferdinand Stolle as editor. The objective was to reach and enlighten the whole family, especially the German middle classes, with a mixture of current events, essays on the natural sciences, biographical

sketches, short stories, poetry and full-page illustrations. Between 1853 and 1880, works by prominent German writers, such as Goethe and Schiller, dominated its pages and at one time it claimed to have the largest readership of any publication in the world. Although its publication has long since ceased, Die Gartenlaube remains important for comprehensive historical analysis in many fields and is regarded as an essential source for the understanding of German cultural history.

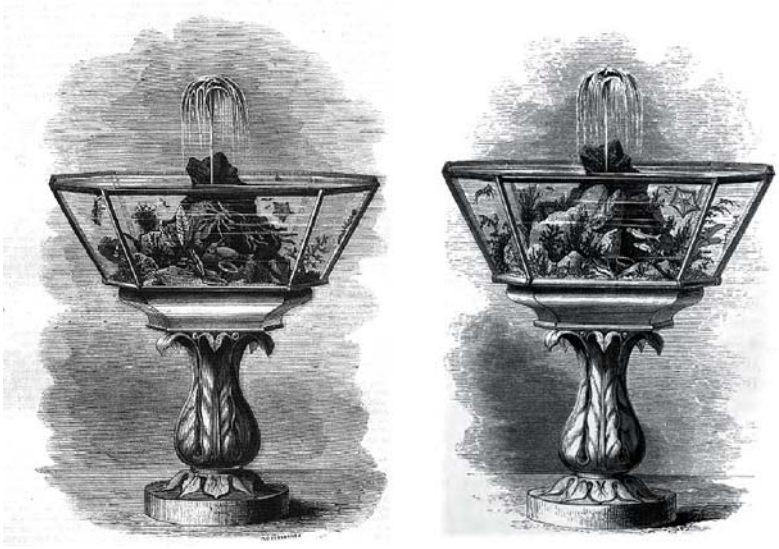


Figure 4: The left image is taken from the 1854 article, "Den Ocean auf dem Tische"; the one on the right is taken from Gosse's 1854 book, "The Aquarium."

In August of 1854 in Issue 33 of a monthly section called "Blätter und Blüthen" ("Leaves and Flowers) in *Die Gartenlaube*, an unsigned three-page article appeared titled, "Wie er- und Behält man den Ocean auf dem Tische, oder das Marine-Aquarium" ("How one keeps the Ocean on the Table, or the Marine-Aquarium"). This essentially parroted information about the marine aquarium derived from British sources. Indeed, Figure 4 shows a side-by-side comparison of the lone figure in the article with one taken from Gosse's book, "The Aquarium: an unveiling of the wonders of the deep sea;" the images are, barring a few minor details, identical.

In May of 1856 in Issue 19 of *Die Gartenlaube*, Rossmässler's first article on aquarium fishes appeared, "Der See im Glase" (the Lake in the Glass"), with the following introduction:

"Besides the "Ocean on the Table," which is now so widely acclaimed in English coastal towns, we should add "the Lake in the Glass" in which inland residents have a special interest. Both are encouraging signs of the daily increasing taste for nature, and following the description of the former in No. 33 of *Die Gartenlaube* last year by another author - the first article about the aquarium to appear in Germany - we present here now a description

Figure 5: A cover from *Die Gartenlaube*.

Figure 6: The image from "Der See im Glase," 1856.

of the "Lake in the Glass" and a comprehensive guide to its furnishing and care.

"When the Ocean on the Table - or whatever one calls this decorative and instructive artifact also referred to as the aquarium - first became known from England, I could have kicked myself when I realized that, as a student of nature dedicated to the popularization of this wonderful science, it was my usual habit for many years to make scientific observations of aquatic animals and plants in large glass containers, but I overlooked the possibility of using it as a new way to awaken and nurture its scientific sense among the people. The recent events that have led to the production of glass containers and stands after many unsuccessful attempts have only just now led to the desired results, and now as spring has returned after a long and hard winter, we eagerly fill these vessels with life."

That Rossmässler saw the aquarium as a tool to advance the cause of popular science, especially with children, is shown in the following taken from his article:

"An aquarium in the home is an effective way to introduce an intimacy with nature into a child's world. Kindergartens and schools – yes, even the best of schools - should make use of it. It sharpens the eye and focuses it within a circle of serenity previously unnoticed. For the child with an inquisitive mind, the story of the development of snails and that of many insects and frog-like amphibians provide not only something interesting to talk about, but useful knowledge as well."

The three champions of the aquarium in its early development were Gosse in England, Carbonnier in France and Rossmässler in Germany, but the three were motivated quite differently. "Des Menschen Wille ist sein Himmelreich" ("His own desire leads every man") is an old German proverb, and thus Gosse used the aquarium to extol the glory of God, Carbonnier viewed it as an opportunity to increase the population of new fishes introduced into France and its possessions, and Rossmässler saw it as a means of educating the masses in the natural sciences.

Rossmässler advances a rather weak argument for the freshwater aquarium when he states, **"For its part, the freshwater aquarium has the decided advantage of the combination of animal life cavorting about below the water level and green plants rising joyfully above them, while in the marine aquarium, everything must stay under water,"** referring to the type of aquarium pictured in his article of a small girl watching the creatures moving about (Figure 6). In this tank the plants emerge from the water and tower over the tank, leaving very little room within the tank for the fish.

Brunner (loc. cit.) spends some time asking why there was this sudden change in interest from saltwater to freshwater aquariums and offers some metaphysical explanations based upon the serenity of the latter. I think his first answer is closest to the real reason, i.e., **"… had the handling and maintaining of saltwa-**

ter aquariums already come up against too many limitations?" It is true that in the matter of interest on the part of the public, the marine aquarium has always won hands down. In a public aquarium, visitors flock to the marine exhibits while the freshwater tanks are quickly passed by. However, these institutions have the resources and the trained staff to maintain saltwater collections, whereas the average person of the time did not. Marine tanks were difficult to maintain even with easy access to salt water, and artificial salts were never a success in the Nineteenth Century. Carbonnier had it right when he stated in his "Practical Guide to Pisciculture" (Carbonnier, 1864), **"It remains now to provide some background before stocking the aquarium with plants and fish, and to discuss the care required to achieve the desired results. They will pertain especially to fresh water, for which we believe holds no secrets."**

There were no secrets – at least no insurmountable ones - to maintaining the freshwater aquarium; the success of the marine aquarium, on the other hand, had to wait until the Twentieth Century when technology came to its rescue, albeit at a much higher cost than its freshwater cousin.

Table 3 shows the amount of space Rossmässler devoted to the different topics he discussed in "Der See im Glase." Not surprisingly, plants and snails – his early interests - account for over 60 percent, whereas fish took up only five percent. With regard to plants, Rossmässler described 51 different kinds but these were to be decided by the kind of aquarium it was designed to be:

"Before I describe them, readers will have to deal first with the question of whether they want their plants to be just part of the landscape or whether the aquarium should have more the appearance of a thicket of plants." The latter Rossmässler referred to as **"…a small botanical island …with only a limited space for the fish…"**

The entire fish section is as follows:

"Turning now to the fish, keep the aquarium free of predatory types such as trout, pike and perch. Small herbivorous fish of any kind are suitable, since in this small living space their growth is restricted and they remain small. This is demonstrated by the goldfish (actually a carp, *Cyprinus auratus*), which in a pond grows to about one foot but in an aquarium reaches no more than 4-5 inches in ten years. Incidentally, the origin of the goldfish is China, the only aquarium fish imported from other parts of the world. Feed our little fish sparingly with dried ant eggs (if it is not a sacrilege for a scientist to describe ant pupae as eggs!), white wafers, bread crumbs and the like. The many little plants and animals that show up over time - this occurs also in the wild – and that can be found at the bottom of the tank, can also serve as food. As they romp blithely about in the vessels of square form and size specified on page 256 [i.e., about 20 gallons], these small minnows must imagine they are an audience for the languid fish of China dressed in gold. Let's introduce the weather fish, *Cobitis fossilis*, into the aquarium as weather forecasters, but first we must make a place for him where the sandy bottom is free of stones so that he can dig through it."

TABLE 3: BREAKDOWN OF "DER SEE IM GLASE"

SECTION	PERCENT
Introduction	5.2
Setting up the tank	12.8
Aquatic Plants	43.7
Snails and other small water animals	19.0
Fish	5.1
Amphibians	3.3
Maintenance	7.3
Epilogue	3.6
TOTALS	**1.000**

Figure 7: The cover of "The Aquarium: Instruction and Guidance for its Creation and Maintenance," by Ludwig Müller.

Regarding maintenance, Rossmässler did not advocate water changes, but relied upon the plants to remove the detritus:

"This then is only about life in our aquarium. But will it remain alive? Do we need a lot of care and effort to achieve it? How often do we need to change the water? The answer is Never. If the plants are happily thriving they will, with their roots, take up all the decaying waste materials that the animals add to the water. At this moment, standing next to the desk at which this was written, is a large aquarium whose water has not been renewed once in six months. Sometimes one just needs to top up what is lost by evaporation. Note that because the water can become overheated, the place for the Freshwater Aquarium is not at a window that is illuminated by strong sunlight for long periods. Dead fish do not escape one's attention because they lie on their sides and float on top of the water, so these larger bodies can be removed easily before they rot. Nevertheless, in those six months at least ten larger snails died and rotted in my aquarium, their empty shells now lying on the bottom, although no fish has died. That which could have endangered the animal life was immediately taken up by plants as nutrients."

LUDWIG MÜLLER
(IMPORTANT NOTE: See my essay, "A Case of Piracy and Plagiarism" on pages 631-635.)

Before turning our attention to Rossmässler's most important work, "Das Süsswasser-Aquarium," it is necessary to discuss "The Aquarium: Instruction and Guidance for its Creation and Maintenance," written by Ludwig Müller and published in 1856, a year after the debut of "Der See im Glase" and a year before "Das Süsswasser-Aquarium" appeared on the scene.

Until recently, no one was aware of the existence of this book until a German aquarist discovered a reference to it (Barford, 1902) in a short review titled, "Das Aquarienbüchlein aus dem Jahre 1856. Ein Beitrag zur Geschichte unserer Aquarienliebhaberei" ("The aquarium booklet from 1856. A contribution to the history of our aquarium hobby"). A further search found mention of it in numerous bibliographies, paperback lists and catalogs (some containing commentary on the book) dating from 1856 to the turn of the century. However, no library in Germany had a copy and it was considered a "long lost" book. Only one was known to have survived until a copy was discovered in the Harvard College Library and subsequently digitized by Google. It is more a booklet than a book, however, since it only consists of 38 pages.

The Harvard Library copy is bound but the original had only a paper cover, so it is not surprising that so few copies survived these 150 years or so.

If the book was a mystery, however, its author is even more so but more on that later.

Unlike "Der See in Glase," which contained only one image, Müller's book had 24 illustrations. There were striking differences between the two as well (see Tables 3 and 4), notably that there was much more emphasis on fish and other living creatures and much less on plants in Müller's little book. In setting up the tank and maintenance, they were about equal.

TABLE 4: BREAKDOWN OF "THE AQUARIUM. INSTRUCTION AND GUIDANCE FOR ITS CREATION AND MAINTENANCE"

SECTION	PERCENT
Introduction	5
Setting up the tank	5
Fish	10
Water insects and snails	34
Amphibians	15
Aquatic Plants	17
Maintenance	14
TOTALS	**1.00**

The following is the introduction in the book:

"As it involves little effort and without a significant expenditure of time, the display of aquariums or water tanks for marsh and aquatic animals in our living rooms has awakened in many the desire to devote a portion of their attention and observation to natural history, as a representation for which the aquarium must be considered.

"A great deal of interest has always been paid to Gold- and silver fish. The less common species of fish, however, are overlooked and the amphibians and aquatic insects that are found in our lakes and rivers are barely noticed. Through the aquarium you will get to know them better, for their basic nature and way of life, just as their exterior appearance, is a rich and interesting source of knowledge for many.

"With their characteristic discernment, the best equipped among those whose desire it is to better know the residents of our ponds and streams, are observed in women. The aquarium is both appealing and praise-worthy, and provides us with food for thought. In viewing an aquarium, a new, previously unknown world unfolds for us.

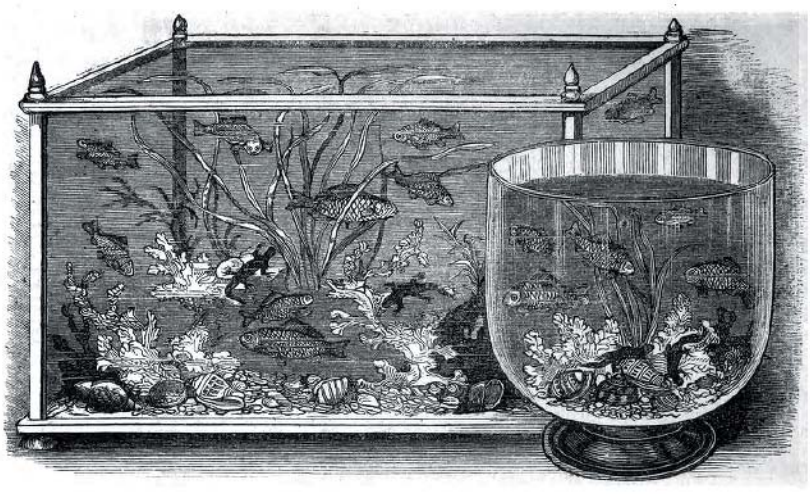


Figure 8: From "The Aquarium: Instruction and Guidance for its Creation and Maintenance," by Ludwig Müller.

"As unworthy of our attention as many of these animals may appear to us, we must keep assuring ourselves that they all, like every one of us, fill and assume an important place in God's Creation and Establishment. In nature, there are things that we do not know, and even the simplest of their virtues has some

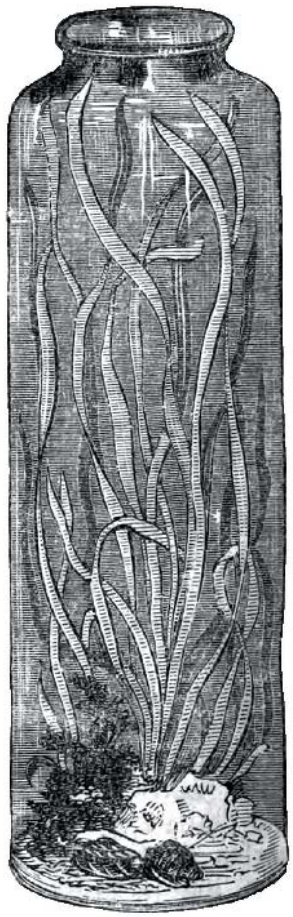


Figure 8: Vallisneria aquarium from "The Aquarium: Instruction and Guidance for its Creation and Maintenance," by Ludwig Müller.

natural and important purpose worthy of observation, for the Creator made us receptive to the beauties and mysteries of nature and instilled in us a desire for spiritual enlightenment.

"They say that to make discoveries is one of the most satisfying pleasures of the human mind, and this sentence acknowledges that we must stand firm in the truth that besides the natural history itself, this scientific field beckons to the energetic explorer, attracting him with its large depository of instructive and interesting facts. Nature is inexhaustible, and we can never stop learning. Increasingly and at every opportunity we can learn from it. The more this happens, the more thoroughly we appreciate that Divine Providence has created this wealth of resources for all of us. We proceed now to the care of the creatures that concern us."

What may surprise some is his comments on women, the first such in the history of the aquarium hobby. In addition to the above is the following taken from the fish section:

"It has long since been a favorite activity among women to keep goldfish in round bowls, and yet few have acquired a more detailed knowledge of the habits and customs of their pets required to keep them healthy for the duration of their confinement."

As for the religious references, they suggest that the author might be a clergyman. The special attraction of natural history for the clergy at the time was explained by John C. Loudon, writing in the *Magazine of Natural History* (Loudon, 1835)

"Compared even with a taste for classical studies, for drawing, painting, or any other branch of the Fine Arts; or for amateur turning, or any other kind of a mechanical employment; a taste for Natural History in a clergyman has great advantages, both as respects himself and others. It is superior, in a social point of view, even to a taste for gardening. The sportsman often follows his amusements to the great annoyance of his parishioners; the horticulturist exercises his gentler pursuit within his garden; and the classical or indoor student of any kind secludes himself in his closet or his laboratory; but the naturalist is abroad in the fields, investigating the habits and searching out the habitats of birds, insects, or plants, not only invigorating his health, but affording ample opportunity for frequent intercourse with his parishioners. In this way their reciprocal acquaintance is cultivated, and the clergyman at last becomes an adviser and friend, as well as a spiritual teacher."

Other than his book, however, nothing is really known about Ludwig Müller. There is a "Doktor" in front of his name but in light of a number of minor errors in his book, such as including two lizards and a snake in the section entitled "Amphibians," I doubt that he had a scientific education at that level, further

suggesting that his doctorate was in theology or perhaps was honorary. There is speculation that he was the author of the 24-page aquarium section in the 1857 *Naturgeschichte der Amphibien und Fische* (*Natural history of amphibians and fish*), since the illustrations in the two publications are the same, but this has not been proven. In any case, this does not shed any light on the author himself.

In the plant section Müller shows a really odd, extremely elongated aquarium (Figure 8) containing *Vallisneria spiralis (misspelled as "Valisneria," another example of one of the minor errors that anyone versed in "Naturwissenschraft" or Nature Science would not have made) and a few snails.*

In the section entitled "General remarks on the establishment and maintenance of an aquarium," Müller shows two pieces of equipment (Figure 9), a net and a method of changing water in a goldfish bowl. Rossmässler, I note, failed to provide any illustrations on this subject either in "Der See im Glase" or "Das Süsswasser-Aquarium."

At the end of Müller's book there is an interesting half-page advertisement for aquariums built by Ernst Häckel, a metal fabrication and plating factory located in Wurzen near Leipzig. Their standard sizes ranged from 26 inches to 43 inches in length and from 11-1/5 to 21 inches in height. Their prices, in terms of today's currency, were 15 gallons, $77; 25 gallons, $95; 40 gallons, $113; and 60 gallons, $140. The firm would build aquariums to order, and they boasted that the **"…biggest so far made in our factory had a circumference of 19 feet and a height of 2-3/4 feet…"**

"The Aquarium: Instruction and Guidance for its Creation and Maintenance" was fairly well-written and must have been widely available in its day since it was included in so many references and, as a paperback, it must have been inexpensive. In my view, the relative emphasis placed on the individual areas was, in my view, superior to that of Rossmässler's "Der See im Glase." However, a comparison of the two was summed up nicely in a review that appeared in the *Botanische Zeiting* for October 1856, a review in which I heartily concur:

"Its [i.e., "Der See im Glase"] scientific value strikes one as far higher than the first [i.e., "The Aquarium: Instruction and Guidance for its Creation and Maintenance."] This is further vouched for by the fact that the author is already known as a real naturalist. To this can also be added the jewelry of a truly attractive presentation, a characteristic of Rossmässler's works."

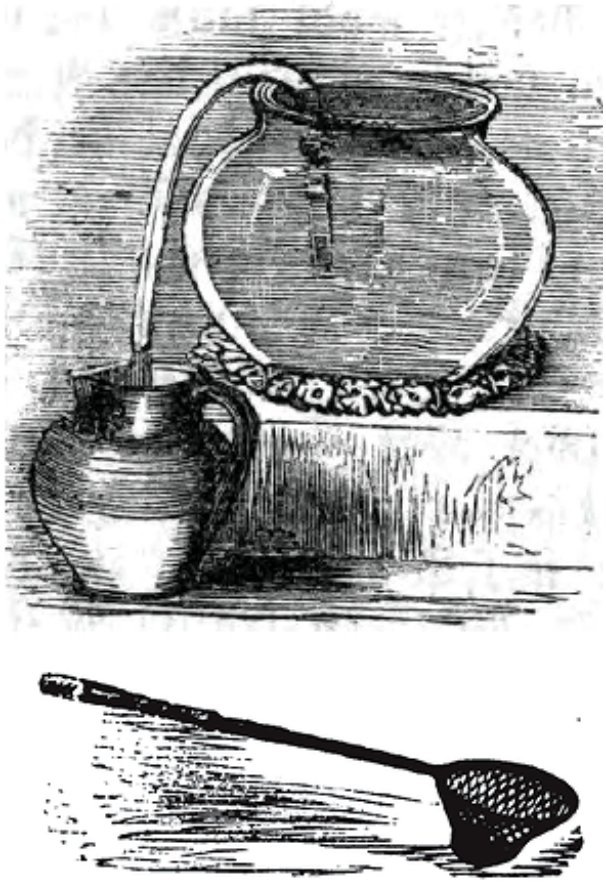


Figure 9: Images from "The Aquarium: Instruction and Guidance for its Creation and Maintenance," by Ludwig Müller.

Although Müller's book arrived on the scene before "Das Süsswasser-Aquarium," it apparently had little effect - if any - on the aquarium hobby in Germany. Not only had Rossmässler already paved the way with his "Der See im Glase," but because of his numerous articles on nature topics he was very well-known where Müller was not. In any event, the matter was settled upon the arrival of "Das Süsswasser-Aquarium."

DAS SÜSSWASSER-AQUARIUM

In 1857 Rossmässler published his famous book, "Das Süsswasser-Aquarium, Eine Anleitung zur Herstellung und Pflege desselben" ("The Freshwater Aquarium, A guide for its Establishment and Maintenance")." Depending upon how ones does the count, it contained 88 pages and 81 figures, over half of which of the latter were of aquatic plants. Table 5 presents a breakdown of the sections of the book, which may be compared to Tables 3 and 4. A quick comparison shows the close similarities with his "Der See im Glase" and the differences with the Müller book (i.e., the greater emphasis on fish and other living creatures and a lesser emphasis on plants in the latter).

Rossmässler dismisses the marine aquarium, partly because he had no experience with them but also because he believed that they would never succeed because of their cost. For the times, he certainly was right. Not only were aquarium heaters, filters and aeration unavailable to freshwater aquarists, saltwater aquarium technology such as marine salts, ultraviolet sterilizers, filters, protein skimmers, deionizers, reverse osmosis and the like were unavailable to the would-be marine aquarist. Only after World War II would marine aquariums be feasible – albeit still expensive – for the homeowner.

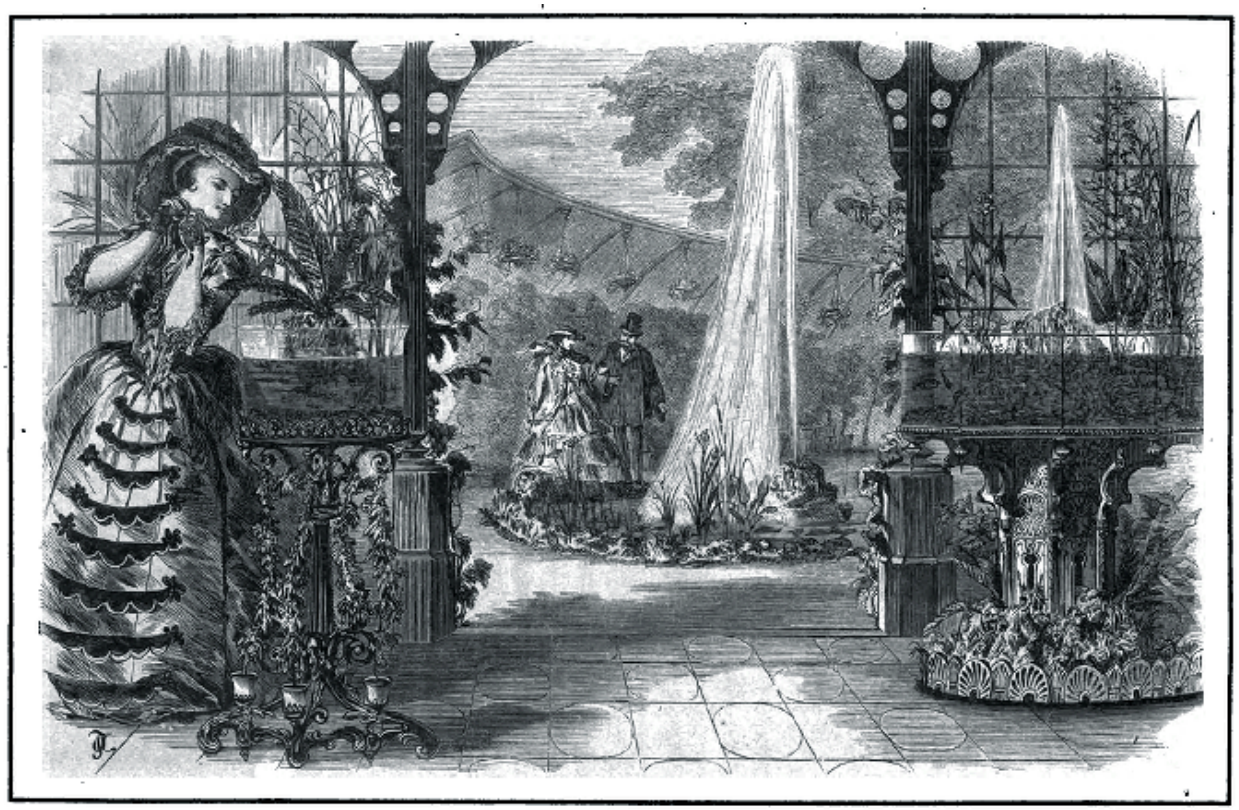


Figure 10: From "Das Süsswasser-Aquarium," by Emil Adolph Rossmässler.

Rossmässler discusses three types of aquariums:

"At the top of the list, and at least until now almost alone in its use, we have the vase-like aquariums as I will call them for brevity, i.e., those which consist of large, wide, cup-shaped glass vessels. The cover picture shows one on the left side.

"Then comes the box aquariums, in which glass panels are set in a cast-iron framework (see the right side of the picture). [Author's note: One has to look hard to see the differences between the two depictions. The one on the left has a flared top and is all-glass; the one on the left has straight sides and distinct panels.]

"The third type I call the basin aquariums. You find these only in attached greenhouses and garden living rooms, and are constructed of stone with a clay bottom."

The last type is the aquarium of the gardener (and the origin of our word for a fish tank), essentially a vessel used to grow aquatic plants, hence the clay on the bottom for the plant roots, but since it contains water, there is no reason why fish and/or other aquatic animals may not be added. A more detailed history of what Rossmässler terms the basin aquarium can be found in my monograph, "Who Invented the Aquarium?" (Klee, 2012).

The section of the book dealing with the living creatures of the aquarium is most unusual, and its introduction follows:

"The goldfish defines the theme of this chapter. We obtained it from the Chinese, the only species that has ever been introduced over a wide range in Europe.

"But even if the goldfish (*Cyprinus auratus*, thus a generic brother to our carp, *Cyprinus carpio*) will always appear more aristocratic in its official Mandarin dress alongside the simple dress of our native fishes, the latter shall still remain our compatriots and have a priority claim to our favor.

TABLE 5: BREAKDOWN OF "DAS SÜSSWASSER-AQUARIUM"

SECTION	PERCENT
Foreword	2
History of the freshwater aquarium	2
Of the various types of aquariums	1
What is an aquarium an•d what should it be?	2
General rules for the aquarium	3
Introduction to the plants	1
a. water plants	20
b. marsh plants	17
Plants for the pond aquarium	12
Fish and other creatures for the aquarium	
a. Fish	1
b. Water insects and snails	18
c. Amphibians	5
Aquarium construction	4
Filling and furnishing the aquarium	4
Care and feeding of aquarium fish and other creatures	4
Collecting specimens	2
The bassin aquarium	2
Totals	**1.00**

"But almost every class of animals provides creatures to enliven our aquarium; for example, if you bother to provide the necessary means to prevent the water shrew from escaping, you can certainly keep it at home. I hereby introduce the creatures of the aquarium, one after another, starting from the low-

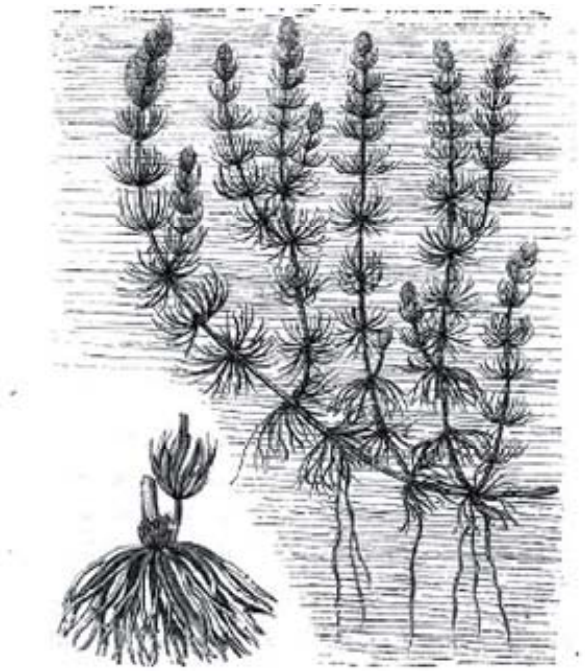


Figure 11: *Ceratophyllum demersum*, from "Das Süsswasser-Aquarium," by Emil Adolph Rossmässler.

est and then ending with those that stand on the highest rung of the animal kingdom."

The second paragraph shows Rossmässler's predilection towards native animals and the third signals his intention to describe these animals from the lowest to the highest in the animal kingdom. To do this, he divides the chapter into eight sections; Section I infusorians, Section II polyps, Section III worms (e.g., tubifex), Section IV insects, Section V crabs (e.g., *Gammarus*), Section VI mollusks, Section VII fishes, and Section VIII amphibians.

The other chapters of the book that deal with the types of aquariums and their construction, aquascaping, care, feeding and collecting are all well-written and comprise the basics of the aquarium hobby even as practiced today. However, other than plants and animals, the book is devoid of any illustrations whatsoever; drawings and diagrams would have been helpful in all of these areas. As I have mentioned, even Müller's small book contained two illustrations of this sort. Considering Rossmässler's background and skill in illustration, this deficiency is difficult to explain.

Rossmässler's last chapter expands on the basin aquarium, but as this form is a transition between the aquarium of the gardener and the "parlour aquarium" of the day, this is understandable. Except for the lack of illustrations in the areas mentioned and fish diseases (very little was known then about the latter), Rossmässler overlooked very little for the fledging aquarist when he wrote his book.

ROSSMÄSSLER'S LEGACY

The credit to Rossmässler for the development of the aquarium in Germany is based upon the fact that after the launch of the marine aquarium before the large audience of *Die Gartenlaube*, he recognized the great opportunities for the masses in the observation of aquatic animals in glass jars, an activity that for him and other scientists was not new. Because freshwater plants and animals were procured nearer at home much more easily and cheaply, he replaced the aristocratic "Ocean on the Table" with the more democratic "Lake in the Glass." In this he was helped by the technological development in the production of flat or sheet glass that made the aquarium affordable for many people. It is worth noting that 1880 marked the date of the 4th Revised edition of "Das Süsswasser-Aquarium" (edited by Otto Hermes, Director of the Berlin Aquarium), published 14 years after his death.

Rossmässler is not only regarded as the Father of the aquarium hobby in Germany, but also as the champion and sometimes founder of natural history museums, in particular the one in Leipzig, an early representative of the movement for nature conservation, a fighter

for environmental protection and a reformer of scientific education in schools.

Rossmässler would most likely not have welcomed certain elements in the future development of the aquarium because he wanted to encourage people to monitor nature close to home. He would have been critical of the introduction of tropical fish and plants, apart from the excesses of the aquarium accessories industry such as “burping clams” and the like, and I have no doubt that he would be turning over in his grave if he saw the brisk business done today in plastic plants. Then again, perhaps the intensive study of ichthyology and ecology that has been pursued by many aquarists, resulting in the development of new knowledge of what would have otherwise remained just a group of non-economic small fishes, might have reconciled him to a great extent.

EPILOGUE

The German revolution of 1848 turned the interplay of science, politics and religion into a public affair. Many of Rossmässler’s contemporaries shared his fundamental belief that any sound societal order had to be grounded in a scientific view of the world. According to this conviction, religious devotion had to be channeled away from the institutionalized churches and - through the mediation of science teachers - directed toward the admiration of the natural world. Consequently, freethinking and politically engaged scientists such as Rossmässler tried to create democratic political structures by cultivating nature studies. Their hero was a man whose affinities for democratic and liberal ideas were already well known, but whose close affiliation with leading circles of established scientists in Europe and with the royal court of the Prussian king made him, on first view, a rather surprising model to emulate: Alexander von Humboldt, cosmopolite, traveler, and Germany’s towering figure in the field of natural sciences.

Imbued with the spirit of Humboldtian thinking, Rossmässler and those sympathetic to his ideas left a remarkable imprint on post-revolutionary cultural and intellectual life in Germany, despite numerous obstacles and even open resistance by state and church authorities. They helped launch a broad movement to make science popular among the German population, although the legitimacy and potential intellectual authority of this field remained highly contested.

Unfortunately, in Germany, unlike in other Western countries, a gap widened over the course of the nineteenth century between rapid economic modernization and political democratization, which allowed state authorities, the military and old elites to dominate the political arena and deny the claims for

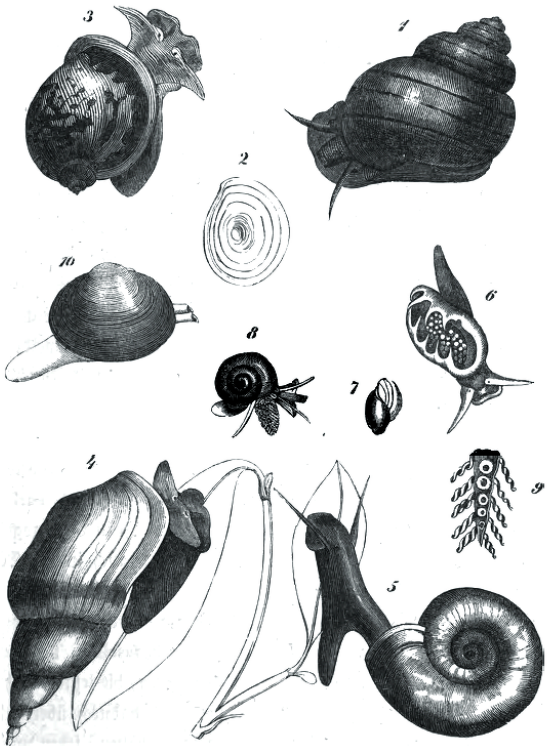


Figure 12 : Snails for the Aquarium. from Das Süsswasser-Aquarium, 1857.

Figure 13: Emil Adolf Rossmässler (1806-1867) later in his life.

participation raised by the middle classes and the workers.

When Otto Ule and Karl Müller decided to publish the journal *Die Natur: zeitung zur verbreitung naturwissenschaftlicher kenntniss und naturanschauung für leser aller staände* (*Nature: A Newspaper for the dissemination of scientific knowledge and views of nature for readers of all levels*), they heard that Rossmässler was interested in publishing a similar magazine and, knowing that he could attract staff and provide quality illustrations, added his name along with theirs to the masthead in the first two years of publication. Towards the end of his association with the magazine, however, Rossmässler wanted Ule and Müller to lower the price of the magazine and to set its level closer to the people.

Rossmässler got along quite well with Ule, a vicar's son who had also been involved as a Democrat in the revolutionary events of 1848/49. Ule had been fined and imprisoned for several weeks for insulting a Prussian minister so, like Rossmässler, a career at a Prussian university was impossible and he was forced to work as a journalist and writer. On the other hand, Müller, a pharmacist, couldn't suppress his resentment at being criticized for the price of the magazine when the price of Rossmässler's own book, *Das Süsswasser-Aquarium*, was set so high. Nevertheless, Rossmässler left on an amicable basis and Ule and Müller continued to publish the magazine. It turned out that they were the better businessmen since it had a 50-year run, a respectable showing for the time. I tell this story because it shows how dedicated Rossmässler was in striving to introduce and encourage the study of nature among the common folk.

At the Natural Science Association of Saxony and Thuringia in 1871, a speaker gave Rossmässler a posthumous but involuntary compliment. After a presentation on the Darwinian theory of evolution, which then of course, was still very controversial - Ule was for and Müller was against - the rapporteur noted that **"Archdeacon Schmidt from Aschersleben followed up on the previous lecture by explaining that he was a staunch opponent of Darwinism, his malacologic experience contrasting with that of Rossmässler who has been a pronounced Darwinian long before the appearance of Darwinism…"** Better the Archdeacon could recognize a little of Rossmässler's work, even if this man of the church had certainly meant something quite different!

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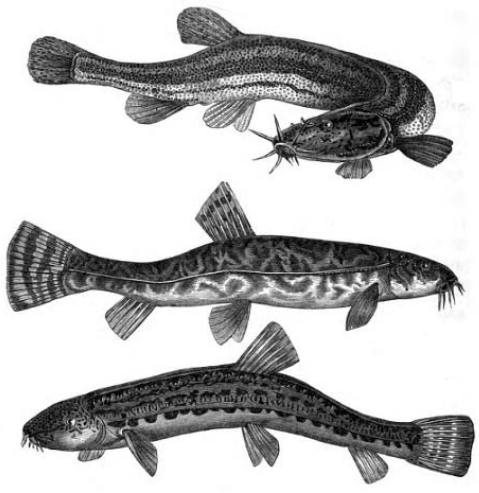


Figure 14 : Examples of three different loaches from the 1880 edition of "Das Süsswasser-Aquarium."

The Development of the Aquarium Hobby in Germany, 1852-1890

by Albert J. Klee, Ph.D.,
Aquarium Hobby Historical Society, Yahoo Files Section, February 9, 2013

American aquarists as a rule know little about the very early development of the aquarium hobby in Germany. What is generally known are mostly Ernst Bade's books from the turn of the century, i.e., "Süßwasser Aquarium" (1896) and "Praxis der Aquarienkunde" (1899), and two post World War I books, Christian Brüning's "Ichthyologischer Bilderatlas" (1932) and Arnold and Ahl's "Fremdländische Süßwasserfische" (1936).

To this end, I explore here the development of the aquarium hobby in Germany from 1852 to 1890, viewed through the literature of this period. Since I will proceed chronologically, these references are arranged in order of year of publication and are identified by number. All other references are identified by author and year and are placed in an "Additional Bibliography." When referring to the title of a book or article I present both the original German title (so you can find it in the references) as well as a translation into English.

LIEBIG'S WORLD IN A GLASS

Reference 1 (1852), an anonymous review titled, "Liebig's Welt in einem Glase" ["Liebig's world in a glass"], requires the following introduction.

In 1849, Robert Warington devised an ecologically balanced system using a 12-gallon aquarium in which he placed two small goldfish. Also placed in this container was a small *Vallisneria spiralis* plant and five or six water snails, *Himnaea stagnalis*. The container was then more or less sealed (he used muslin). The plants produced oxygen and took up the carbon dioxide produced by the fish, the pond snails served as garbage disposers and their young were eaten by the fish. In daylight, this biological balance held for years. A replica of this system in the form of about a meter wide water-filled glass sphere is in the Natural History museum of Vienna and is shown in Figure 1.

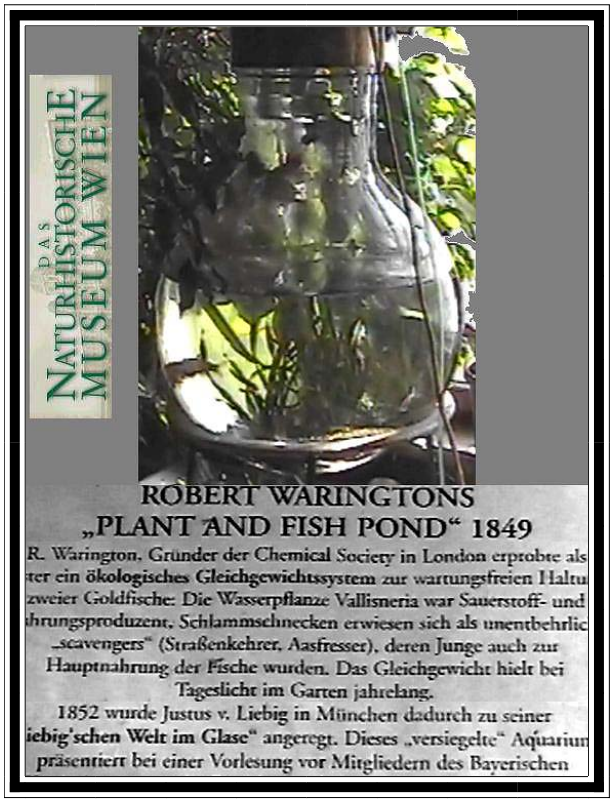


Figure 1: A replica of Warington's sealed, balanced aquarium in the Natural History Museum of Vienna. The last line of the legend reads, "Inspired by this, in 1852 Justus von Liebig created in Munich his "Liebig's world in the glass." This "sealed" Aquarium, presented at a lecture to members of the Bavarian Royal House, was the introduction of the aquarium into Germany."

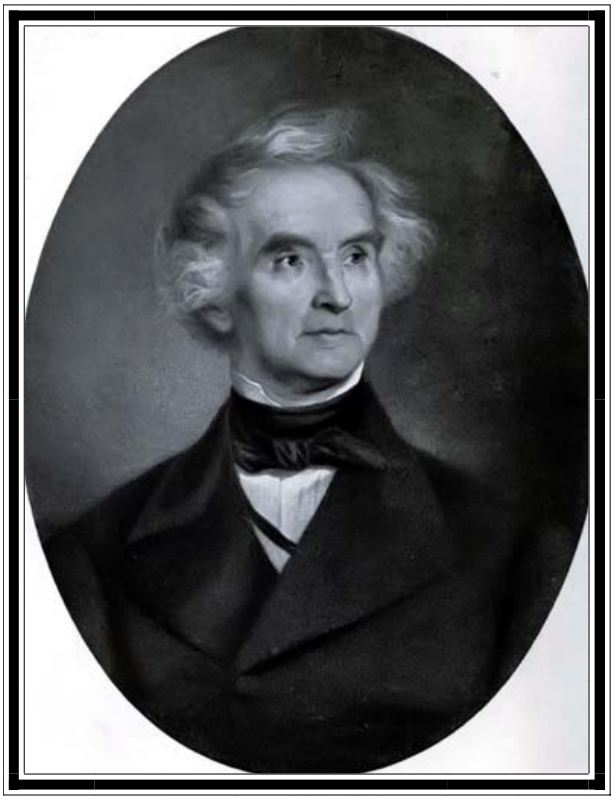


Figure 2:
Justus Freiherr von Liebig (1803-1873).

Justus Freiherr von Liebig (1803-1873) was a German chemist (Figure 2) who made major contributions to agricultural and biological chemistry, and worked on the organization of organic chemistry. As a professor (he received an appointment from the King of Bavaria to the University of Munich in 1852), he devised the modern laboratory-oriented teaching method, and for such innovations, he is regarded as one of the greatest chemistry teachers of all time. He is known as the "father of the fertilizer industry" for his discovery of nitrogen as an essential plant nutrient, and for his formulation of the "Law of the Minimum," often simply called "Liebig's Law." The principle actually was developed in agricultural science in 1828 by Carl Sprengel, a German Botanist, but was later popularized by Liebig. It states that growth is controlled not by the total amount of resources available, but by the scarcest resource, i.e., the limiting factor. An image of a barrel - often called Liebig's barrel (Figure 3) – is sometimes used to explain Liebig's law. Just as the capacity of a barrel with staves of unequal length is limited by the length of the shortest stave (say phosphorus) and can only be increased by lengthening that stave, when that stave is lengthened, another one becomes the limiting factor.

During a visit to England he was shocked to observe the sewage of Britain being sent out to sea and subsequently delivered a tremendous tirade against the British for their practice of importing bones from Europe instead of using their sewage as a fertilizer. In later years his reputation became so great that he was regarded as the final authority in chemical matters, and he was often involved in scientific controversies. In the field of biochemistry, for example, Liebig became involved in a famous dispute with Louis Pasteur. As a supporter of Berzelius (a famous Swedish chemist), he claimed that all chemical changes were

Figure 3: Liebig's Barrel.

brought about by catalysts and that no organisms were involved; thus in 1869 he argued that there was nothing biological about fermentation. Pasteur, however, managed to demonstrate that the vinegar produced by wine souring on contact with air resulted from the action of yeast.

While at the University of Munich, Liebig became fascinated with Warington's work and made his own replica that quickly became known as "Liebig's world in a glass." The article is a summary of both Liebig's and Warington's observations and is important because it marks the beginning of the aquarium in Germany.

The next on the scene was an article (Reference 2) titled, "Kasten für die Wasserpflanzen, oder das Zimmer-Aquarium" ["Cases for aquatic plants or the Parlour Aquarium"] but this was merely a translation of Ward's "The Aquatic Plant Case, or Parlour Aquarium" that appeared in The Garden Companion, and Florists' Guide of 1852, a copy of which appears in my monograph, "Who Invented the Aquarium?" (Klee, 2012). This was followed in 1854 with "Blumengestell mit Fischbehälter" ["A flower stand with a fish tank"] (Reference 3), a picture of which is shown in Figure 4. This, however, was nothing more than the traditional gardener's aquarium, albeit a very elaborate one, containing fish. At the end of this reference, under the title of "artistic garnish," was the drawing of the aquarium shown in Figure 5.

DR. HEINRICH BETTZIECH-BETA

In 1854 and 1855 there appeared four articles in the weekly magazine, *Die Gartenlaube* (a magazine also discussed in my Roßmäßler monograph), all containing the phrase, "Der Ocean auf dem Tisch" ["The Ocean on the Table"]. Until recently, the author of these articles was unknown until Mathias Pechauf, in an article titled "Wer war der Verfasser des 'Ocean auf dem Tische'?" ["Who was the author of the 'Ocean on the table'?"] identified him as Dr. Heinrich Bettziech-Beta.

Bettziech-Beta was born in 1813, the son of a farmer in a small village in Saxony, Werben by Delitzsch. Of Slavic/Serbian ancestry, his birth name was Johann Heinrich Bettziech but as he was a follower of Hegel's philosophical views, he took the pseudonym "Beta" to get around the "taint of foreign birth."

He attended the Latin School of the Francke'schen Foundation in Halle, and then studied philology, philosophy and science at the University of Halle. After earning his

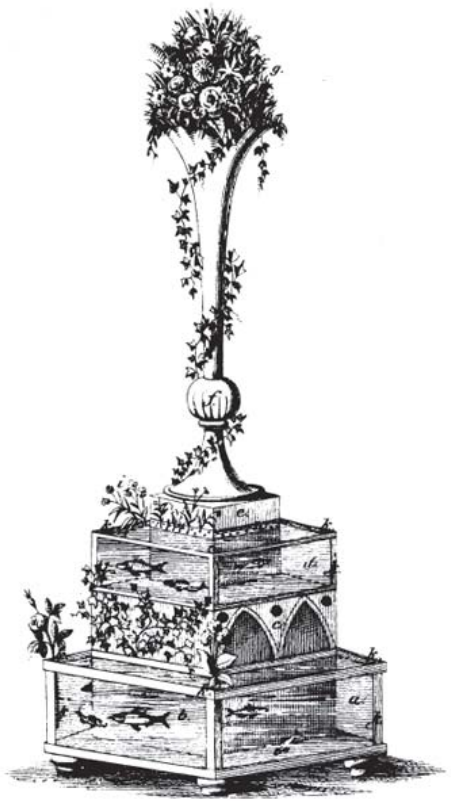


Figure 4: "A flower stand with a fish tank," from Reference 3, 1854.

Figure 5: "Artistic Garnish," from Reference 3,1854.

Ph.D. in 1838, he moved to Berlin. Although he did not participate directly in the revolution of 1848, he edited the *Berliner Krakehler*, a satirical political magazine which was banned in 1849. In addition, he wrote numerous pamphlets on current topics that criticized the Prussian justice system and so was investigated for "incitement to treason" with a possible sentence of two to nine years in prison.

A fugitive warrant was issued for him but he escaped in 1851 by boarding an emigrant ship in Bremen and went to London where he married his first wife. Here he made his living by writing for English, German and Russian newspapers and magazines. As the London correspondent for *Die Gartenlaube*, he made many interesting contributions about all aspects of social life in London and throughout the United Kingdom and thus significantly contributed to the great success of this magazine in Germany. Bettziech-Beta knew Karl Marx but there was no love lost between them, Marx terming him a "hack." He held an open house for all emigrants from Germany and supported many of them. After the general amnesty on the occasion of the inauguration of King William I of Prussia (later Emperor William I of Germany), he returned to Berlin in 1861 to continue his writing, dying there in 1876 after a long illness.

Returning now to Bettziech-Beta's articles previously mentioned, the first one (Reference 4) discussed Philip Henry Gosse's 1854 book, "The Aquarium: an unveiling of the wonders of the deep sea"; the next two (References 5 and 6) discussed artificial sea water and Reference 7 provided instructions on the establishment of marine aquaria and their maintenance. This last article, "Wie erund behält man den Ocean auf dem Tische, oder das Marine-Aquarium" ["How one keeps the Ocean on the Table, or the Marine-Aquarium"] is the one that prompted Roßmäßler to write his famous article on freshwater aquariums (Reference 8), "Der See im Glase" [The Lake in the Glass"].

Reference 9 (1856) was based upon an article that appeared in an 1854 issue of *The Gartenlaube* that discussed the principle of the balanced aquarium, and Reference 10 was Ludwig Müller's "Das Aquarienbüchlein aus dem Jahre 1856. Ein Beitrag zur Geschichte unserer Aquarienliebhaberei" ["The Aquarium Booklet from 1856. A contribution to the history of our aquarium hobby"]. However, References 7, 8 and 10 have been discussed in detail in my article on Roßmäßler, so I won't describe them again here.

Georg Ritter von Frauenfeld (1807-1873) was an Austrian naturalist and zoologist (Figure 6), specializing in entomology and malacolo-

Figure 6:
Georg Ritter von Frauenfeld (1807-1873) .

gy, and was curator of the mollusk collection in the former Kaiserlich-Königliche Zoological Court Cabinet in Vienna (now the Museum of Natural History). In 1851 he founded the Zoological and Botanical Society in Vienna and from 1857 to 1859 took part in the Novara expedition. In 1860 he was awarded the Austro-Imperial Order of Leopold III. Class, and elevated to the hereditary knighthood. In 1868 he became vice president and editor of the Association for the Dissemination of Scientific Knowledge, published in Vienna.

Reference 11, "Ueber Aquarien" ["About Aquariums"], was written in 1856 by Frauenfeld and discussed both salt and freshwater aquariums with about one third of the text taken from translated English sources. As it was with everything that Frauenfeld wrote, however, it was of high quality compared to some of its predecessors.

A little different in approach was Reference 12 (1857) "Naturwissenschaftlicher Seehandel, oder: Der Ocean auf dem Tische noch einmal" ["The maritime trade in nature science, or: The Ocean on the table once more"] where the author (anonymous) discussed the commercial side of the marine aquarium hobby and included material about Lloyd's establishment in London. Figures 7 and 8 show illustrations taken from the article.

Reference 13 (1857) is a two-part article in four sections, the first one written under H. Heinrich-Beta's own name: "Die Natur als Hausfreundin: I. Blumenfenster, II. Flora's Krystall-Palast in Zimmer, III. Blumenfenster

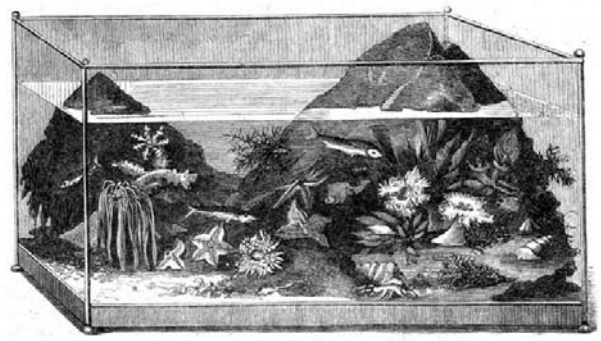


Figure 7: From "The maritime trade in nature science, or: The Ocean on the table once more," Reference 12,1857.

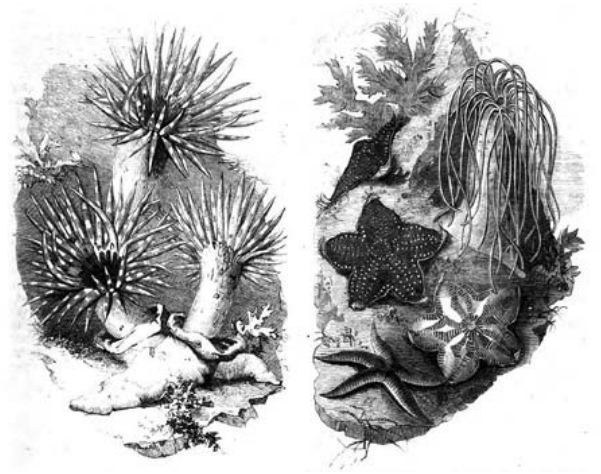


Figure 8: From "The maritime trade in nature science, or: The Ocean on the table once more," Reference 12,1857.

Figure 9: "The Flower and Aquarium Window," from Reference 13, 1857.

mit Aquarium, IV. Blumenvasen und Gartenhäuser" ["Nature as a Friend of the Family: I. Flower Window, II. The Crystal Palace of Flowers in the Room, III. Flower & Aquarium Window, IV. Vases & Garden Sheds"]. The only part of this article that is relevant to the aquarium, however, is Section III, "The Flower and Aquarium Window," an illustration of which is shown in Figure 9. Reference 14 is Roßmäßler's book "Das Süßwasser-Aquarium" which, like references 7, 8 and 10, has also been discussed in detail in my article on Roßmäßler, so I won't describe it again here either.

Another of those short articles that appeared in the garden magazines of the time, - Reference 15 (1857) - was titled "Ueber Zimmer Aquarien" ["About Room Aquariums"]; Figure 10 shows the aquarium described in the article.

Reference 16 (1858), "Ueber Aquarien" ["About Aquariums"], which appeared in a weekly magazine of horticulture and botany, was written by Frauenfeld and to be expected was a cut above the last, dealing with both marine and freshwater aquaria. Frauenfeld discussed light, temperature and feeding for both marine and freshwater aquaria, and also artificial marine water for the former. Regarding the vessel itself, the author was not sanguine about all-glass types such as the typical bell jar since they were usually not cooled properly and broke easily when jarred. They often burst, seemingly without any cause, flooding the room and trapping the animals in the broken glass where they quickly died. The author recommended pentagonal and octagonal aquaria

Figure 10: From "About Room Aquariums" Reference 15, 1857.

made with zinc or iron frames where the sides flared outward progressing to the top.
Published in 1858, Reference 17, "Aquarien zur Belustigung" ["Aquariums for Amusement"], is interesting because of where it appeared, i.e., in "Der ärztliche Hausfreund: Zur Förderung der Gesundheitspflege und Kenntniß des menschlichen Körpers und der Natur: Aerzten und Nichtärzten gewidmet" ["The Medical Family Friend: For the promotion of the health care and knowledge of the human body and nature. Dedicated to Physicians and Laymen"].This was a weekly magazine, edited by a medical doctor and somewhat similar to the health care newsletters of today, although nature subjects that had a bearing on health were at times included. The article itself dealt essentially with the carbon dioxide/oxygen relationship between plants and animals and gave no details about how one was to set up and maintain an aquarium, referring the reader instead to Müller's 1856 aquarium book, which apparently was more fairly wide-read than previously realized.

The decade of the 1850's ushered the aquarium hobby into Germany and produced two of its most important early books, Müller's "Aquarium. Belehrung und Anleitung solche anzulegen und zu Unterhalten and Roßmäßler's "Das Süßwasser-Aquarium. Eine Anleitung zur Herstellung und Pflege desselben. It was off to a good start.

THE DECADE OF THE 1860'S

Karl August Möbius (1825- 1908) was a German zoologist and pioneer (Figure 11) in the field of ecology. In 1863 he opened in Hamburg the first German marine public aquarium exhibit. In 1868, shortly after passing his doctoral examination at the University of Halle, he was appointed Professor of Zoology at the University of Kiel and the director of the Zoological Museum. Marine animals were among his main research interests and his first comprehensive work on the fauna of the Kiel Bay emphasized its ecological aspects ("Die Fauna der Kieler Bucht," co-authored with Heinrich Adolph Meyer, and published in two volumes in 1865 and 1872, respectively). In 1888 Möbius became the director of the Zoological Collections of the Museum für Naturkunde in Berlin, and Professor of Systematic and Geographical Zoology at the Kaiser Wilhelm University, Berlin, where he taught until 1905, retiring at the age of 80.

This decade began with Reference 18, "Einrichtung und Erhaltung der Aquarien, mit Berücksichtigung der Aquarien des naturhistorischen Museums in Hamburg" ["Establishment and Maintenance of Aquariums, with regard to the Aquariums of the Museum of Natural History in Hamburg"], written by Möbius and published in a magazine for "gardening and flower enthusiasts," but being authored by Möbius it was more informative than most such articles. He described some of the fish kept at the Hamburg Natural History Museum and, for the first time, fish imported from India and Java,

Figure 11:
Karl August Möbius (1825- 1908).

including the marine Butterfly fish, *Chelmon rostratus* and the Archer fish, *Toxotes jaculator*. The article went on to mention the development of the aquarium citing Ward, Priestly, Ingenhaus and Sennebier, followed by a discussion of the carbon dioxide/oxygen cycle in the aquarium. The Museum had three aquariums of various sizes in the 40 to 50 gallon range for the two marine tanks, smaller for the lone freshwater tank; these and their contents were described in detail.

Reference 19 (1860) had the usual garden magazine content so I'll quote the author's introduction to the article, **"Parlor aquariums been written about many times in various magazines, so much so that we have always shied away from augmenting its literature. Today, however we want to devote a few words to the same,"** and move on!

The third book on the freshwater aquarium appeared in Germany in 1861 (Reference 20), "Das Süßwasser-Aquarium: Kurze Anleitung zur besten Construction der Aquarien und Instandhaltung derselben, sowie Schilderung der Süßwasserthiere" ["The Freshwater Aquarium: Short guide to the best construction of aquariums and their maintenance thereof, and a description of its freshwater animals"], written by Dr. Eduard Heinrich Graeffe. Although Graeffe was Swiss, not German, his book is in German and was published in Hamburg where he was living at the time.

Graeffe (1833-1916) specialized in Hymenoptera, Diptera and Hemiptera. He was hired by Johann Godeffroy, a wealthy shipping magnate with a private museum in Hamburg where he was employed in order to arrange the collection as a scientific exhibit. The museum, which contained insects from Australia, Samoa, Fiji, Tonga and the Phoenix Islands, also functioned as a dealership in natural history material and lasted from 1861 to 1885. Earlier he had worked at the Zoological Station in Trieste where there were a number of aquariums in its basement and where Graeffe most likely obtained his interest in the subject.

Table 1 shows how the Graeffe broke down the various sections in his book. When one compares this with Roßmäßler's Süsswasser-Aquarium (Klee, 2013a) the main difference noted is the reversal of emphasis on plants versus animals, i.e., Roßmäßler spent 40 percent on plants and Graeffe spent 39.5 percent. Indeed, in his introduction to his book Graeffe wrote: **"There have been various writings about the aquarium, of which the best known is by that writer of popular science, Mr. Roßmäßler. However, the latest experiences of our English aquarium friends were excluded and in addition he takes the plant kingdom into account more than anything else, whereas here it is the animal kingdom that takes precedence. Therefore, my work might not be entirely superfluous."**

Although Graeffe's book did have some illustrations that were not of plants or animals

TABLE 1: BREAKDOWN OF GRAEFFE'S "DAS SÜSSWASSER-AQUARIUM"

	%
Introduction	3
The aquarium as a water vessel	7
Establishment of the aquarium	3
Stone and gravel in the aquarium	3
Aquatic plants and their function	7
Filling the tank	1
Aquatic animals and their establishment	39.5
The capture and introduction of animals in the aquarium	5
Maintenance of the aquarium	1
Descriptions of its freshwater animal life	26.5
Final considerations	4
Total	100

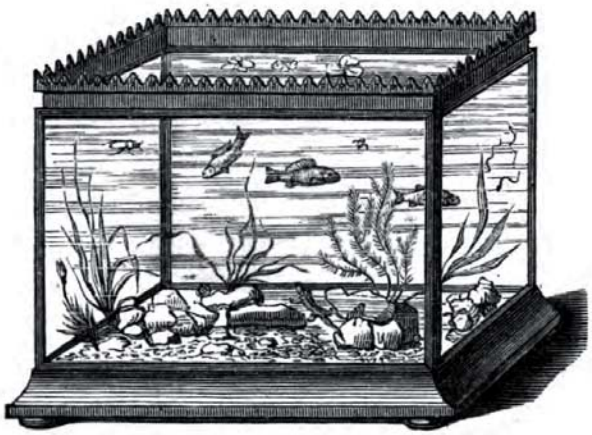


Figure 12: From "Das Süßwasser-Aquarium: Kurze Anleitung zur besten Construction der Aquarien und Instandhaltung derselben, sowie Schilderung der Süßwasserthiere," Reference 20,

(Figure 12), they were, however, more or less copies from previous literature. In short, this book is just an extension of Mueller's with some added illustrations copied from English sources.

Reference 21 (1863) - "Das Aquarium" - by an anonymous author appeared in a publication that contained essays on cultural and historical topics of the times. It was, in essence, a fairly lengthy historical essay on the development of the aquarium, both public and private, and included among other things Dujardin's work in France and Barnum and Cutter's in America. It was very well done and was the first of this type to appear in the German literature.

Reference 22 (1863) was a short but concise article, "Einige Bemerkungen über Aquarien" ["Some remarks about aquariums"], by Dr. Karl Möbius that appeared in a zoo journal. It presented a comparison of the advantages and disadvantages slope-back versus flat-sided tanks with regard to substrates and aeration. He followed this two years later (1865) with another article in the same journal (Reference 23), "Einige Fingerzeige für die Bevölkerung und Erhaltung der Aquarien" ["Some tips for the population and conservation of aquariums"]. Anything written by Möbius deserves careful reading and this article is no exception. He sets the theme of his article as follows: **"We demand more from aquatic animals than nature provides. We catch fish in rivers, crabs in streams, snails in bogs, mussels in ponds and put them all in one and the same limited water space. Is not similar to when we placed mammals, birds, reptiles and insects from hot and cold zones, from dry deserts and from damp shady woods into the same room? And yet we expect them to move happily, eat and reproduce. We need to connect to nature if we want to learn the scientific principles of the aquarium so that we are able to achieve the greatest possible perfection under artificial conditions."**

He goes on to cite as an example the advice that **"...a newly setup aquarium should contain only pure-washed sand, pure stones, pure river or lake water is erroneous. No water is pure; the water in streams with a gravel base is different from the water of a pond with a calcareous bottom, and the water in a marshy ditch contains substances other than river water, no matter that they may all look alike in a clear-glass aquarium. There are animals that live in muddy water over a muddy bottom, those that live in water over a sandy bottom, those that live in water over a stony base and there are those that thrive on all soil types."**

"I myself have had to overcome with effort the abhorrence of a mud bottom in an aquarium. In the tanks that were set up for Mr. H.A. Meyer and me when we were hired to study the fauna of Kiel Bay, the animals would only thrive when, in addition to the live ones, decaying plants were also in them. Only when we finally decided to place a layer, three to four fingers high, of dark mud from the port of Kiel in two aquariums, did we manage to get the mud inhabitants healthy."

The editor also chimed in with the following comment: **"We have had the same experience**

Figure 13:
Prof. Dr. Gustav Jäger (1832-1917).

with tadpoles. All the feeding and changing of water came to naught when the mud bottom in which they dig to find wholesome food was missing; only one must be careful not to disturb it and muddy the water."

Georg Frauenfeld wrote an article in 1869 (Reference 24) that dealt with the problems of supplying marine water to aquariums situated inland, "Beschreibung eines einfachen Seeaquariums für Aktinien" ["Description of a simple marine aquarium for Actinia"]. Frauenfeld reduced evaporation and kept his tank from becoming contaminated with dust by the use of a tight glass cover and maintained the water level almost to the top. Every six to eight weeks he ran the water through a clean towel and removed the secretions that settled on the glass interior. In this manner he kept anemones alive for over a year without any water changes.

"Das Leben im Wasser und das Aquarium" ["Life in the Water and in the Aquarium"] is a 360-page book (Reference 25) written by Prof. Dr. Gustav Jäger (1832-1917) in 1868 (Figure 13). Jäger was a German natu-

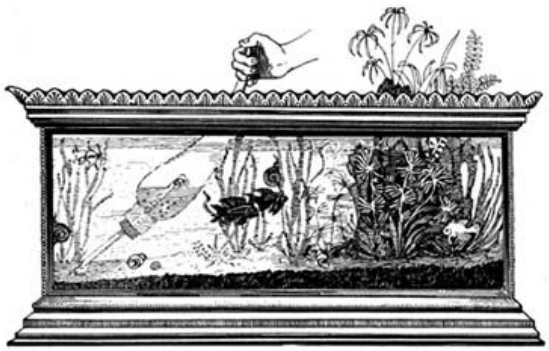


Figure 14: From "Life in the Water and in the Aquarium," Reference 25, 1868.

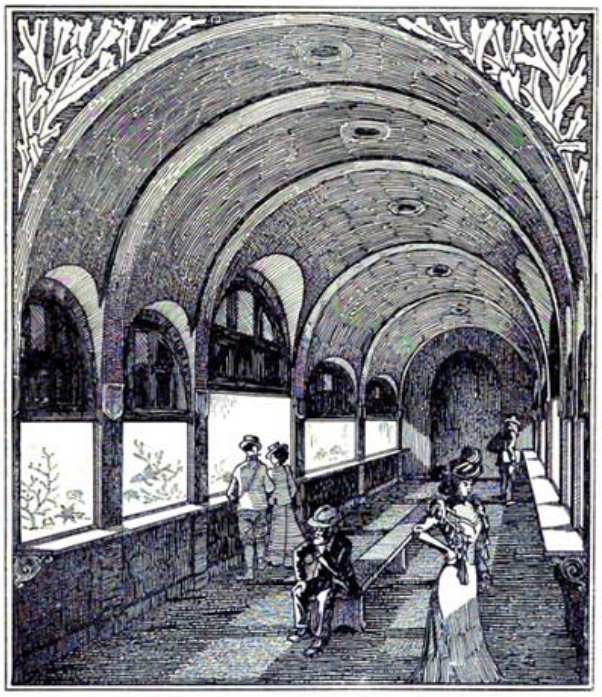


Figure 15: From "Life in the Water and in the Aquarium," Reference 25, 1868.

ralist and hygienist. After studying medicine at Tübingen he became a teacher of zoology at Vienna and in 1868 he was appointed professor of zoology at the academy of Hohenheim. Subsequently he became teacher of zoology and anthropology at Stuttgart polytechnic and professor of physiology at the veterinary school. In 1878 Jäger advanced the first crude version of the pheromone concept. His postulated skin "anthropines," popularly dubbed "lust compounds," came astoundingly close to reality but the idea was too far ahead of the possibilities of chemistry and the life sciences at this time to be corroborated by experiments. In 1884 he abandoned teaching and started practice as a physician in Stuttgart. Unfortunately, although the information was sound, very little in his book was concerned with aquariums per se; the freshwater aquarium section was only 6 pages, the marine aquarium only 8-1/2 pages. Figure 14 shows the only freshwater illustration in the book and Figure 15 shows the only one for marine water, a woodcut of the Hamburg Aquarium.

We return now to Dr. Heinrich Bettziech-Beta (Reference 26) with three of his articles, "Aquariumscultur, Der Ocean auf dem Tische and Die Aquariums-Marine" ["Aquarium Culture, The Ocean on the Table and The Marine Aquarium"] in his 1868 book, "Die Bewirthschaftung des Wassers und die Ernten daraus" ["Water, its Management and the Crops from it"]. The first described public aquaria, the second described the private aquarium (including tank construction, water changes, artificial salt water, maintenance, etc.) and the third described animals suitable for the marine aquarium. These three topics took up a total of 45 pages but there was only a single illustration (Figure 16), that of a private marine aquarium.

Reference 27 (1868) brings us back to the freshwater aquarium with a 17 page article titled "Das Aquarium" in a journal called (translated), "Nature and Revelation, for the Mediation between nature research and Faith for all levels of education," published by a Munich synod and popular with some religious establishments (the copy Google digitized was from the Batz Memorial Library of the Abbey of Gethsemani, Kentucky). In it the author (anonymous) boils down Roßmäßler's book to 17 pages with no illustrations but he does refer the reader to his book for those seeking more details.

Speaking of Roßmäßler, Reference 28 is the

Figure 16: From "Water, its Management and the Crops from it," Reference 26, 1868.

Figure 17: From "The Room Aquarium," Reference 29, 1870.

Figure 18: From "The Room Aquarium," Reference 29, 1870.

second edition of his book, published in 1969 and edited after his death by his friend, Alfred E. Brehm. Brehm changed almost nothing in the book, but some illustrations of fish such as the stickleback, the bitterling, three minnows (*Phoxinus laevis*, *Alburnus licidus* and *Leuciscus rutilis*) and three loaches (*Cobitis fossilis*, *Cobitis barbatula* and *Cobitus taenia*) were added (the scientific names of some cited here have been changed since then).

The decade of the 1860's had its share of competent writers who added material rather than simply repeating what had preceded them or what had been imported from Great Britain, notably, Karl Mobius, Georg Frauenfeld and Heinrich Bettziech-Beta. It also saw the publication of Eduard Graeffe's, "Das Süßwasser-Aquarium: Kurze Anleitung zur besten Construction der Aquarien und Instandhaltung derselben, sowie Schilderung der Süßwasserthiere" and the second edition of Roßmäßler's "Das Süßwasser-Aquarium."

THE DECADE OF THE 1870'S

The decade of the 1870's started off with Hermann Jäger's book, "Das Zimmer-Aquarium" ["The Room Aquarium"] in (translated) "The Room and House Nursery. Instructions for growth, maintenance and use of ornamental plants in the living areas with accessories along with descriptions of the most beautiful ornamental plants" (Reference 29). This was a short, 7-page article discussing the basic requirements for the living room aquarium, including the vessel, plants (as might be expected in a book of this sort, this took up the major portion of the article), fish and maintenance operations such as water changes. The reader was referred to Roßmässlers's Second Edition of "Süßwasser -Aquarium" for further details. Two illustrations were included, Figure 17 showing an ornate double-glass vase aquarium and Figure 18 depicting a framed window box aquarium.

An anonymous 1873 article in *Die Gardenlaube* (Reference 30), "Mein Stuben-Aquarium" ["My Parlor Aquarium"], provided details of the construction of the author's aquarium (Figure 19). In addition to fish, tadpoles, frogs and lizards, the author added diving beetles, dragonfly larva and other aquatic insects but fed them well enough with raw meat, earthworms and snail meat so that the fish and tadpoles were not attacked. As with the previous author, the reader was referred to the second edition of Roßmäßler's book for further information.

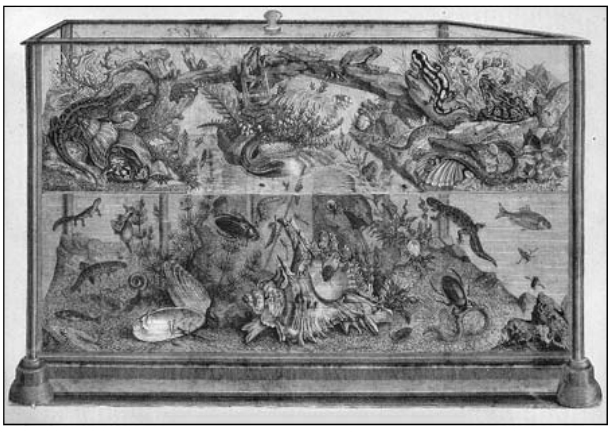


Figure 19: From "My Parlor Aquarium," Reference 30, 1873.

Figure 20: From "Images from the aquarium, the invertebrates of freshwater," Reference 33, 1878

In a well-written article (Reference 31), Friedrich Rossbach discussed the basic principles of the salt and freshwater aquarium including some of its history, lighting and heating. He also described a number of public aquariums and provided some details of the tanks used by them.

Michael Bach in his 1876 18-page article, "Aquarium" (Reference 32) in "Studien und Lesefrüchte aus dem Buche der Natur" ["Studies and gleanings from the book of nature"], didn't add anything new and it was clear that he relied heavily on Roßmäßler's work.

CARL FRIEDRICH WILHELM HEß

Dr. Carl Friedrich Wilhelm Heß (1841-1918) was a Professor of Botany and Zoology at the Technical University of Hanover. His Ph.D. thesis (1865) was on eastern Australian decapod crustaceans. In 1874 he wrote "Bilder aus dem Leben schädlicher und nützlicher Insekten: Die Hymenopteren" ["Pictures from the life of harmful and beneficial insects: The Hymenoptera"] and in 1892 "Die Feinde des Obstbaues aus dem Thierreiche: eine Anleitung zu ihrer Erkennung und Vertilgung für Obstzüchter, Gärtner, Landwirthe u.s.w." ["The enemies of fruit growing in the animal kingdom: a guide to their recognition and destruction for fruit breeders, gardeners, agriculturists etc."].

Reference 33 is a two-part book written by him in 1878, "Bilder aus dem Aquarium, die wirbellosen Thiere des Meeres" and "Bilder aus dem Aquarium, die wirbellosen Thiere des Süßwassers" ["Images from the aquarium, the invertebrates of the sea" and "Images from the aquarium, the invertebrates of freshwater"]. They were available separately or as two single books. The first book discussed and illustrated all kinds of marine animals except fishes; the only reference to fish was in discussing the formulas for marine water and in the commercial aspects of fishing. The second book was pretty much the same, Heß pointing out in his introduction that the book was designed to provide an overview of the lower freshwater animals. He does discuss the tanks themselves and one is shown in Figure 20.

Heß remarked that when there are a lot of plants and animals in the aquarium one can blow air into the water with a bellows, although he preferred a water fountain driven by gravity flow. However, this posed a problem

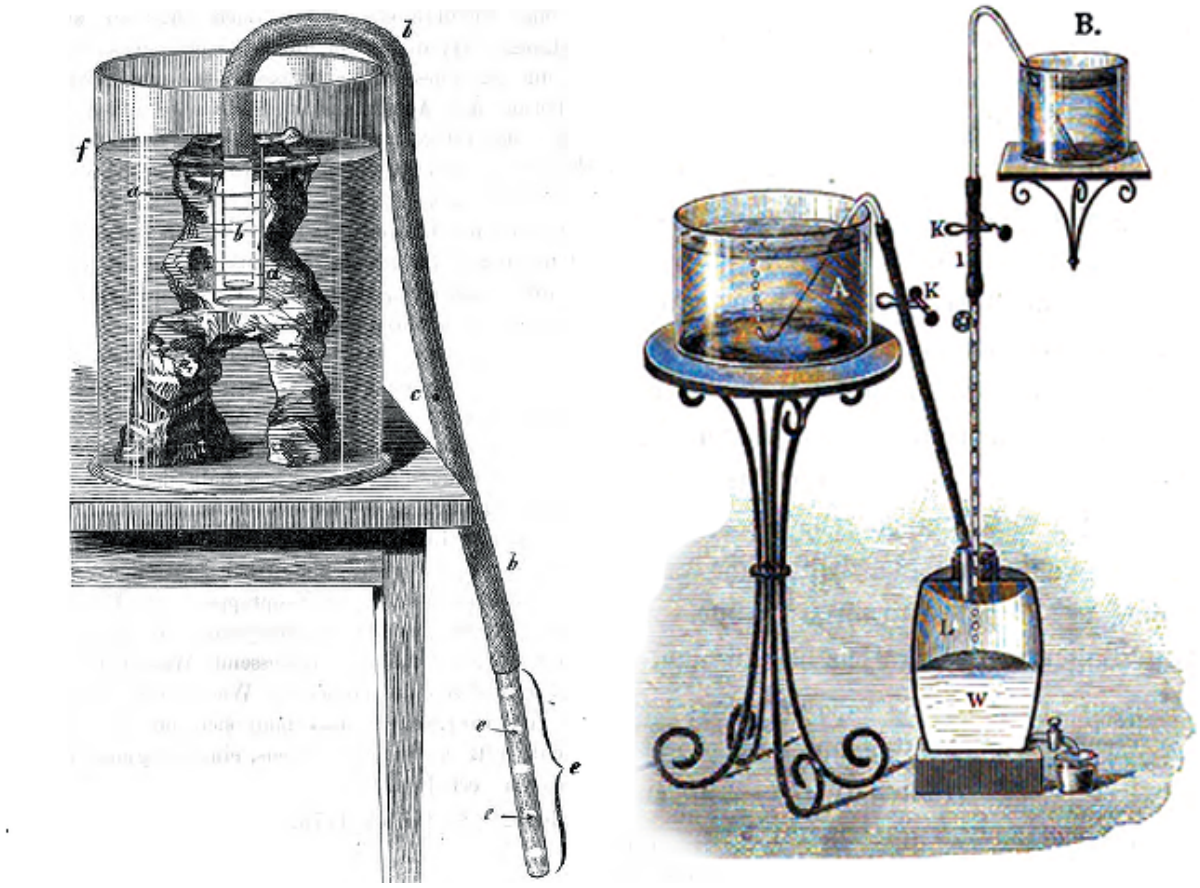


Figure 21: From "Images from the aquarium, the invertebrates of freshwater," Reference 33, 1878

with vase aquaria since no drainage pipe can be attached to them physically because they shatter easily. Thus, if not attended to, the water often flows over the edge of the tank and onto the floor. This problem could be solved a special type of airlift called a "Heber, the word for "Lift" in German (Figure 21, left). After priming the airlift tube, it is led to a short glass cylinder, closed at the bottom, where the water flows from the bottom of the tube into the cylinder while the air stays in the tube and continues to build up. However, above the top of the glass cylinder the excess water is removed so the pressure of the water contained in it is too low to force down the water retained by the air column and the lift stops working.

Figure 21, right is interesting in that it shows a variant on the familiar gravity aeration system. In the figure on the right an open container filled with water is connected to a closed container containing air. As the water flows from the top container to the bottom it displaces the air in the lower container and sends it to aquarium. When the upper container is empty, the water in the lower one is released, poured back into the upper one and the process repeated. Heß remarks that even using large containers, the process lasts but a short time.

Finally, Figure 22 shows a paddlewheel, the lower part of which is immersed in the aquarium so that the water is stirred and hence aerated. The driving mechanism is a clockwork motor.

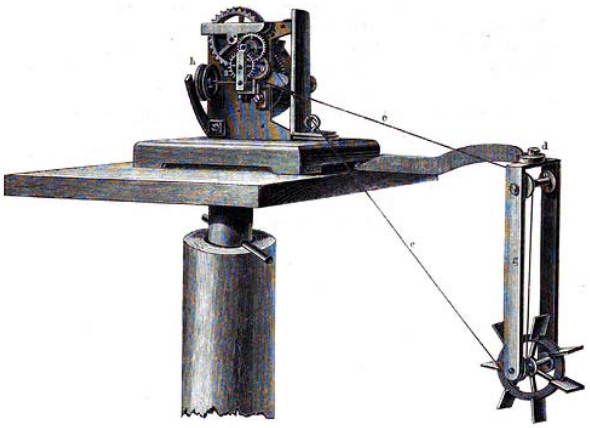


Figure 22: From "Images from the aquarium, the invertebrates of freshwater," Reference 33, 1878

With regard to fish diseases, there was much scientific research taking place at the time and aquarists borrowed freely from scientific publications to use in their own. Since this is a specialized area I won't pursue it further here except to quote one such scientist of the day, the Baron de la Valette St. George, Professor of Anatomy and Director of the Anatomical Institute at Bonn. The following was taken from an article he wrote for the German Fishery Association in Berlin (Reference 34):

"War is the watch-word of the whole of organic nature; there is a constant war of all organisms against outward unfavorable circumstances, and there is constant war among the different individuals. The feed- grain which falls into the ground, the worm crawling on the earth, the butterfly hovering over the flower, the eagle soaring high among the clouds, they all have their enemies - outward enemies threatening their existence, and inward enemies eating their life and strength.

"Even fish, which claim our special attention, are by no means permitted to spend their life in peace. Plants and animals endanger their very life, and when they have been fortunate enough to escape these, man comes and seeks to catch and destroy them with numberless arts and tricks.

"Confined to a special sphere of life, the water, they frequently do not find in it the necessary conditions of existence. In their very cradle, so to speak, that is, in the egg, the tender germs, scarcely awakened to life, are threatened by a dangerous enemy belonging to the lowest grades of the vegetable kingdom. This is the much-dreaded *Saprolegnia ferax* in an incredibly short time its long threads envelop the egg, choke it and destroy it."

The decade of the 1870's was most noted for the publication of Wilhelm Heß's two books, "Bilder aus dem Aquarium, die wirbellosen Thiere des Meeres," and "Bilder aus dem Aquarium, die wirbellosen Thiere des Süßwassers." These books of themselves were not especially important to the aquarium hobby, but they did pave the way for a more important book by Heß that would appear in the next decade. However, this decade also signaled an interest in aquarium fish diseases, spurred on by the research conducted on the diseases of native and commercial fishes by a number of scientists such as La Valette St. George.

THE DECADE OF THE 1880's

In 1886 Heß published his "Das Süßwasseraquarium und seine Bewohner: Ein Leitfaden für die Anlage und Pflege von Süßwasseraquarien" ["The Freshwater Aquarium and its Inhabitants: A Guide to the installation and maintenance of freshwater aquariums"] (Reference 35). This book, however, was a vast improvement over his 1878 freshwater aquarium book. A breakdown of the book's contents is shown in Table 2. Here the amount of space devoted to equipment, installation, filling and maintenance is almost equal to that of plants, and that devoted to animals is three times that of plants. In the table I have broken down the contents within the animal section and the fish predominate. Indeed, as a percentage of the whole book, fish account for 19.4%, essentially equal to

TABLE 2: BREAKDOWN OF HEß'S DAS SÜSSWASSERAQUARIUM UND SEINE BEWOHNER		
	%	%
Introduction		1.2
Equipment, installation, filling and maintenance		17.8
Plants		20.6
Animals		60.4
Reptiles	9.2	
Amphibians	16.4	
Fish	32.2	
Insects & Spiders	12.5	
Crabs	13.2	
Mollusks	5.3	
Worms &Polyps	11.2	
Totals	**100**	**100**

that devoted to plants. Furthermore, there were 105 illustrations in this 255-page book, and at the end of the book he listed 22 suppliers throughout Germany of aquarium animals and equipment.

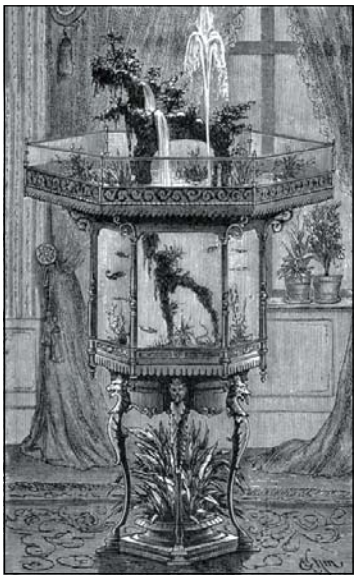


Figure 24: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

Heß described the construction of aquariums in great detail (Figure 23) and some of the more interesting types are shown in Figures 24 and 25, the former showing a very ornate combination aquarium/terrarium. One always wonders, however, if any of the aquariums such as the one shown in Figure 24 were ever

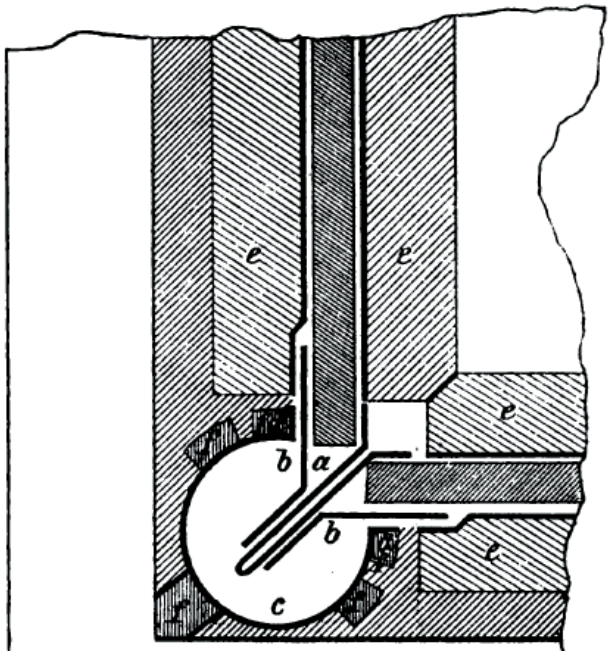


Figure 23: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

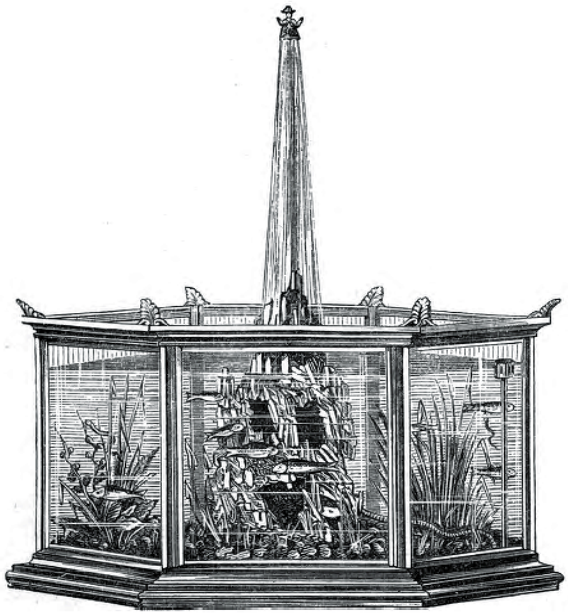
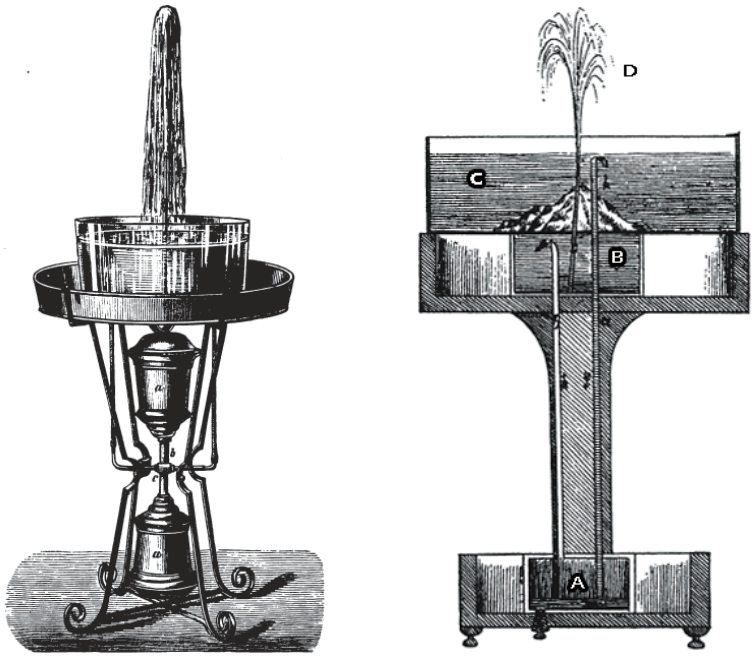


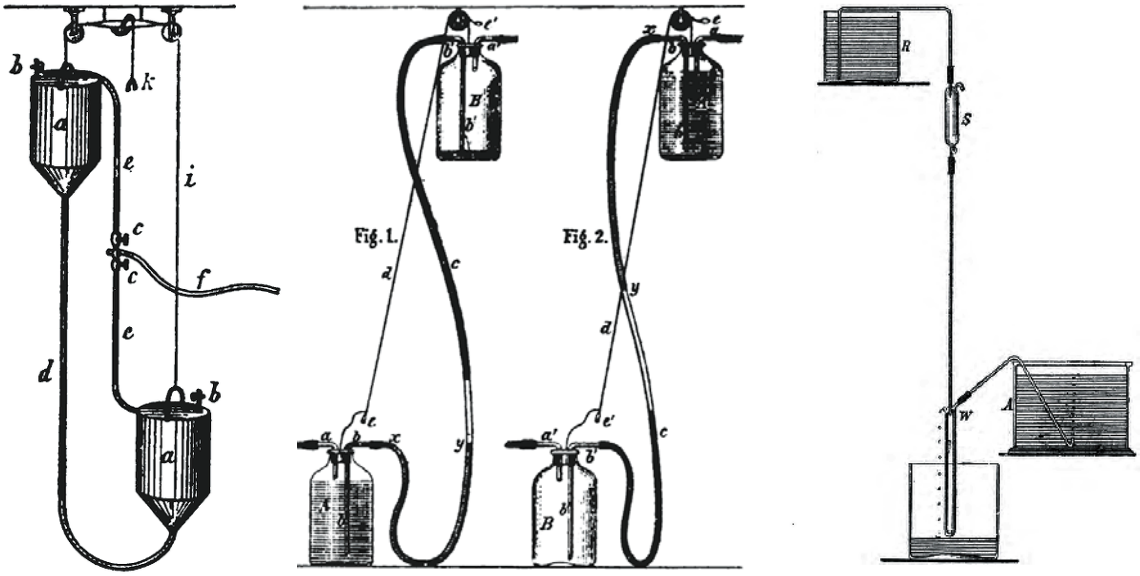
Figure 25: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.



Figures 26 and 27: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

constructed. For one thing, how was access to the fish provided for (feeding, maintenance, etc.) when there was a terrarium on top of it? The woodcut shows a fountain and a waterfall, presumable driven by air (we'll get to how fountain aquarium were made soon), but where were the containers for the air and water and the conduits for them? Behind the curtain for the former and under the rug for the latter?

Heß shows a number of fountain aquariums, two of which are shown in Figures 26 and 27. Both of them are based upon the principle of water displacing air. The one in Figure 26, however, rotates the two reservoirs so that when the one filled with water is on top, the water flows down and displaces the air which is used to produce the fountain flow. Heß remarked that, depending upon the size of the reservoirs and the size of the tubing, the air flow could be sustained for two to ten hours before the reservoirs needed to be rotated. The principle is further explained in my article, "The Early History of Aquarium Aeration" (Klee, 2013b). In Figure 27, at the start



Figures 28, 29 and 30: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

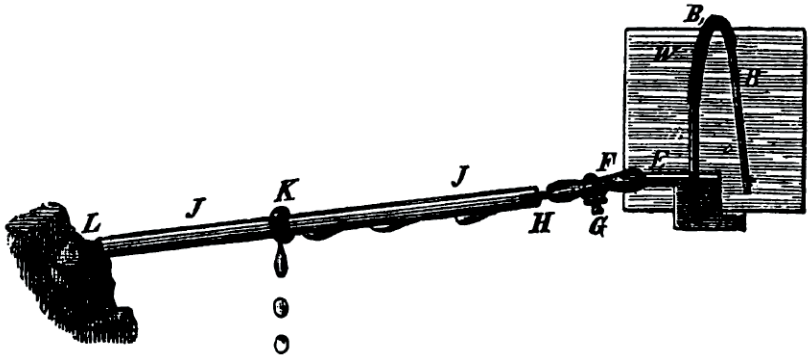


Figure 31: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

A is a reservoir containing air and B is a reservoir containing water. On the top of reservoir B is a fish tank, C. Water flowing from C into A compresses the air above it, forcing the air up into B where it pushes the water into the nozzle D where it then falls back into C replenishing the fish tank water. After a while B is empty and the process stops. Excess water is removed from C via a valve and the process is started over again.

A number of free-standing aeration devices based upon the displacement principle are discussed in Heß's book and I show two of them in Figures 28 and 29. Instead of rotating the air and water reservoirs as in Figure 25, the reservoirs were simply raised and lowered simultaneously using a pulley system.

Figure 30 is an interesting variation using the air lift principle. Water is drawn from reservoir R into a glass tube S that is open to the air at its top. This acts as a Venturi and as water passes through, air is mixed with the water. It passes through a U-tube and then, because now it is an air-lift, rises through the left portion of the tube to a chamber, W, where the water separates from the mixture and falls into the collection reservoir while the air continues into Aquarium A.

Figure 31 is based upon the drip or drop method. Water is drawn off from the reservoir on the right via a narrow tube that fits loosely into a larger tube, J, which is closed at its end, L. Tube J is positioned slightly downward (the author mentioned that it can be held in place by leaning end L against a rock in the aquarium to be so aerated). The flow of water is adjusted by the pinch clamp G. Water will back up in J and run back to point H where it forms droplets that run along its lower part. A rubber ring slides along J and its position determines where the water droplets will be released (presumably into an aquarium that, because of the buildup of water, must be emptied of excess water at times).

Figure 32, left shows a device using the Venturi principle to add air to the column of water leading from the aquarium. A smaller tube (a) from the aquarium is inserted into a larger one (c), the water running through picking up air as it moves downward into the pipe-

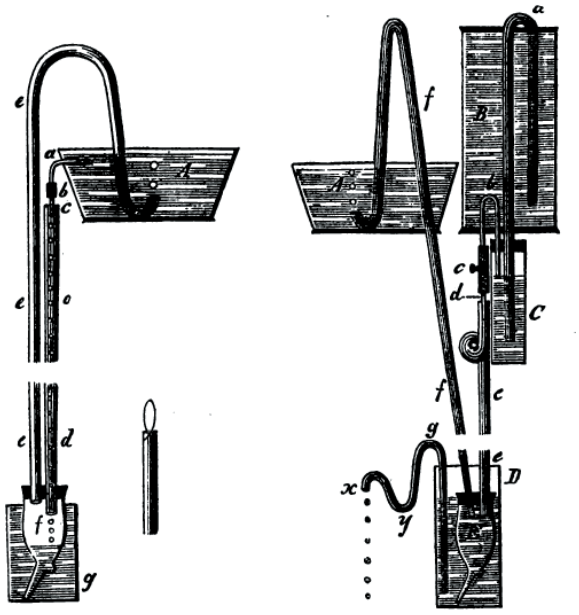


Figure 32: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

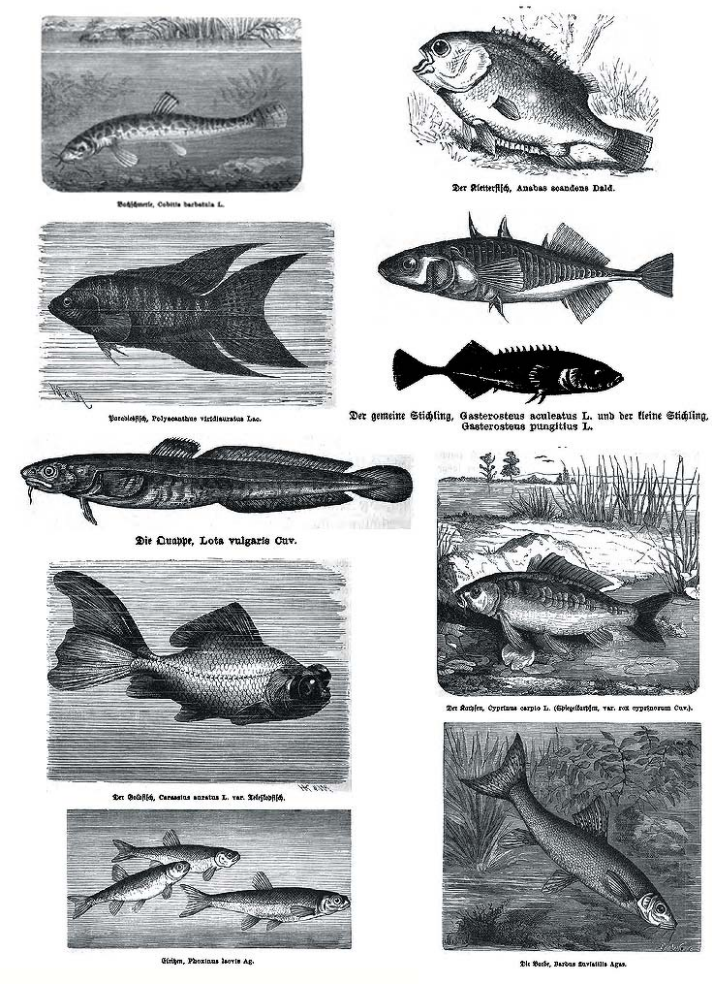


Figure 33: From "The freshwater aquarium and its inhabitants," Reference 35, 1886.

shaped container f (whose point is open) that is set in a sealed reservoir g. A short rubber tube fitted with a screw clamp (b) is used to control the flow. The air/water mixture separates in f and the air travels via a second tube to the aquarium. Following Pascal's Rule, in order to produce the necessary counter-pressure the deeper the water in the aquarium, the higher must be the glass (g). As a general guideline, one set the height of g the same as the height of the water in the aquarium.

Figure 32, right shows a modification of the system. A very wide and high earthenware pot (B) filled with fresh water is set on the table that holds the aquarium. Tube a carries the water into the bottle (C) where any sediment collects in the bottom. From C the water flows through the siphon (b) and from there on uses the same Venturi principle to pick up air as described in the preceding device. Tube (g) is a self-working lift that drains water from the open vessel (D) into a separate container.

Heß described a number of aquarium fishes, both native and exotic, and a number of these are shown in Figure 33.

A number of booklets of varying lengths end this decade. References 37 (72 pages), 39 (23 pages) and 40 (30 pages) were authored by Guido Findeis, an Austrian who was also a publisher of books and magazines on many subjects, including nature. Reference 38 (57 pages) was written by

Figure 34: "The saltwater aquarium and its inhabitants," Reference 38, 1886.

Figure 35: Bruno Dürigen (1853-1930.

Alexander Orleb and his brother, Gustav (Figure 34), and differs from the others in that it was intended for young readers.

Only the following, however, merits further discussion, i.e., the 52-page booklet (Reference 36) by Bruno Dürigen (Figure 35, "Fremdländische Zierfische: Ein handbuch für die naturgeschichte, pflege und zucht der bisher eingeführten aquarienfische" ("Exotic ornamental fish: Tips for the observation care and breeding of the paradise fish, gouramies, goldfish, telescope fish, dog fish [i.e., *Umbra*] etc.").

Dürigen (1853–1930) was interested in natural sciences in general, especially in the broad field of zoology. Although he wrote "Germany's amphibians and reptiles: a description and depiction of all the amphibians and reptiles occurring in Germany and adjacent areas"], he is most famous for his "The poultry farming manual and textbook of racial science, breeding, care and management of domestic, farm and ornamental fowl," consisting of 1082 pages in two volumes. Initially self-educated, as a guest student he completed his studies at the Berlin University, obtained an honorary doctorate and became an honorary professor for poultry science at the Agricultural Academy, Berlin. As we shall shortly see, Dürigen was also the first editor of the *Blätter für Aquarien und Terrarienfreunde*.

His "Exotic Ornamental Fish" book was published in 1886 by Paul Matte, the latter a famous breeder of exotic fishes. Based upon both Matte's and Dürigen's experiences, it was the first publication devoted solely to exotic aquarium fishes. Figure 36 shows the cover of the booklet and some of the fishes discussed.

Figure 36: "Exotic Ornamental fish: Tips for the observation care and breeding of the paradise fish, gouramies, goldfish, telescope fish, dog fish etc.," Reference 36, 1886.

TABLE 3: SELECTED PUBLICATIONS OF EMIL BUCK	
1874 *Zoologischer Garten*	
	Power generation unit for the freshwater aquarium.
1875 *Zoologischer Garten*	
	The power generation unit for the aquarium.
	Anemones in the aquarium.
	The breeding of young sticklebacks in the freshwater aquarium.
	A self-starting lift for the vase aquarium.
1879 *Zoologischer Garten*	
	The room pond aquarium and its equipment.
1889 *Isis*	
	Communications on some cold-blooded vertebrates: The Fishes.
1889 *Zoologischer Garten*	
	Beck's masonry aquarium and its inhabitants.
1890 *Zoologischer Garten*	
	A sequel to Beck's masonry aquarium and its inhabitants.
1891 *Zoologischer Garten*	
	A new aeration apparatus for vase and box aquariums.
1892 *Zoologischer Garten*	
	Breeding mosquitoes for the purpose of feeding fish.
	The fan of my aeration system.
	More about my aeration apparatus.

TABLE 3: SELECTED PUBLICATIONS OF EMIL BUCK, CONTINUED	
1894 *Nature and House* II	
	Something about the freshwater shrimp (*Gammarus pulex* fabr).
1894 *Blätter für Aquarien-und Terrarienfreunde*	
	The cylinder lamp and its use in aquariums.
	Winter food for small aquatic animals.
	An interesting crustacean.
	More about the interesting Shell cancer.
	A useful ornament for aquariums.
1895 *Blätter für Aquarien-und Terrarienfreunde*	
	for aeration equipment.
1895 *Nature and House* III	
	A useful ornament for aquariums.
1895 *Zoologischer Garten*	
	Safety of the crayfish in aquariums.
1895 *Report of the Association of Natural History in Offenbach am Main Volume 36*	
	Observations of sponges of Lake Constance and their breeding in the aquarium.

DR. EMIL BUCK

Many of the devices shown and discussed in Heß's books were the brainchild of Dr. Emil Buck (e.g., Figures 19, 20, 29 and 30) and published, along with other articles concerning the aquarium, in the Zoologische Garten over the years 1874-1897 and in the *Blätter für Aquarien und Terrarienfreunde* (which we will get to shortly) over the years 1894-1895. Excepting when his material was reprinted from other publications, Buck's articles always were the lead in the *Blätter*. Figure 37 shows a grav-

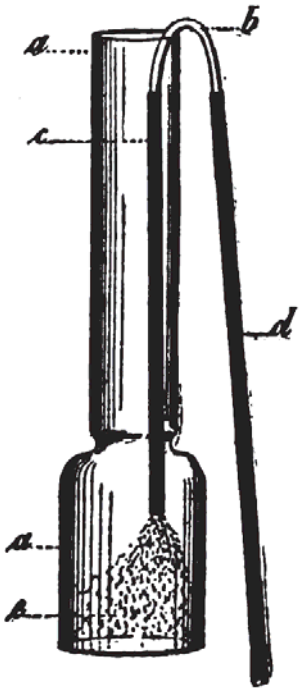


Figure 37: A gravel cleaner designed by Emil Buck, from the *Blätter für Aquarien und Terrarienfreunde,* No. 10, 1854.

el cleaner he made from a cylinder taken from an oil lamp and discussed in issue No. 10 of the *Blätter* for 1854 and Table III lists some of hid articles on fishes and equipment.

Emil Buck, the youngest son of wealthy parents, was born in 1840 in Metz. In 1845the family moved to Frankfort, where the family had roots since 1745. Although his mental development was strong, his health was somewhat delicate. Despite this handicap he developed an interest in the lower animal world in a significant way, crawling around on all fours in the garden for worms, insects, etc. seeking to look and observe them. He was not strong enough for the family's agricultural trade, and so in 1856 accompanied his elder brother, Victor, to Rotterdam to teach. The business administration department, however, was of no interest to him so Buck left in 1863 when, by the death of his parents, he had become independent wealthy and devoted himself exclusively to scientific study, particularly those related to his cherished biological studies of the lower freshwater animals.

He always sought to fill the gaps that existed in the state of affairs of his education, especially his knowledge of ancient and modern languages. He was tireless in the enrichment of his scientific knowledge, and in 1869 he joined the Senckenberggischen Naturforschenden Gesellschaft (Senckenberg Natural History Society). In 1873 he became its corresponding secretary and member of the management, and in 1879 took over the management of the herpetological section at the Senckenberg Museum. In 1875 he left for Zurich to attend the University of Zurich and in 1877 he received his Ph.D., his thesis titled, "Some Rhizopodenstudien." In the December 1876 issue of the *Journal of Microscopy*, this thesis work received a very favorable review.

His special interests were of two kinds, both of which were pursued in the minutest detail. The first was research on the world in miniature. The other was to provide environments in which the microcosm of fresh water could thrive. He was an authority in the establishment and maintenance of aquariums.

He was an avid aquarist and made his own tanks from cement and, with pumice, created miniature landscapes. There were no missing bays, ledges or terraces. Miniature heights, sometimes steep, sometimes gently sloped, went down to the water level of the "lake" to a small moss-covered island. The lower riverside areas provided swampy places and the rock bed was a sunken pool of water. All the living conditions of the nature of a lake were

Blätter für Aquarien- und Terrarien-Freunde.

Bestellungen durch jede Buchhandlung sowie jede Postanstalt. Preis jährlich Mark 3, monatlich 2 Nummern.

herausgegeben von der Creutz'schen Verlagsbuchhandlung Magdeburg.

Anzeigen werden die gespaltene Nonpareillezeile mit 15 Pf. berechnet und Aufträge in der Verlagshandlung entgegengenommen.

№ 1 u. 2. Schriftleitung: Bruno Dürigen in Berlin S.W., Friesenstr. 25. I. Band.

Inhalt:

An die Leser! — W. Geyer: Wünsche und Ziele der Aquarien-Liebhaberei. — W. Hartwig: Verbessertes Aquarium. — Beliebte Wasserpflanzen. — W. Hartwig: Züchtung des kleinen Blattfuß, Lep. productus (mit Abbildung). — Die Schleimfäden des Seefichling-Nestes; nach Prof. K. Möbius' Untersuchungen (mit Abbildung). — P. Matte: Aufzucht von Blaufelchen. — P. Jung: Unsere Schlangen. — B. Dürigen: Die vierzehige Fußschleiche (Sepa monoecton). — Vereins-Nachrichten. — Ausstellung von Aquarien und Terrarien. — Kleine Mittheilungen. — Fragekasten. — Bitte. — Anzeigen.

An die Leser!

Mit Schluß des Jahres 1889 hat die Wochenschrift „Isis", welche ihrer Bestimmung gemäß in ihren Spalten auch der Aquarien- und Terrarien-Liebhaberei Raum geben sollte, aufgehört zu erscheinen. Da nun aber jene Liebhaberei während der letzten Jahrzehnte einen solchen Aufschwung genommen, daß sogar eigene Vereine sich gebildet haben, so faßte die mitunterzeichnete Verlagshandlung den Plan, eine Zeitschrift ins Leben zu rufen, welche ausschließlich den Zwecken der Aquarien- und Terrarien-Freunde dienen, ihnen Fingerzeige für die Einrichtung und Instandhaltung von Süßwasser- und Seewasser-Aquarien und Terrarien geben, sie bei Erwerb, Pflege und Züchtung der in denselben zu beherbergenden Thiere und Pflanzen durch Winke und Unterweisungen wissenschaftlicher und praktischer Art unterstützen sollte. Nachdem auch das inzwischen unter dem Titel „Aquarium und Terrarium" entstandene Organ des Vereins für Aquarien- und Terrarien-Liebhaber zu Berlin in ihren Verlag übergegangen, legt sie hiermit die 1. Nummer des neuen Blattes, dessen Leitung der mitunterzeichnete B. Dürigen übernommen, den Lesern vor.

Der Zweck unserer „Blätter" ist schon oben in wenigen Strichen gekennzeichnet. Sie sehen ihre Aufgabe darin, den Liebhabern von Zimmer-Aquarien und -Terrarien, den Pflegern empfehlens- und begehrenswerther Wasser- und Glashaus-Pflanzen, den Freunden der so ungemein anziehenden und so unerschöpflichen Stoff zur Unterhaltung und Belehrung bietenden, leider aber erst

Figure 38: The first issue of the *Blätter für Aquarien und Terrarienfreunde,* No. 1 & 2 combined, 1890.

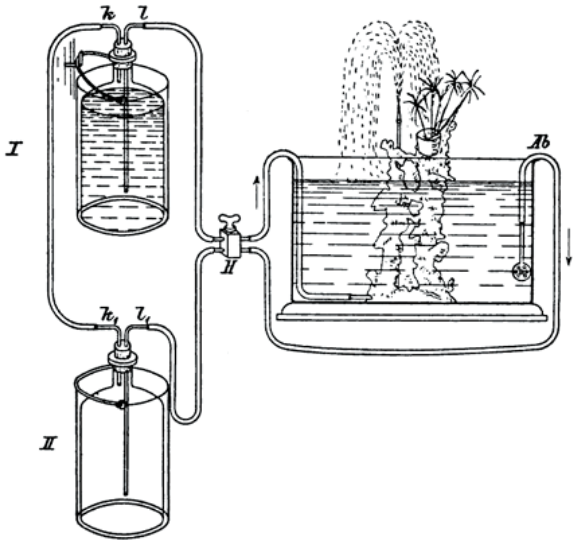


Figure 39: Paul Nitsche's fountain aeration device, from the *Blätter*, 1890.

so created, that the animals, some of them very rare, lived and multiplied. Highly inventive, he devised devices for aeration and was intent on improving them, as witnessed by his numerous publications. In 1866, worried for the survival of his animals, he was producing a flow of water and aeration in his aquarium by a device powered by strong spring work.

Emil Buck died in 1889 and in his obituary dedicated to him, Oskar Boettger (a German zoologist associated with the Senckenberg Museum in Frankfurt) stated: **"Biology owes the deceased an abundance of subtle and detailed observations, the aquarist loses one of its founders and most indefatigable apostle.**"

THE BLÄTTER FÜR AQUARIEN UND TERRARIENFREUNDE

The first issue of this magazine – 24 issues a year - appeared in 1890 under the editorship of Bruno Dürigen in Berlin (Figure 38). Very little on aquariums appeared in this issue, but in issue 22 Paul Nitsche discussed and described the fountain aeration devices shown in Figure 39. In an article by Wilhelm Geyer titled "Wünsche und Ziele der Aquarien-Liebhaberei" ["Desires and goals of the aquarium hobby"], the author discusses various groups of fishes, including the Cyprinodonts or "Zahnkarpfen" as the Germans termed them, a direct translation of the scientific name, i.e., tooth carps. In this section the author states: "Among them here included in the genus Fundulus are 20 species, informally known as "killi-fishes," making it the first time that the term killifish appeared in an aquarium hobby periodical. However, the Germans persisted in their use of Zahnkarpfen for these fishes, just as the Americans persisted in their use of Panchax until the advent of the American Killifish Association in 1962 when the whole world switched to using the term, killifish.

There were three pages of advertisements in the combined, No. 1 No. 2 issue but unfortunately, advertisements dropped off to only one page (and even less) in subsequent issues and continued on in this way for the remainder of the year. Each subsequent issue had about 10 pages, including advertisements

Paul Matte, Lankwitz,
Post- und Bahnstation Südende, Berlin-Anhalter Bahn.
— Anerkannt größte Züchterei fremdländ. Zierfische. —
Aquarien, Terrarien, Zimmer-Fontainen, Transportgefässe.
Preis-Verzeichniß
über Fische, Amphibien und andere Aquarien- und Terrarien-Thiere,
Aquarien-Pflanzen, Bodenfüllungen ꝛc. auf Wunsch gratis und franco.

Figure 40: Paul Matte's advertisement in the *Blätter*, 1890.

The advertisements, however, provide us with a good idea of the stage of development of the commercial side of the hobby in Germany at this time. Aquatic plants such as *Vallisneria spiralis* and *Aponogeton distachyon* (the latter originally from South Africa) were offered, as were aquariums of all shapes and kinds including ornate vases, four- and six-sided flat aquaria and fountain aquaria. Paul Matte's ad is shown in Figure 40 and reads, "The acknowledged biggest breeder of Exotic ornamental fish."

The fourth edition of Roßmäßler's book was available in two different bindings. A longer book – 213 pages – on marine aquaria, "Seewasser-Aquarien im Zimmer" ["Marine Aquaria in the Living Room"], written by Reinhold Eduard Hoffmann was also advertised. A third book (198 pages), written by Wilhelm Geyer, "Katechismus für Aquarienliebhaber: Fragen und Antworten über die Einrichtung, Besetzung und Pflege des Süsswasser-Aquariums, sowie über Krankheiten und Züchtung der Fische" ["Catechism for aquarium lovers: Questions and Answers on the establishment, staffing and maintenance of the freshwater aquarium, as well as diseases and breeding of fish"], was also advertised.

By 1890 then, the aquarium hobby, both freshwater and marine, was thriving and well on its way into the pioneering efforts on the part of German aquarists to explore foreign lands and to introduce new exotic species into the hobby.

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ENDLER'S GUPPY: A SPECIES OR NOT A SPECIES?

By Albert J. Klee, Ph.D.

Aquarium Hobby Historical Society, Yahoo Files Section, March 16, 2013

One of the most divisive controversies in the aquarium world, one that has also spilled over into the professional world of ichthyology, is the naming of Endler's Guppy as a new species. The description of a new species and its ultimate disposition involves certain steps that must be taken by the author of the species and also actions by other ichthyologists that may arise along the way. A basic knowledge of the process is helpful in explaining controversies such as this one; it may also heal old wounds or, at the very least, reduce the level of acrimony in the dispute.

THE NAME

The name of the new species is admittedly not the first thing that comes to mind to its describer but there is no getting around it since there are rules that govern how one names a species. These rules are those put down by the International Commission on Zoological Nomenclature (ICZN), which acts as the adviser and arbiter for the zoological community by generating and disseminating information on the correct use of the scientific names of animals. The ICZN is responsible for producing the International Code of Zoological Nomenclature - a set of rules for the naming of animals and the resolution of nomenclatural problems. The essentials of this Code can be summed up in two words: bookkeeping, i.e., the rules for the construction of a name, and priority, i.e., the adjudication of instances where two ichthyologists for whatever reason have described the same species under two different names. For further discussion of these matters and examples of each I refer the reader to my monograph, "The Name Game?" (Klee, 2009).

Consequently, in addition to following the rules in deciding the name of the new species, an author must also do his homework to make sure that he or she is not, in a sense, "reinventing the wheel," since all that would accomplish is to present the world with one more synonym and we certainly have enough of those already. In any event, the name is not really much of a concern of aquarists, although it does annoy the aquarium community no end when a name has to be changed because an author was careless in following the rules of name construction or when priority deemed it necessary under the Code. However, since neither bookkeeping nor priority is an issue with Endler's guppy, we'll proceed to more important matters.

THE CRITERIA

What really comes first is the establishment of the reasons why the author thinks the fish in question is a new species. Oddly enough, except in very rare cases the International Commission on Zoological Nomenclature plays no substantive role here since it does not attempt to second-guess ichthyologists in this regard. The ichthyological community, however, does play an important role since if it doesn't accept the reasons given for the describing of a new species then it is simply ignored, although the name remains valid and cannot be used again by another ichthyologist. If there is no consensus about the new species then a controversy is generated, and this is what happened when Poeser, Kempkes and Isbrücker named *Poecilia wingei* in 2005 (Poeser *et al.*, 2005).

Historically, attributes (e.g., a forked tail), counts (e.g., the number of scales along the lateral line) or measurements (e.g., the ratio of the height to length) were used to describe a fish and were generally accepted as valid criteria. As time went by other characteristics

were added to this list of commonly acceptable criteria, such as the shape of bones or (if it was a livebearer to be described) the construction of the gonopodium . The Poeser paper, however, used color and breeding behavior as their criteria, thus unloosing an avalanche of objections.

With regard to color, the Poeser paper stated: "Its closest relative is the common guppy, *P. reticulata*, sharing identical meristic data, but differing by its enhanced metallic body pigmentation. This brightness in body pigmentation is also noticed in the females of *P. wingei*. Moreover, in the zone adjacent to the distribution area of the common guppy, *P. wingei* males exhibit a unique melanophore pattern, viz., a large band in the midsection of its body. The importance of this feature, i.e., the spatial distribution of melanophore patterns, is decisive for its recognition as a valid species."

With regard to breeding behavior, the Poeser paper stated: "The behaviour of *P. wingei* is new to science and is therefore extensively described." This is followed by 858 words of detailed description, a bit involved for a criterion of this sort.

Dr. Felix Breden, who has done extensive work with Endler' guppy at both at the morphological and DNA levels, outlined the reasons for Poeser being wrong at the April 2007 meeting of the American Livebearer Association (ALA) and these were summarized in the September issue of the *Tropical Fish Hobbyist* (Coletti, 2007). The six main reasons that he maintained Poeser was in error were as follows:

1. Behavioral differences can only be classified if a companion group is compared and done so over many generations.
2. Melanophore patterns are not criteria for speciation.
3. Coloration differences are not criteria for speciation. *Poecilia* are polymorphic by nature.
4. No real gonopodial differences between Cumana Endler's and guppy populations exist. This is necessary for taxonomic speciation among livebearers.
5. Endler's guppy hybridizes with other guppy populations frequently. Indeed there is little to no natural barrier to hybridization in the wild.
6. He found no DNA differences when comparing the Cumaná Endler's guppy to *Poecilia reticulata* populations to warrant a new species.

If the ichthyological community agreed with Breden, then Poeser's "new" species would be ignored and confined to the trash heap.

THE GENETICS OF THE GUPPY: AN INCIPIENT SPECIES?

For a long time the guppy was considered a taxonomic group with only one biological type, *Poecilia reticulata.* However, DNA sequence based studies revealed a marked genetic differentiation among guppy populations (Alexander and Breden, 2004; Carvalho *et al.*, 1991; Russell and Magurran, 2006; Shaw *et al.*, 1991). In particular, this phenomenon was especially true for fish from the Caroni vs. the Oropuche drainages of Northern Trinidad and for the Endler guppies from Cumaná vs. other populations from Venezuela. This genetic differentiation was interpreted as being the consequences of independent cases of incipient speciation in *P. reticulata.*

Guppy populations evolve rapidly, within 10 to 102 generations, as a response to changes in selection exerted by predators. The rates of evolution involved can be up to seven orders of magnitude greater than those seen in the fossil record. In 1998 Magurran reviewed the work on the Trinidadian guppy, *Poecilia reticulata*, a species that is renowned for its capac-

ity for population differentiation. Sexual selection, particularly female choice, appeared to reinforce the divergence that natural selection had generated. Perplexingly, however, there were no reproductive barriers that prevented interbreeding between these populations, even those that had been separated for at least 106 generations. Magurran postulated that sexual conflict may be the key to explaining this absence of speciation. Male reproductive behavior, particularly the high incidence of sneaky mating (a situation where if the female is not receptive, males frequently employ a form of coercive mating: the male approaches the female without any display, swings his gonopodium forward and tries to insert it into the genital pore of the unwilling female), may be instrumental in producing sufficient gene flow to prevent reproductive isolation.

Sneaky mating has the potential to undermine female choice, and is known to be an important means of sperm transfer in wild populations. Sexual dimorphism, also a result of sexual conflict in guppies, may inhibit speciation in another way. Morphological differences between the sexes, which have arisen for reproductive reasons, mean that males and females are pre–adapted for different foraging niches. This, in turn, reduces the opportunity for the development of different feeding behaviors, a mechanism that seems to have been important in sympatric speciation, the process through which new species evolve from a single ancestral species while inhabiting the same geographic region, of other fish species. Magurran concluded that the observed population differentiation in Trinidad was an instance of “evolution in action” where population differentiation has not led to the formation of species.

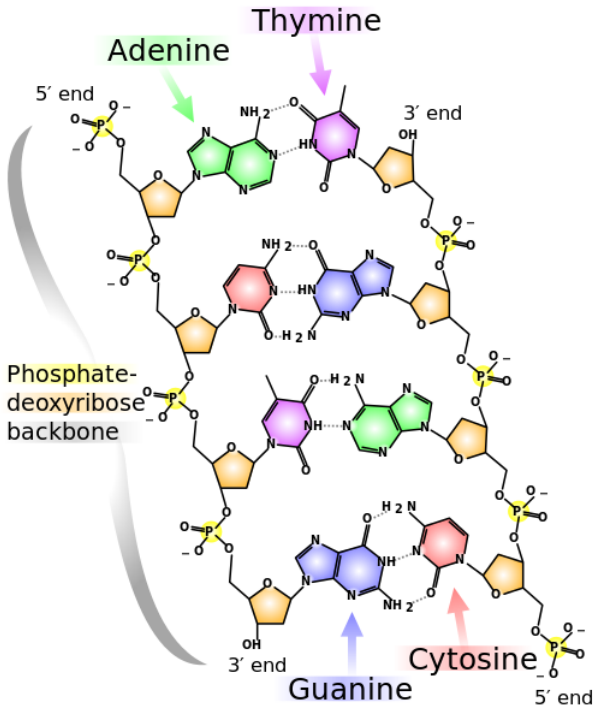
AUTOMATED DNA SEQUENCING: A PRIMER

Automated DNA sequencing is a research tool used by many ichthyologists to determine the sequence of DNA or genetic code that serves as the blueprint of life for every organism on earth. The process of DNA sequencing translates the DNA of a specific organism into a format that is decipherable by researchers and scientists.

DNA (which stands for Deoxyribonucleic acid) is made of chemical building blocks called nucleotides. These building blocks are made of three parts: a phosphate group, a sugar group (not the same as 'table sugar', however) and one of four types of nitrogen bases. To form a strand of DNA, nucleotides are linked into chains, with the phosphate and sugar groups alternating. There are four different bases in the DNA, namely adenine, guanine, cytosine and thymine but for convenience they are simply called “A”, “G”, “C” and “T.” These four are all that's necessary to write a code that describes our entire body plan. Sounds too simple? Keep in mind that the Morse code uses only four symbols (dot, dash, short spaces and long spaces), and you could spell out entire encyclopedias of knowledge with that simple code!

Double-stranded DNA is simply two chains of single-stranded DNA, positioned so their bases can interact with each other. Importantly, the two strands travel in opposite directions and the bases in the middle "pair up" with the bases on the opposite strand, so that a type 'A' nucleotide is always opposite a type 'T', and 'G' is always opposite 'C' (Figure 1). The dotted lines in Figure 1 are the weak nitrogen bonds that hold the two strands together. This has some critically important consequences: (1) If those two strands are separated, they still "recognize" their opposite strand, and (2) If one strand is lost or damaged, it is possible to build its exact duplicate just by examining the remaining intact strand.

FIGURE 1:
Double-Stranded DNA



In DNA sequencing, overlapping sequence data from many clones is analyzed by computers that re-generate the full length sequence by piecing the short sequences together like a puzzle (Figure 2).

The first step is to break open the cells taken from the fish in question to access the DNA, which can be done either by mechanical methods, such as grinding, or by chemicals methods. This is followed up by separating the DNA from the cell debris (Figure 3).

The next step involves separating the double-stranded DNA segment into its two strands, a

FIGURE 2: The Goal of DNA Sequencing

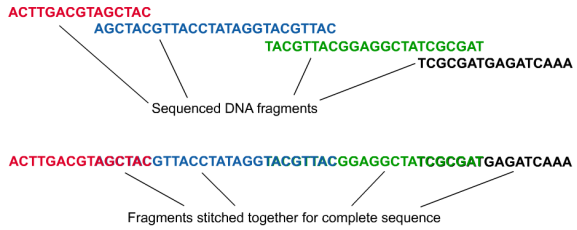
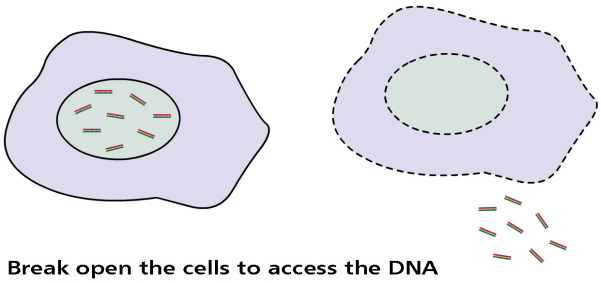


FIGURE 3: DNA Isolation and Purification



Break open the cells to access the DNA
a. Mechanical methods
b. Chemical methods
Purify DNA from the cell debris

process known as "denaturing." This is accomplished by heating the DNA mixture (there's a critical temperature at which this happens), which disrupts the weak forces holding the strands together (Figure 4). In Figure 4 the strands are represented by the dark green and dark red colored bars, the smaller projections representing the four (hence the four colors) different bases. One strand is designated the "template strand," and other the "complementary strand."

In the next step a small strand of DNA consisting of about twenty bases called a "primer" is annealed to the denatured template strand Figure 5). This is needed to prime the next step, DNA extension. In theory the two DNA

FIGURE 4: Strand Separation or "Denaturing"

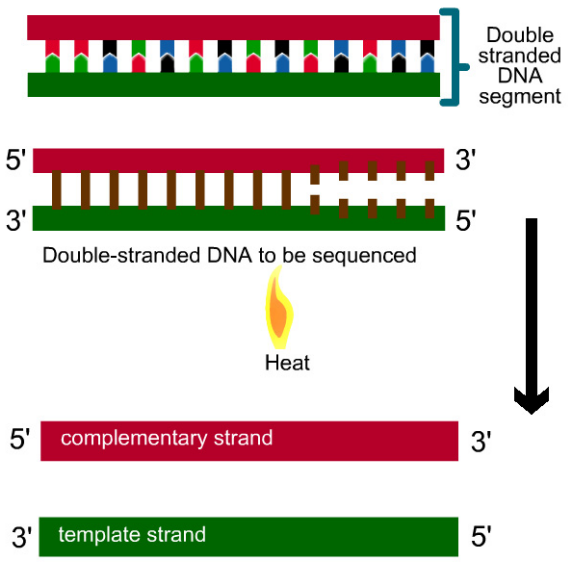
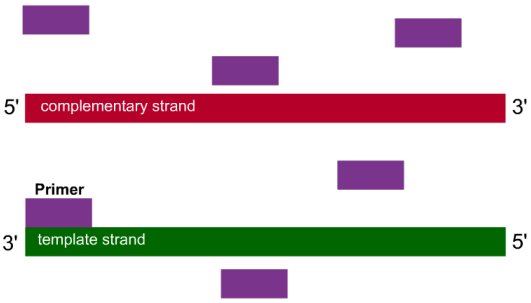
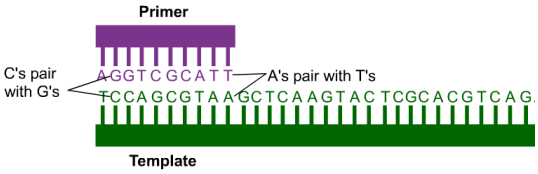


FIGURE 5: Primer Annealing



HOW THE PRIMER ATTACHES TO THE TEMPLATE

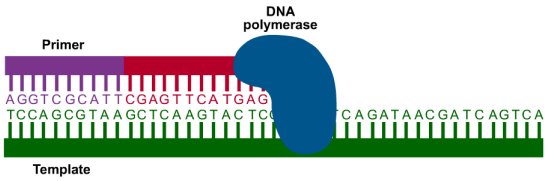


strands that were separated in the preceding step could snap back together but this is avoided by using a rapid cooling process which gives the small primer an advantage over the larger nucleotide. Also a large number of primers are added to make sure they will out-compete the complementary DNA strands for attaching to the template strands.

In the next step a DNA polymerase, an enzyme that synthesizes DNA molecules from the nucleotide building blocks or bases, is added (Figure 6).

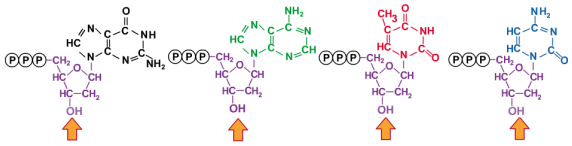
In the termination step (Figure 7) special bases that are missing certain OH groups stop the DNA strand assembly. Each of these modified bases is dyed different colors so they can be read by lasers in the computer.

FIGURE 6: Annealing

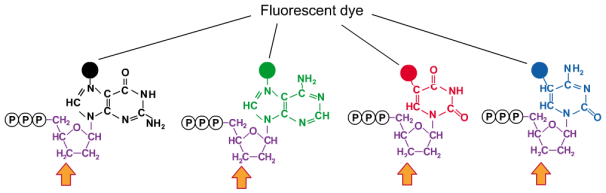


As the DNA polymerase moves down the template, it assembles new DNA chains using the 4 DNA building blocks, i.e., the four bases.

FIGURE 7: Termination

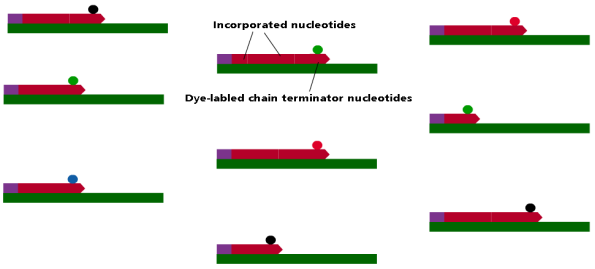


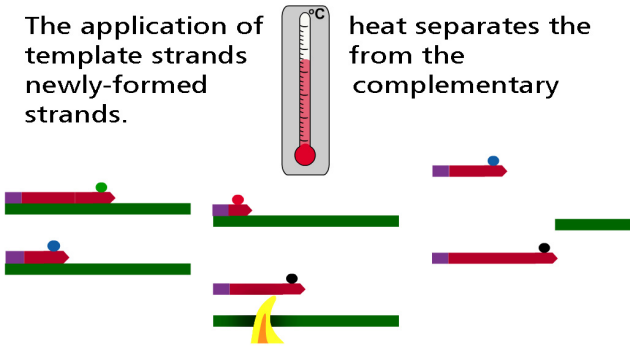
Special dye-labeled bases that are missing certain OH groups stop the DNA strand assembly.



The newly synthesized DNA strands each labeled with one of four dyes are now sorted by length using capillary electrophoresis. First the reaction mixture is heated to keep the newly synthesized strands from annealing with the template DNA strands (Figure 8).

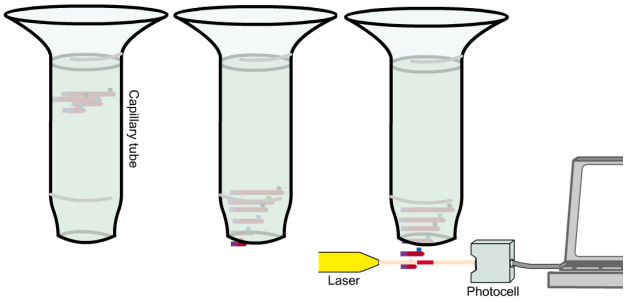
FIGURE 8: Sorting by Capillary Electrophoresis





The dye-labeled single strands are then loaded onto a tiny capillary tube containing a viscous gel-like material (Figure 9). A negative current pulls the electrically-charged DNA

FIGURE 9: Gel Electrophoresis



strands through the capillary. This tube is not much thicker than a human hair and is one to three feet long sufficient to separate strands that differ from only one base. Shorter DNA strands migrate through the gel more quickly and come out of the capillary at the bottom first. As the strands emerge at the bottom of the capillary they pass through a laser beam that excites the fluorescent dye attached to end of each strand. This causes the dye to fluoresce or glow at a different wavelength or color. This color is then detected by a photocell which feeds the information to the computer.

Figure 10 shows an example where the color of the strands, from the shortage to the longest, is red, blue, green, black, green and black. The computer receives this information as TCAGAG.

The computer also receives the information from the photocell as an electropherogram

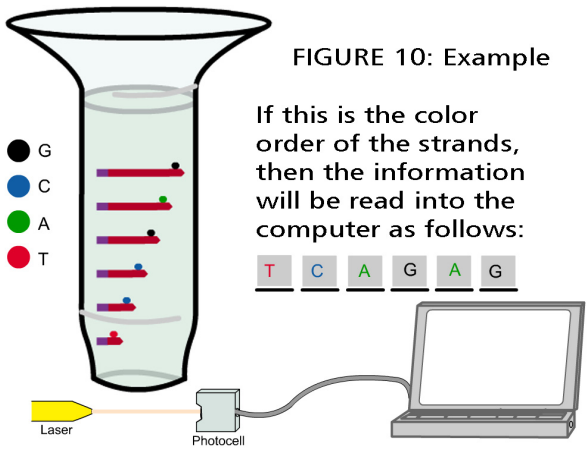


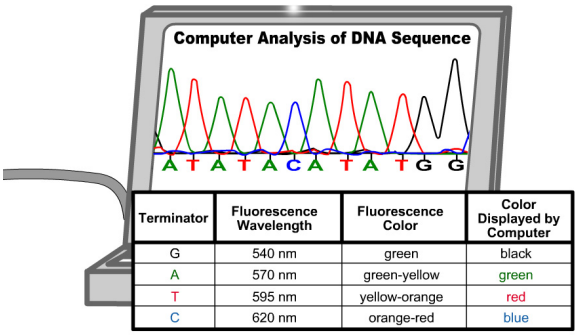
FIGURE 10: Example

If this is the color order of the strands, then the information will be read into the computer as follows:

T C A G A G

which is a tracing of the signals received by the photodetector in each of the four wavelengths (Figure 11). Although the real colors received by the photodetector are closer to green yellow, orange and red, the computer assigns false colors to each of the four the tracings to make it easier to tell them apart. It also prints the letter of the appropriate base below each of the signal peaks. Because successive peaks correspond to DNA segments that differ in length by one nucleotide, the sequence of peaks reveals the sequence of bases in the original DNA sample.

FIGURE 11: Computer Analysis



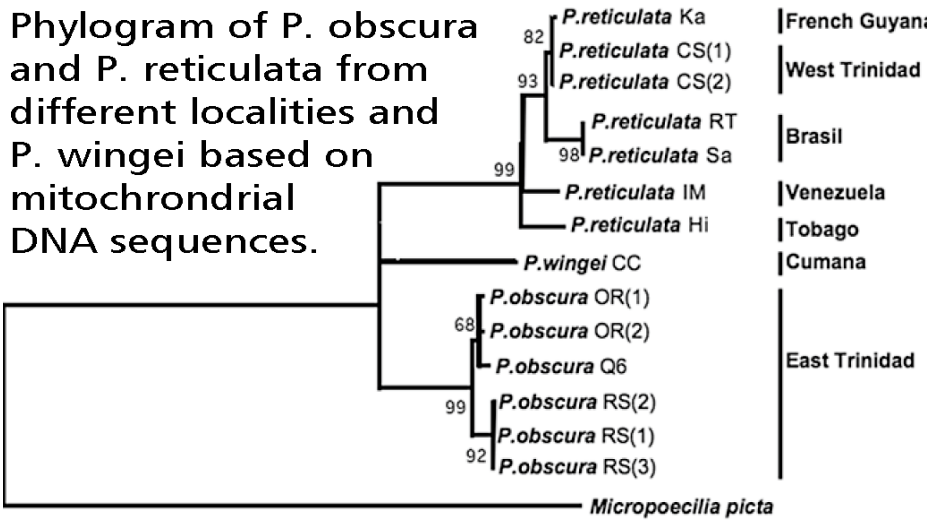
Terminator	Fluorescence Wavelength	Fluorescence Color	Color Displayed by Computer
G	540 nm	green	black
A	570 nm	green-yellow	green
T	595 nm	yellow-orange	red
C	620 nm	orange-red	blue

ENTER THE PHYLOGRAM

In 2009 Schories *et al.* described a third species, *Poecilia obscura*, and showed by molecular phylogenetic analysis that *Poecilia reticulata, P. wingei* and *P. obscura* form a cryptic species complex (i.e., where the fish appear identical but are genetically quite distinct) are old species that arose by parallel evolution rather than being emerging new species.

The team used mitochondrial DNA, mitochondria being structures within cells that convert the energy from food into a form that cells can use. Although most DNA is packaged in chromosomes within the nucleus, mitochondria also have a small amount of their own DNA. This genetic material is known as mitochondrial DNA or mtDNA. Unlike nucle-

FIGURE 12:
Phylogram of P. obscura and P. reticulata from different localities and P. wingei based on mitochrondrial DNA sequences.

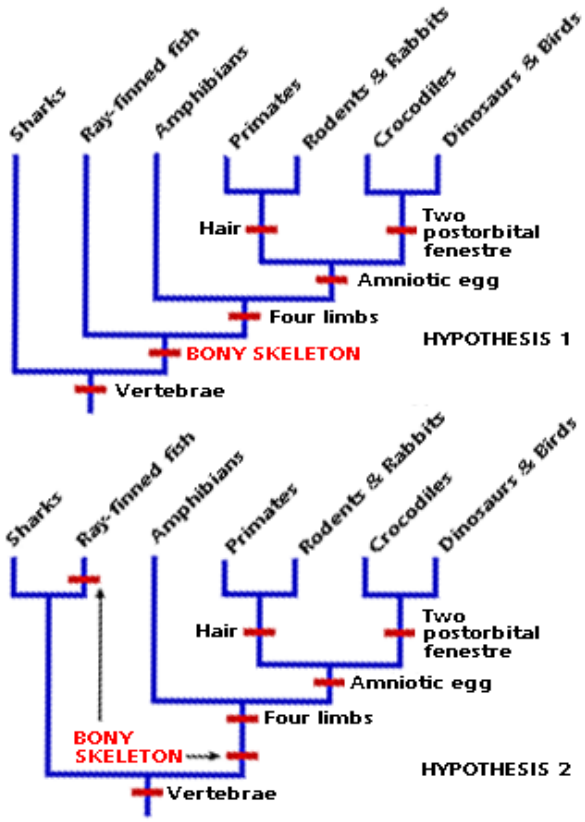


chondrion. Because of this and because the mutation rate of animal mtDNA is higher than that of nuclear DNA, mitochrondrial DNA sequencing represents a mainstay of phylogenetics, in that it allows biologists to elucidate the evolutionary relationships among species and also permits an examination of the relatedness of populations.

ar DNA, which is inherited from both parents and in which genes are rearranged in the process of recombination, there is usually no change in mtDNA from parent to offspring. Although mtDNA also recombines, it does so with copies of itself within the same mito-

Their phylogram (a phylogenetic tree whose branch lengths are proportional to the amount of change) is shown in Figure 12. Note that they did not show that *Poecilia wingei* was a valid species by DNA sequencing directly, since guppy DNA is too variable to distinguish species by DNA sequencing alone. Instead, they used the results of the sequencing as input to the heuristic and branch-and-bound tree searches shown in their paper.

FIGURE 13: Parsimony



In my monograph, "How Cladists Work," I described one heuristic method, i.e., maximum likelihood, but Schories et al. constructed their trees using both parsimony and distance (minimum evolution) criteria. Parsimony scores the number of changes between different character states that at minimum are necessary to explain the observed data given the tree. The best hypothesis is the tree requiring the fewest changes. This score, often referred to as the tree's length, is the minimum number of changes for the tree. Parsimony uses the observations without any attempt to use an explicit model to estimate the total number of changes. In Figure 13, Hypothesis 1 requires six evolutionary changes and Hypothesis 2 requires seven evolutionary changes, with a bony skeleton evolving inde-

pendently, twice. Although both fit the available data, the parsimony principle says that Hypothesis 1 is better - since it does not hypothesize unnecessarily complicated changes.

The Minimum Evolution criterion is a subclass of Parsimony and differs in that the observations are not used directly to calculate the tree score. Instead the data are transformed to pair-wise distances, and the score is calculated from those. Using pair-wise distances is an advantage for some kinds of data such as DNA-DNA hybridization where the data from the experiments are pair-wise differences. Bear in mind, however, that whatever the criterion used, the output from a phylogenetic analysis is nothing more than a hypothesis of relationship of different taxa.

THE ARGUMENT AGAINST HEURISTIC METHODS

Since this is the case, there can be legitimate disagreements on the determination of phylograms or phylogenetic trees. First of all, note that with respect to the Schories *et al.* paper I used the term "heuristic" because the trees are determined by heuristic methods. Heuristics are strategies using readily accessible, though loosely applicable, information to solve problems. For a variety of reasons, the finding of an optimal phylogenetic solution in ichthyology is impractical. For one thing, no one was around over the millennia to observe the evolution of species. A common way of overcoming this unhappy state of affairs, however, is the development of heuristic (approximate) methods.

A method is deemed to be scientific if it performs empirical tests, i.e., if it applies empirical data that could potentially refute the hypothesis of interest, so you can easily see that we are out of luck here. Methods such as heuristics that do not perform tests and therefore are not scientific may nonetheless point to more weakly or ambiguously corroborated hypotheses, such propositions being more easily refuted than those that have been more severely tested and are more strongly corroborated. Based on common usage, data exploration in phylogenetics is accomplished by any method that conducts sensitivity or quality analysis and this includes heuristical methods.

THE ARGUMENT FOR HEURISTIC METHODS

There are some that denigrate heuristic methods as "guesswork," but there are guesses and there are guesses. When I was teaching decision theory I would pose the following problem to my students: If you pull out a single card from a well-shuffled deck of 52 cards, what is the probably of it being an ace? They had no problem in ascertaining the correct answer, i.e., 4 out of 52 or about 7.7 percent.

To my next question, however, there was no equanimity: From a well-shuffled deck of 52 cards I pick one at random and throw it out the window without looking at it. I now pick a single card at random from the remaining 51-card deck. What is the probability that the card is an ace?

Now this can be calculated precisely but my students were not at that stage in the course just yet so I offered the following heuristic argument: The discarding of the card does not add to or subtract from your knowledge. Therefore you have no reason to change your estimate of 4/52. After this statement there were usually still some blank stares from the class so I continued with a variation of the same question: I now pick another single card at random from the remaining deck and toss it out the window. Again, what is the probability that the card is an ace?

I do this until 51 cards have been tossed out the window and a single card remains. Now

the answer is obvious. The situation is identical to picking a card from a deck of 52. It makes no difference whether the remaining deck of 51 still sits on the table or whether it has been tossed out the window. In this case the heuristic argument is as precise as the scientific technique that calculates the true probability.

Returning now to the original problem of throwing out a single card, I devise the following heuristic technique. I write a computer program that simulates the 52-card deck, the random discard of one card and the random drawing of a card from the remaining 51. The computer "looks at" the card and determines whether it is an ace or not and records the information. It starts over with the 52-card deck and repeats the process. It does this 50,000 times and prints out the number of aces it found divided by 50,000. The answer will be so close to the true answer of 4/52 that it makes no practical difference; in other words, for all useful purposes the method is as good as the scientific one.

The method I used was a heuristic one called Monte Carlo sampling. It was invented in the late 1940s by Stanislaw Ulam while he was working on nuclear weapon projects at the Los Alamos National Laboratory. Immediately after Ulam's breakthrough, John von Neumann understood its importance and programmed the ENIAC computer to carry out Monte Carlo calculations. (Being secret, the work of von Neumann and Ulam required a code name and Von Neumann chose the name Monte Carlo, a reference to the Monte Carlo Casino in Monaco where Ulam's uncle would borrow money from him to gamble.) It has been used to solve problems in physical sciences, engineering, computational biology, computer graphics, applied statistics, design and visuals, finance, business, telecommunications and mathematics, to name just some areas. The point is, don't throw out the heuristic baby with the bath water. Heuristic methods do have their uses and at times, very important ones.

SO, IS IT A SPECIES OR NOT?

Speciation in the guppy and its close relatives is complicated by interbreeding, introduction by aquarists and others of guppy populations into locations around the word and habitat disturbances (Rosen 1957, Endler 2011 and Klee 2013). As I pointed out early in this monograph, the ichthyological community plays an important role in this matter in three different ways: (1) If it accepts the reasons given for the describing of a new species, then that is that; (2) If on the other hand it doesn't accept the reasons then it is simply ignored; and (3) if there is no consensus about accepting the new species then a controversy is generated.

Prior to the publication of the paper by Schories et al. there wasn't much acceptance of the new species. Although their paper did not refute Breden's six objections, it added information on a molecular scale that supported Poeser's new species, information that was sufficient for many to change their minds.

Molecular systematics is an essentially cladistic approach: it assumes that classification must correspond to phylogenetic descent, and that all valid taxa must be monophyletic, meaning that each consists of a species and all its descendants.

Molecular phylogenies are sensitive to the assumptions and models that go into making them. They face problems like long-branch attraction (a phenomenon in phylogenetic analyses when highly dissimilar nodes, i.e., those with long branches, cluster together), saturation (where the phylogenetic signal is overwhelmed by multiple changes at each site, a sort of phylogenetic "noise") and taxon sampling problems (e.g., three-taxon trees can be very difficult to estimate correctly if the rates

of evolution are high). This means that strikingly different results can be obtained by applying different models to the same dataset. Only time will tell, therefore, if this is the majority opinion.

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THE BITTERLING TEST FOR PREGNANCY

by Albert J. Klee

(Aquarium Hobby Historical Society, Yahoo Files, July 21, 2013)

Although I have discussed the use of pregnancy urine and the results of a number of experiments therewith, including some of my own, I have not previously looked into the details of the origin of the method, i.e., the use of the European bitterling (*Rhodeus amarus*) in a test for human pregnancy, which, simply put, the fish possesses an ovipositor that is supposed to elongate when the animal is exposed to pregnancy urine.

The procedure was essentially as follows. A mature fish was placed in a quart of water at a temperature of 75 degrees F. The fish was first observed to determine whether the oviduct was beyond normal limits, i.e., about 2 mm. If so, the specimen was rejected and another one selected. Four c.c. of the urine to be tested was added and the fish observed at 24 hour intervals for 72 hours. In a positive reaction the ovipositor reached a length of from 15 to 25 mm. Most of these occurred within the first 24 hours, and so the test was discontinued as soon as it was positive. A negative reaction could only be reported after 72 hours. After the test was completed the fish was placed in a tank with fresh water for recovery. The regression of the ovipositor following a positive reaction took about two weeks, and after three weeks the fish was able to be used again.

The history behind this is as follows: In 1934 Kanter et al. [1] reported successful experiments with the fish, their work being based upon that of Tozawa [2] in 1924, followed by Fleischman and Kann in 1932 [3] and Szusz [4] in 1935. However, when Kleiner et al. [5] repeated their work in 1935 they found it impossible to standardize the fish as Kanter and his colleagues did, i.e., to be able to select specimens that would respond in a like manner, and concluded that the biological reaction obtained was not a specific test for pregnancy.

In 1936 Gottlieb [6] attempted to repeat the experiments of these researchers. His attempts to standardize the fish were only partially successful, however. Fourteen out of 17 fish responded to the pregnancy urine, while 3 did not respond to any kind of urine and were therefore excluded from the test. However, it was impossible to find any of the fish which would not respond to certain urines from non-pregnant women. Urine from non-pregnant women or from males which gave a positive reaction in one fish would regularly give a positive reaction in all other fish. Standardization as required by Kanter and his colleagues, therefore, was found by Gottlieb to be only partially possible.

Gottlieb performed seven sets of experiments, the descriptions and results being as follows (the experiments were carried out during the months of May to September; the fish, therefore, responded to the test outside the breeding season just as well as during it):

1. Twenty-eight urines of women known to be pregnant were tested. Of these, 26 gave a positive reaction within 24 hours, while 2 gave a positive reaction within 48 hours. All the reactions were definitely positive.
2. Fourteen urines of women normally menstruating and definitely not pregnant were tested. Three gave definitely positive reactions within 24 hours, while 1 gave a slightly positive reaction, the ovipositor reaching a length of about 10 mm. within 24 hours. Ten samples gave definitely negative reactions.
3. Fourteen urines of normal males were test-

ed. Three gave a positive reaction within 24 hours. These three cases were tried again on several other fish, all giving a positive reaction.
4. Fourteen urines of female children, aged 6 to 8 years, were tested. Two gave a definitely positive reaction in 24 hours. These were tested over again, each on several fish, and gave positive reactions in 24 hours.
5. Twelve urines of women for at least five years in the post-climacteric period were tested. Three showed a, positive reaction in 24 hours and 1 a positive reaction in 48 hours.
6. Ten urines obtained of women while menstruating were tested. One gave a definitely positive reaction in 24 hours and 1 a definitely positive reaction in 48 hours.
7. Eight urines of women pregnant only two months or less (pregnancy is definitely ascertained now) gave definitely positive reactions in 24 hours.

From Gottlieb's experiments it can be seen that a positive reaction to the test can by no means be considered as reliable. However, none of the urine samples obtained from women who definitely were pregnant gave a negative reaction. The fact that some male urines and some urines from women definitely not pregnant are capable of giving the same reaction, proves that it was not a specific test for pregnancy.

In 1938, Fleischmann and Kann determined that in addition to the estrogen found in pregnant women, a specific non-pregnant adrenal hormone, corticosterone, could cause the observed bitterling ovipositor reaction [7]. This is what made the bitterling test not useful for its originally announced purpose.

ADDENDUM

One of the earliest written records of a urine-based pregnancy test can be found in an ancient Egyptian document circa 1350 BC. A papyrus described a test in which a woman who might be pregnant could urinate on wheat and barley seeds over the course of several days: "If the barley grows, it means a male child. If the wheat grows, it means a female child. If both do not grow, she will not bear at all." Testing of this theory in 1963 [8] found that 70 percent of the time, the urine of pregnant women did promote growth, while the urine of non-pregnant women and men did not. Scholars have identified this as perhaps the first test to detect a unique substance in the urine of pregnant women, and have speculated that elevated levels of estrogens in pregnant women's urine may have been the key to its success.

Hormone research blossomed in the 1930's. Scientists recognized that there is a specific hormone (now known as human chorionic gonadotropin (hCG) that is only found in pregnant women. A number of tests were developed to identify hCG by injecting samples to induce ovulation in rabbits, frogs, toads, and rats. These tests were expensive, required the sacrifice of several animals, and slow, often taking days to get results.

In the Aschheim and Zondek test, an infantile female mouse was injected subcutaneously with urine of the person to be tested, and the mouse later was killed and dissected. Presence of ovulation indicated that the urine contained hCG and meant that the person was pregnant. A similar test was developed using immature rabbits. It was a common misconception that the injected rabbit would die only if the woman was pregnant. This led to the phrase "the rabbit died" being used as a euphemism for a positive pregnancy test. In fact, all rabbits used for the test died, because they had to be surgically opened in order to examine the ovaries. While it was possible to do this without killing the rabbit, it was generally deemed not worth the trouble and expense.

An improvement arrived with the frog test, introduced by Lancelot Hogben, which still was used in the 1950s and allowed the frog to remain alive and be used repeatedly: a female frog was injected with serum or urine of the patient; if the frog produced eggs within the next 24 hours, the test was positive. This was called the Bufo test, named after the toad genus *Bufo*, which was originally used for the test. Other species of toads and frogs have been used later on.

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THE MYTH of the ROMAN AQUARIUM: Reflections on Aquarium Hobby History Research

by Albert J. Klee

(Aquarium Hobby Historical Society, Yahoo Files, January 4, 2014)

In Bernd Brunner's "The Ocean at Home," we find the following paragraph:

> **"These fish were kept in opaque tanks, often made of marble, in front of the house. The first fish to enter the interior of a house in imperial Rome was the sea barbel, a much cherished and expensive breed. Allegedly, they were kept in small tanks underneath the cushions of the guest beds. Around 50 AD, panes of glass were brought to Rome, Herculanaeum, and Pompeii, to replace one wall of the marble tanks; now it was possible to actually see the hustle and bustle of the fish without having to guess their schematic movements from above."**

Because this statement has now been included in Wikipedia (re-phrased as: **"Introduction of glass panes around the year 50 AD allowed Romans to replace one wall of marble tanks, improving their view of the fish."**), it is now widely quoted in various versions on the Internet. If true, this would mark the Romans as the inventor of the flat-sided aquarium, not the British centuries later.

As Allan Nevins puts it in his "The Gateway to History," **"Mankind dearly loves a good story, and dearly loves to believe it true. Before any tale can greatly please the hearer thereof, it must have some degree of verisimilitude; it must conquer part of our faith."** Nevins illustrates this with the story of H. L. Mencken who, early in his career, wrote an article on the bathtub in which he asserted with plausible historical detail that it had been invented in the 1840's, that Millard Fillmore had been the first to install one in the White House, that the medical profession and the public long regarded it with deep suspicion, and that laws had been passed against the perilous contraption by Virginia, Pennsylvania and Massachusetts.

Mencken was astonished that his witty composition was accepted by most readers at face value. He was still more astonished to find newspapers and magazines copying these "facts" in ever-widening circles as they cropped up year after year in the most dignified of periodicals. As Nevins puts it, **"This naiveté of humankind has its humorous side. But to Historians, it is not quite so amusing."**

Although Brunner copied this material from Herrmann Mostar's "Die Arche Mostar ("Mostar's Ark"), the fault lies mainly with Brunner as he did not validate Mostar's statement and simply assumed that what he wrote was true. It should have been clear to Brunner that the assertion was unsubstantiated as Mostar provided no in-text references for any of his statements re the Romans save for one by Conrad Gesner and another by Seneca, both dealing only with the custom of wealthy Romans observing the colors in the death throes of the mullet. Mostar did not provide a bibliography, either. Brunner deserves some credit, however, for replacing Mostar's **"They put a small tank for them under the cushions of the guest bed..."** with **"Allegedly, they were kept in small tanks underneath the cushions of the guest beds."** Even Brunner was not going to buy that myth.

Mostar (1901- 1973), for those not familiar with the name, was a German writer, poet, columnist and, at times, a narrator, playwright and comedian. He also became Germany's most famous critical court reporter. This particular book deals with animals that have lived together with man, including dogs, cats, cocks, hens, doves, songbirds and fish, but also with the quite undesirable such as flies, spiders, bugs, lice, fleas and rats.

Although Mostar asserts that the Romans kept fish in marble aquaria containing glass panes, one in theory cannot disprove it, since one cannot prove a negative, i.e., that the Romans did not do so. In the same manner, if I make the statement that I saw two *Tyrannosaurus rex* copulating in my backyard, there is no way that anyone can disprove it. With regard to such statements we must insist that the assertor provides some evidence that can be assessed by those who are *compos mentis* and who respond with raised eyebrows to reports like little green men traveling through outer space to annoy earthlings with bright lights.

More seriously, such assessors must also have an understanding of how men in other eras lived and behaved. If one is writing about the first century AD, one relies upon (1) the authors of the time and (2) later authors who have done research of this time period and whose work is generally considered of the highest scholarship. For the first I have read the ten Roman authors in the bibliography and for the second the two modern-day authors listed below them.

Ludwig Heinrich Friedländer (1824 - 1909), by the way, was a philologist and historian noted for his comprehensive survey of Roman social and cultural history. His masterpiece was the "Darstellungen aus des Sittengeschichte Roms" ("Representations from Roman Cultural History"), a detailed and vivid portrait of the social life, customs, art and manners of the first two centuries of the Roman Empire. The work remains one of the most complete surveys of Roman life and society. It was translated into many languages, including English under the title, "Roman Life and Manners under the Early Empire."

In point of fact, none of the authors I cite who lived at the time mentioned aquaria with glass sides. If such existed they would most likely have been owned by Romans of wealth and these authors wrote thousands upon thousands of words about this stratum of Roman society. If such tanks had existed, surely at least one of them would have mentioned it. It would have been too good to pass up! Furthermore, neither Higginbotham nor Friedländer uncovered the existence of such aquaria either.

We can also examine the archeological evidence and here also one cannot prove a negative since we cannot state that some future excavation might not unearth a slew of such aquaria (or even a spaceship containing mummified bodies of a greenish hue). Nonetheless, the recent excavations at Pompeii and Herculaneum, which have provided the most detailed information to date of how the Romans of the day lived, have not unearthed any remains of aquaria with glass sides.

According to Higginbotham, Pompeii supplies the most accessible and best-documented group of piscinae built within an urban and, specifically, a domestic setting (the explanatory notes have been supplied by the author):

"The garden pond could be enjoyed and appreciated from different points of vantage, both public and private. The locations of many ponds within Pompeian houses permit the general or remote glimpse suitable for the casual acquaintance or client. Apertures or windows in the atrium and, specifically, in the tablinum (Note: A tablinum is the main room in a Roman house, later used as the formal reception or living room and study or office by the head of the household.) **allowed a more public audience to see the pond. Many of these same piscinae and others could be enjoyed from much more intimate surroundings. The location of dining areas and reception rooms around the garden often took into account the location of the fishpond. Triclinia** (Note: Triclinia are formal dining rooms in a Roman building.)**, set within rooms or shaded by pergolas afforded selected visitors or guests front-row seats to the splendors of the gardens and their ponds. At Pompeii, over twenty examples of piscinae are situated in close proximity to dining facilities with approxi-**

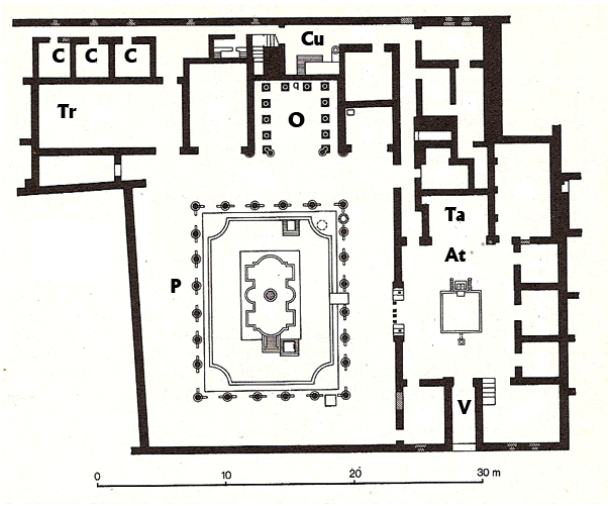

Figure 1: The Casa di Meleagro, Pompeii with a fishpond in the peristyle. Key: C = bedrooms; Cu = kitchen; Tr = triclinium; Ta = tablinum; At = atrium; V = entrance; O = oecus; P = peristyle. A peristyle is an open colonnade in a building surrounding a court that usually contains an internal garden, in this case, however, it is a fishpond. Note the oecus, the principal salon in a Roman house used occasionally as a triclinium for banquets, faces the fishpond.

mately an equal number located where they can be seen easily from reception rooms and garden exedrae (Note: An exedrae was a semi-circular recess or plinth sometimes set into a building's façade.). **The connection between ponds and dining areas is not solely aesthetic but has a gastronomic component as well. Fish or eels fresh from the piscina would make an impressive addition to private meals among friends and honored guests."**

Figure 3: The opposite view of the fishpond. Water cascaded down the six small stairs at the rear, Water also issued forth from a columnar fountain in the center of the pond. The semi-circular niches provided shade for the fish and protection for the smaller fry.

None of the fish receptacles discussed here by Higginbotham, however, are located within buildings and none have glass sides. An example of what Higgenbotham was describing is shown in Figures 1, 2 and 3.

Actually, the only known Roman tanks that contained live fishes are holding tanks associated with transporting fish by boat, fishmonger shops and kitchens. Athenaeus of Naucratis, a Greek historian circa 200 AD, describes

Figure 2: The fishpond in the Casa di Meleagro peristyle. The small square tank in the foreground, which was topped with marble revetment and painted blue, was linked to the larger pond by a single pipe. Higginbotham suggests that it probably served as an enclosure for special fish or to hold the fish while the larger pond was being cleaned.

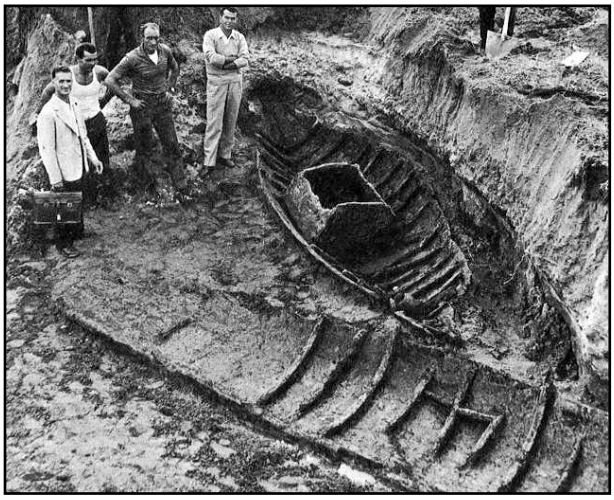

Figure 4: Boat with a fish holding tank (circa late second or early third century AD) found at Fiumicino (a coastal town in the central Italy), near what was the entrance to the Claudian harbor. It was constructed with wooden boards and coated with lead.

a ship built by Archimedes at the behest of the tyrant Hiero II, which had a live tank built into the bow and was constructed of lead and wood. During the construction of the airport at Fiumicino in 1958-59, a boat with a live tank (*navis vivaria*) built with wooden boards and coated with lead was unearthed near what was the entrance to the Claudian harbor (see Figure 4). The presence of holding tanks at some fishmonger's shops have been found in the market of Ostia and also at private houses in or near the kitchens. None of these, however, were made of marble or constructed with glass sides.

Mostar made other statements that are questionable, to say the least. In the following, Mostar is referring to eels, carp and bream: **"Well, all these fish live in water basins that were made from the most precious marble. However, they were still housed outside of the home; the eel had already made it to the fountain."**

Higginbotham, however, states that seaside fishponds were either excavated in rock or constructed of concrete. Inland ponds were usually built of concrete walls with masonry facings. The earliest fishponds built with a datable building method employed concrete faced with *opus incertum*. *Opus incertum* was an ancient Roman construction technique, using irregular shaped and random placed uncut stones or fist-sized tuff blocks inserted in a core of Roman concrete called *opus caementicium*. The *opus incertum* used in these fishponds appears to date to the last years of the second century BC or, more probably, the early years of the first century BC. *Opus reticulatum* was a construction technique using small pyramid shaped blocks of tufa set in a core of *opus caementicium*. The tufa blocks cover the surface, with the pointed end into the cement, so the square bases form a diagonal pattern that resembles a net, hence the name. The masonry facings were often of marble but the fishponds themselves were made of concrete.

Mostar also claimed that, with the arrival of aquaria with glass sides, guests could now also see the mullets breeding during their demise (**"Und nun erblickten die Damen und ihre Kavaliere die Seebarben beim Liebesspiel…"**), a patently ridiculous claim.

Because of erroneous statements such as these and because he provides no references for his assertion that the Romans had glass-sided aquaria, Mostar cannot be taken seriously and, by extension, neither can Brunner in this instance. For an assertion having this degree of consequence to aquarium hobby history, whoever wrote the Wikipedia piece should have done the required research, refuted the assertion out of hand or, better still, not mentioned it at all.

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The Perils of Aquarium Hobby History Research: A Case History

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, January 11, 2014)

In my research into matters involving mullets (*Mullus barbatus*, and *Mullus surmuletus*), food fishes esteemed in Roman times, I came across several references to Hortensius (i.e., Quintus Hortensius Hortalis, 114 BC - 50 BC), one of the foremost Roman orators (Figure 1). He dominated the courts by using a florid style and by resorting to shameless bribery. Despite his best efforts at legal trickery and intimidation, he was defeated by Cicero in the Verres case, where Cicero was prosecuting Caius Verres for gross misgovernment in Sicily. Cicero's success in this case won him great acclaim and considerably helped his political career. Hortensius later joined Cicero in several *causes célèbres*, with Cicero always speaking last.

Hortensius gradually withdrew from politics into cultivated luxury. The vast wealth he had accumulated was spent on splendid villas, parks, fishponds and costly entertainments. He was the first to introduce peacocks as a table delicacy at Rome, and Cicero puts him among the aristocrats solely concerned about their fishponds. Lucius Licinius Lucullus, for example, a friend of Hortensius, was well-known for having cut a channel through a mountain near Naples to allow the sea to enter his fishponds and stir the water within to prevent stagnation, for which feat he earned the nickname, "Xerxes in a toga," after the Persian general who cut a channel through the isthmus of Mount Athos for this fleet to pass through. Hortensius also constructed similar fishponds at vast expense, so designed that the tide caused sea water to flow into them.

Hortensius used to water his plane trees with wine, and in a certain case in which he and Cicero had both to speak, he asked Cicero as a favor to change with him, as he was obliged to go home to water with his own hands a plane tree which he had planted on his Tusculum estate. Hortensius was noted for the pains he took in arranging his toga, folding it just so before a mirror. It is said that he once prosecuted a colleague for assault and battery because the latter, meeting him on a narrow footpath, had jostled him and disordered the folds!

One of the references to Hortensius I came across was an 1868 translation of *The Ocean World* by Louis Figuier. Figuier (1819-1894) was a French chemist and writer on occult subjects (Figure 2). After taking his doctorate in medicine and completing his postgraduate study in chemistry, he was made professor of chemistry at the school of Pharmacy in Montpellier and later exchanged this post for a similar one in the School of Pharmacy of Paris. Many honorary degrees in science and medicine were conferred upon him by various faculties during his career. However, in his research he found himself opposed by Claude Bernard, a French physiologist whom historian I.

Figure 1:
Quintus Hortensius Hortalis (114 BC - 50 BC).

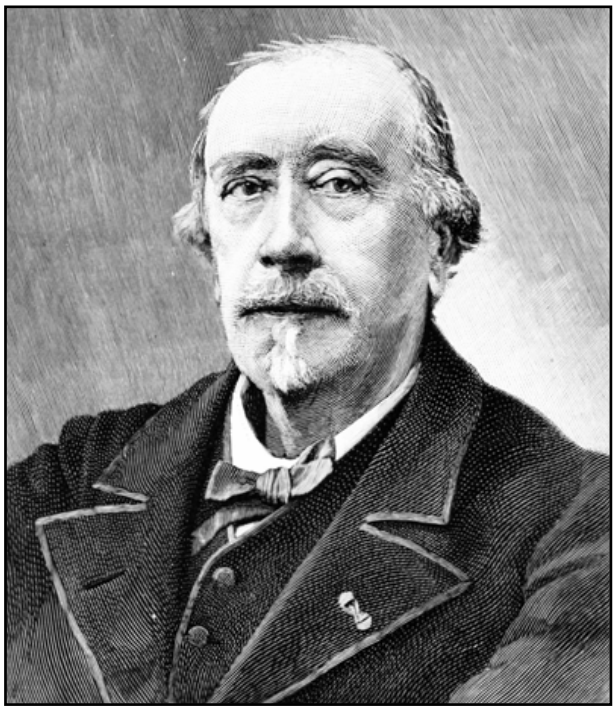

Figure 2: Louis Figuier (1819-1894).

Bernard Cohen of Harvard University called "one of the greatest of all men of science." As a result of this conflict, Figuier abandoned his research to devote himself to popular science. Much of the scientific information in the novels of Jules Verne, by the way, was taken from his works.

In any event, in *The Ocean World* I came across this statement in the section under mullets:

The great rival of Cicero, the advocate Hortensius, who attracted crowds of people to the Forum by his eloquent and elegant discourses, had an inordinate passion for this kind of enjoyment. These little inhabitants of the waters were led by a small canal which was carried under the festive table, and his great enjoyment was to witness the agonies of the unhappy fish just taken from its native element and carried to the table, palpitating with its dying convulsions, as it perished beneath his eyes, he in the meanwhile enjoying a sumptuous banquet.

This was accompanied by an artist's representation of what this might look like (see Figure 3). David W. Cheever, by the way, attributed to Martial (he cites Book X, Epigram XXX) the claim that Roman **"Pisciculture was carried so far that fishponds were constructed on the roofs of houses. More practical persons conducted a stream of river-water through their dining-rooms, so that the fish swam under the table, and it was only necessary to stoop and pick them out the moment before eating them; and as they were often cooked on the table, their perfect freshness was thus insured."**

Martial, however, said no such thing. The epigram actually reads, **"The line seeks not its prey in the distant sea, but the fish, descried from above, draws down the cord cast from bed or couch. If ever Nereus feels the power of Aeolus, the table, safe-supplied from its own store, laughs at the storm; the fishpond feeds turbot and home-reared bass; to its master's call swims the dainty lamprey; the usher summons a favorite gurnard, and, bidden to appear, aged mullets put forth their heads."**

Martial mentions nothing about fishponds on the roof or fishing under the table. On occasion, a rod and line was thrust out of a window from a bed-

Figure 3: "Agony of a Red Mullet at the Feast of Hortensius." From Figuier's "The Ocean World."

room to dangle over an outdoor fishpond (this is discussed thoroughly in the Fourth Edition of my "The Toy Fish," and this is what Martial was alluding to.

However, I was somewhat dubious about the claim and set out to see if I could find any validation of it in the writings of the authors of the day, such as Cicero, Pliny, Varro and others. In this endeavor, I was unsuccessful.

My next thought was that perhaps the translator had made an error so I started a search for the original French version. Alas, there was no such version. Unfortunately, Figuier provided no in-text references nor did he provide a bibliography. On the Title page, however, was the statement, "Chiefly translated from "La Vie et les Mœurs des Animaux," but when I examined that document I found nothing in it about fish. In the introduction by the translator, on the other hand, I found the following:

It is stated on the Title-page that "The Ocean World is chiefly translated from M. Louis Figuier's two most recent works. The History of the Ocean is to a large extent, but not wholly, compiled from 'La Terre et les Mers,' one of the volumes of M. Figuier's 'Tableau de la Nature'; but the larger portion of the work is a free translation of that author's latest work, 'La Vie et les Mœurs des Animaux'; other chapters, such as 'Life in the Ocean,' the chapter on Crustaceans, and some others, are compiled from various sources; they will not be found in either of M. Figuier's volumes; but in other respects his text has been pretty closely followed."

One misstatement was immediately apparent, i.e., only one such work was mentioned on the title page. What the remainder of this bibliographic gobbledygook meant was a mystery to me (and, as I shall later point out, I was not alone) but slogging on I examined *Les Poissons, les Reptiles et les Oiseaux* in Figuier's *La Vie et les Mœurs des Animaux* from his *Tableau de la Nature* and found what I was looking for:

Le rival de Ciceron, l'avocat Hortensius, qui attirait tout le peuple au forum par la beauté de ses harangues, avait une passion désordonnée pour ce petit habitant des eaux. Il faisait venir les rougets dans de petites rigoles jusque sous la table du festin; et il se délectait, assis devant un somptueux banquet, du plaisir de voir un de ces malheureux poissons retiré du bassin et apporté sur sa table, palpitant et agité des convulsions de l'agonie, périr sous ses yeux, en se colorant de mille nuances irrisées.

Keeping in mind that I needed here a more literal translation than an artistic one, I translated it as follows:

The rival of Cicero, the lawyer Hortensius, who attracted all the people in the forum by the beauty of his harangues, had a wild passion for these little inhabitants of water. The mullets were led into a small canal that was carried under the festive table, and he enjoyed sitting in front of his sumptuous banquet, the pleasure of seeing one of those unfortunate fish removed from the pond and brought to the table, and in agonizing convulsions, die before his eyes in iridescent colors of a thousand shades.

Although this didn't differ much from that of Figuier's translator, it did make clear that Figuier was saying that Hortensius brought his fish to the dining room by some sort of water conduit connected to one of his fishponds. The translator's **"... just taken from his native element..."** is not the same as my **"... removed from the pond..."** In any event, Figuier's statement could not possibly be true. For proof of this I refer to Marcus Terentius Varro (116 BC - 27 BC), Rome's greatest scholar and a satirist of stature, whose vast and varied erudition in almost every department of literature earned for him the title of the "most learned of the Romans" (Figure 4).

He was a man of immense learning and a prolific author. Inspired by a deep patriotism, he intended his work, by its moral and educational quality, to further Roman greatness. Seeking to link Rome's future with its glorious past, his works exerted great influence before and after the founding of the Roman Empire in 27 BC. Though not attracted to a political career, he played some part in the public life of the Roman Republic. Politically, he supported Pompey and during the civil war he commanded one of Pompey's armies. He escaped the penalties of being on the losing side in the civil war through two pardons granted by Julius Caesar, and Caesar later appointed him to oversee the public library of Rome in 47 BC.

Figure 4:
Marcus Terentius Varro (116 BC - 27 BC).

His only complete work extant, *Rerum Rusticarum Libri Tres*, has been described as "the well digested system of an experienced and successful farmer who has seen and practiced all that he records." One noteworthy aspect of the work is his anticipation of microbiology and epidemiology. Varro warned his contemporaries to avoid swamps and marshland, since such areas "breed certain minute creatures which cannot be seen by the eyes, but which float in the air and enter the body through the mouth and nose and cause serious diseases." The following is taken from this book. Appius Claudius Pulcher (97 BC - 49 BC), was a consul of the Roman Republic and a good friend of Varro's. This is he, talking to Varro:

Our common friend Quintus Hortensius had fishponds near Bauli which had cost him a great sum to build, and I know, for I often used to stay with him at his country-house, that he used always to send to Puteoli to buy the fish for dinner. And it was not enough that his fish-ponds didn't feed him, but he must needs, if you please, with his own hands feed them, being more anxious lest his mullets should feel the pangs of starvation than I do lest my asses at Rosea should go hungry. He spent, too, a good deal more on the former than I do on the latter in the matter of both food and drink. For all I need for the feeding of my costly asses is one little slave, a trifle of barley, and water found on the estate, while Hortensius in the first place kept an army of fishermen to feed the fish, who used constantly to bring him masses of tiny fishes which were destined to serve as food for the big ones. He would buy, besides, salt-fish, and throw it into his ponds, when the sea was stormy, and when, owing to the weather, the market that supplies the fish-ponds (the sea, that is) refused its food, and the live food, the fish eaten by the common people for supper, could not be got to shore with a net. You would sooner, said I, have got Hortensius's consent to your taking his carriage-mules from the stable and keeping them for your own, than a bearded mullet from his fish-pond.

This fanaticism and concern for his bearded mullets became a standing joke throughout Roman society but the point here is that Hortensius was so devoted to his fish that he could not stand to send them off to the banquet table, opting instead to purchase them from the market in Puteoli. He would not have constructed such a conduit from one of his fishponds to his dining table any more than a present-day fish fancier would serve up his pet arowana to dinner guests. Thus, Figuier's account is a myth, nothing more. The coup d'etat was provided by the following review that appeared in 1868 in *The Contemporary Review*:

The title-page of this lavishly-illustrated volume informs us that it is "*chiefly* translated from 'La vie et les moeurs des animaux' of L. Figuier." Monsieur Figuier is well known as a popular compiler, holding about the same position, as a French writer of natural history, which the Rev. J. G. Wood does on this side of the Channel. But in this volume it is difficult to ascertain for what M. Figuier is to be held responsible. We are told that "the History of the Ocean is to a large extent, but *not wholly*, compiled" from one of M. Figuier's volumes, but that "the larger portion of the work is a free translation of that author's latest work," and that "other chapters are compiled from various sources; they will not be found in either of M. Figuier's volumes." After these naive admissions, we may well ask what is the book? Truly a very patchwork of compilation, utterly without authority as a work of reference! We must admit that the various compilers who have had a share in the

volume, have frequently avoided misstatements, while they have popularized the history of the inhabitants of the sea from the zoophyte to the vertebrate fish. Yet we meet with random writing and vague exaggeration more frequently than we expect, even in a French compilation. Thus we are told that the little Janthina shells inhabit the deep sea, and often form banks of many leagues in extent! Another marvelous story is that of a cuttlefish 60 feet long, not counting its arms, which are represented as about 40 feet more and weighing 4,000 pounds, which encountered a French corvette. The fish, according to the illustration taken on the spot and given here, should have been more than a match for the ship (Figure 5). The editor, however, suggests (in, we presume, 'compilation' Latin) that this should be taken *cum grano salis*.

In this paragraph the reviewer first rakes the translator over the coals for the confusion over what was Figuier's work and what was not. He then opines that it is a very patchwork of compilation, utterly without authority as a work of reference, and finishes off by pointing out some errors (I smile at the statement, "…vague exaggeration more frequently than we expect, even in a French compilation"). The reviewer goes on to suggest that the only value the book has is as a children's book and even there because of its pictures:

The best portions of the book are those on the Acephalæ and the Echinoderms, which are very fairly illustrated. Some of the plates are spirited, and all of them accurate in this portion of the volume. The latter portion is less complete, the plates rather sensational, and some interesting facts, such as the existence of water-snakes, altogether omitted. Yet the book, with all its faults, and they are many, may be useful in leading children to inquire into the nature of the creatures they find by the sea-shore. It ought to be taken by schoolboys to the sea-side, and its pictures may afford much home amusement besides. These, excepting in the lower forms of life, have scarcely been chosen with judgment. Every common shell of our coasts, even our black garden slug, the common cowrie, and shells seen on every cottage chimney-piece, are figured elaborately, while the world of shells was before the artist from which to choose. We fully appreciate the value and the necessity of popularizing technical knowledge, but we do trust that when M. Figuier's translators produce their next volume of science for the million, in the forthcoming "Insect World," they will give us engravings not more, nor better executed, but better selected.

My reading of Figuier's *Les Poissons, les Reptiles et les Oiseaux* did have some additional value. In his *The Ocean World* Figuier talked about Publius Vedius Pollio (born 1st century BC - died in 15 BC) who was a Roman equestrian of the 1st century BC, and a friend of the Roman emperor Augustus, who appointed him to a position of authority in the province of Asia. In later life he became known for his luxurious tastes and cruelty to his slaves - when they displeased him, he had them fed to moray eels (or lampreys; the exact fish is not certain) that he maintained for that purpose, which was deemed to be an exceedingly cruel act. In a highly rhetorical passage, the Christian writer Tertullian stated that after exe-

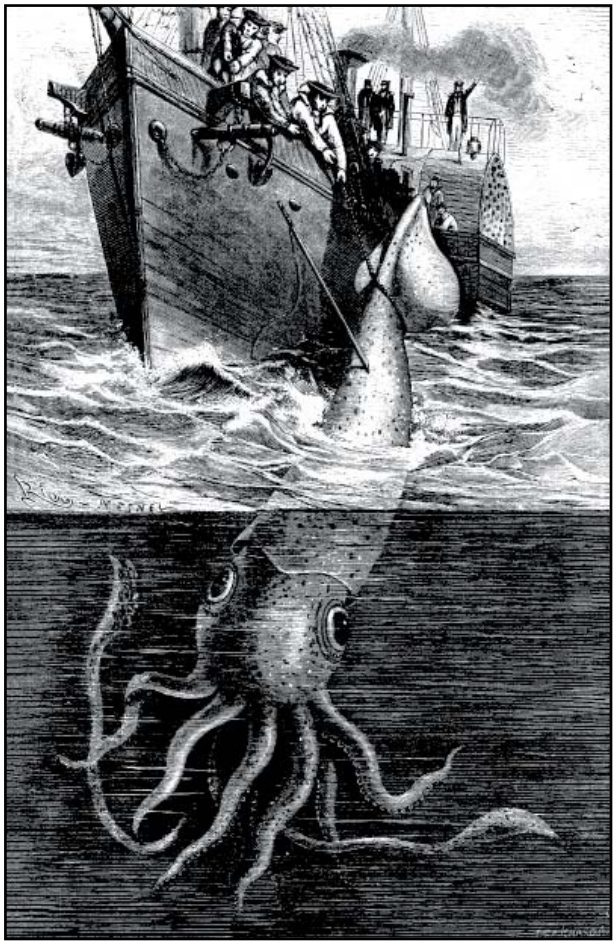

Figure 5:
"Gigantic Cuttle-fish caught by the French Corvette Alecton, near Teneriffe."
From Figuier's "The Ocean World."

cuting slaves, Vedius had his lampreys "cooked straight away, so that in their entrails he himself might have a taste of his slaves' bodies too."

When Vedius tried to apply this method of execution to a slave who broke a crystal cup, Augustus (Vedius's guest at the time) was so appalled that he not only intervened to prevent the execution but had all of Vedius's valuable drinking vessels deliberately broken.

This incident, along with Augustus's demolition of the massive villa he inherited after Vedius's death in 15 BC, were frequently referred to in antiquity in discussions of ethics and of the public role of Augustus. Vedius died in 15 BC and among his many heirs, Augustus received a large part of Vedius's estate, including his villa on the Gulf of Naples, along with instructions to erect a suitable monument on the site. The emperor demolished the house and constructed in its place a colonnade in honor of his wife Livia, which he dedicated in 7 BC. During or shortly after Augustus's reign, Ovid praised his demolition of Vedius's house as a grand statement against immoral luxury made even at the emperor's own cost. Also in the 1st century AD, Vedius's story was used by the philosopher Seneca and by Pliny the Elder. In two ethical treatises, Seneca used Vedius's treatment of the cupbearer and Augustus's response to illustrate the extremes to which anger could lead and the need for clemency. Although Pliny the Elder mentioned Vedius's lampreys in his *Natural History* while treating varieties of fish, Pliny was no admirer of Augustus and noted the man's friendship with Augustus while ignoring the story of the latter's clemency. His handling of the story has been seen as "a gratuitous jibe" at the emperor.

In *The Ocean World*, Figuier did not show an artist's rendition of this practice but in *Les Poissons, les Reptiles et les Oiseaux* he did and I include the illustration here (Figure 6).

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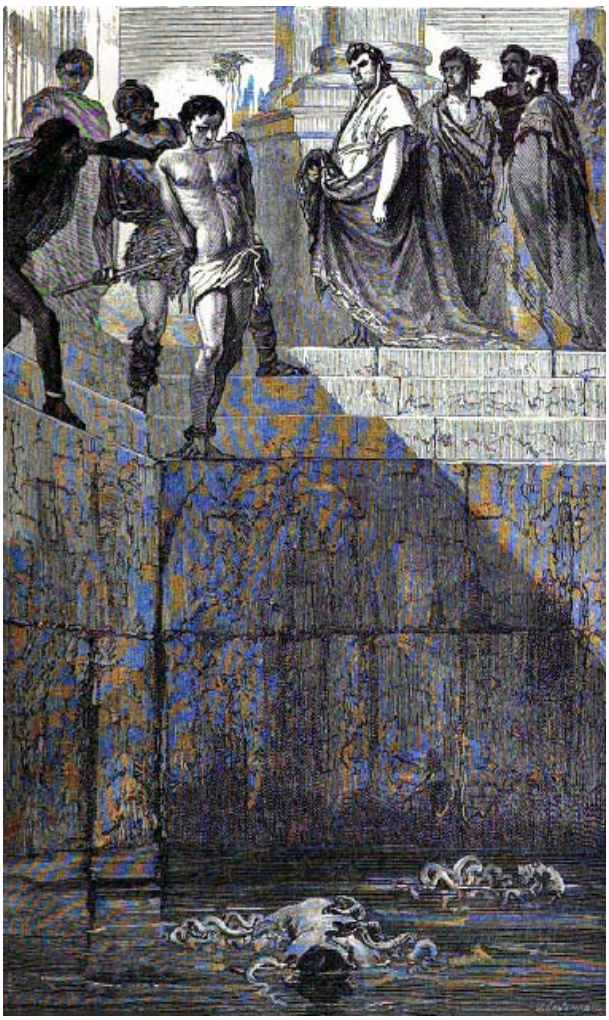

Figure 6:
"Esclave romain jeté aux Murenes" ("Roman slave thrown to the Moray eels"). From Figuier's "Les Poissons, les Reptiles et les Oiseaux." The illustrator clearly did not know what a Roman piscina looked like!

THE GARDENER'S AQUARIUM

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, February 22, 2014

In the process of working on my monograph, "Who invented the aquarium?" (Klee, 2012), a good friend of mine asked, "Who was the first aquarist to use the word "aquarium?" After some additional research I determined that it was Robert Warington, writing in the January 1852 issue of *The Garden Companion, and Florists' Guide*.

It should be noted that some erroneous information has appeared on this subject, mainly in dictionary entries and in Wikipedia posts. For example, The Oxford Universal Dictionary (third edition, 1933) states the date of first use as 1854 and a Wikipedia article reads: **Philip Henry Gosse was the first person to actually use the word "aquarium," opting for this term (instead of "aquatic vivarium" or "aqua-vivarium") in 1854 in his book *The Aquarium: An Unveiling of the Wonders of the Deep Sea***. In point of fact, although Philip Gosse undeniably was responsible for the popularization of the term "Aquarium" in the fish hobby sense, he was not the first one to use it. Warington preceded him. Gosse himself did not claim priority in this matter, the following being his clear and elegant explanation of why he used the term:

A neat, easily pronounced and easily remembered, significant, and expressive term is so advantageous, that it is worth taking some trouble to select the best. For the subject of this volume some have chosen the word Vivarium, and I have myself occasionally used it. The only objection to it is that it lacks distinctness of signification. It literally means any enclosure in which living animals are kept; and the ancients used it to signify a park, a rabbit-warren, and a fishpond; indeed, I am not sure whether our word "warren," is not "Vivarium" Saxonised. Thus it is quite as applicable to the whole Zoological Garden as to any particular house, yard, or tank in it. To avoid this indefiniteness, others have used the term Aqua-vivarium. The objection to this is its awkward length and uncouthness, which render it unsuitable for a popular exhibition or domestic amenity. I have adopted the word Aquarium, as being free from the objections which lie against the other two, while it possesses the neatness of the former, and the definiteness of the latter.

He goes on to say (and here lies the subject of this monograph):

The term had already been in use among the botanists, to designate the tanks in which aquatic plants were reared; and the employment of the same term for our tanks is not forbidden by the character of the service to which they are put, since this is not an alteration, but only an extension. The growth of aquatic plants is still a most important and pleasing feature of our pursuit, and the addition of aquatic animals does not at all detract from the appropriateness of the appellation.

In my "Who invented the aquarium?" monograph I discussed what I call "The Gardener's Aquarium," leaning heavily upon John Loudon's An Encyclopædia of Gardening (Loudon, 1824) in which he showed several examples of the more ornate aquaria and suggested that fish might be added to them.

Loudon's 1,311-page Encyclopædia was the finest reference book on the subject at the time and is still highly regarded to this day. He has been described as the "father of the English garden" and without him it is unlikely that we would have the modern garden in its present form, and indeed the passion (or obsession) for gardening both professionally and as a hobby. Loudon's work as a journalist and author led to the "democratization" of gardening. Through his articles and books, the pleasures of gardening, growing plants and garden visiting became available to people at all levels of society, either in their own modest gardens or in public areas such as parks. When Loudon was born in 1783, the Landscape movement was at its height for those who had the land and the wealth to afford it. It is due to Loudon that the gardener took over from the landscape designer in the 20th century.

Although Loudon referred frequently to aquaria and showed numerous examples, he did not supply a precise definition. This was left to his future wife, Jane C. Webb, a most extraordinary woman (Figure 1). In 1827 Webb published – anonymously - a novel titled *The Mummy!* She was a contemporary of Mary Shelly who, nine years earlier, had written *Frankenstein,* also written anonymously since women in those days had difficulties getting published. It drew many favorable reviews, including one in 1828 in *The Gardener's Magazine* on the inventions proposed in it.

The novel starts in the year 2126. There were air mattresses, mirrors that transmitted images over distances, and an apparatus that drew water from a rain cloud. Travel was by balloons, inflated with hydrogen gas and propelled by a mercury-based gas produced from an electrical machine. Smaller versions of the balloons were in the form of aerial horses that dandies could ride. Mail was placed into balls and discharged by steam cannons. Every town had a wire net to catch the balls and there was a special ball that made a distinctive noise as it passed through the air to let the recipients know a letter was forthcoming. There were houses fitted with grooves on the bottom that fit on railroad tracks so they could be moved at their owner's convenience. This was science fiction when Jules Verne wasn't even born yet!

Figure 1:
Left: John Claudius Loudon (1783-1843)
Right: Jane C. Webb Loudon (1807-1858)

How they met is told in Jane Loudon's own words:

About this time Mr. Loudon formed his first acquaintance with me. My father died in 1824; and, finding on the winding up of his affairs that it would be necessary for me to do something for my support, I had written a strange wild novel called *The Mummy,* in which I had laid the scene in the twenty-second century, and attempted to predict the state of improvement to which this country might possibly arrive. Mr. Loudon chanced to see the review of this book in the *Literary Gazette,* and, as among other things I had mentioned a steam-plough, it attracted his attention, and he procured the work from a circulating library. He read it, and was so much pleased with it, that he published, in *The Gardener's Magazine* for 1828, a notice of it under the head of "Hints for Improvements;" and he had from that time a great desire to become acquainted with the author, whom he supposed to be a man. In February, 1830, Mr. Loudon chanced to mention this wish to a lady, a friend of his, who happened to be acquainted with me, and who immediately invited him to a party, where she promised him he should have the wished-for introduction. It may be easily supposed that he was surprised to find the author of the book a woman; but I believe that from that evening he formed an attachment to me, and, in fact, we were married on the 14th of the following September.

Although Loudon was 24 years older than Jane, she cared deeply for him. In her 1840 book, *Instructions in Gardening for Ladies*, she dedicated the book to him thusly: **To J.C. Loudon, Esq., F.L.S, H.S., Z.S., etc., to whom the author of the following pages owes all the knowledge of the subject she possesses, this work is dedicated by his affectionate wife…** In 1843, John Loudon died of lung cancer, leaving her with a 10-year-old daughter, Agnes, who would grow up to author children's books. At the time, they had been married for fourteen years. Jane wrote: **I do not attempt to give any description of the talents or character of my late husband**

as an author; his works are before this world, and by them he will be judged; but I trust I may be excused for adding, that in his private capacity he was equally estimable as a husband and a father, and as a master and a friend.

She quickly became fascinated with her husband's field of horticulture and gardening, and in the meticulous manner her husband needed for his researches, acted as his secretary, copyist, researcher, note taker and even his co-author on some of his books. The Loudons were considered the leading horticulturalists of their day, and their circle of friends included Charles Dickens and William Makepeace Thackeray.

Part of Jane Loudon's understanding about gardening was due to the influence of John Lindley, an important figure in horticulture who lectured regularly at the Royal Horticultural Society and campaigned to get women interested in gardening. She attended his lectures and became one of his ardent followers, becoming one of the foremost popularizers of horticulture for women in the 1800's.

For centuries, the sole purpose of books written for female gardeners had been to show how ladies might supervise the care of flower and herb gardens, not to do any gardening themselves. When it appeared in 1840, Jane Loudon's *Gardening for Ladies* broke new ground by being the first ever practical hands-on guide for green-thumbed gentlewomen. It was an immediate success, selling 1,350 copies on the day of publication and more than 200,000 in total. It was largely through Jane Loudon that gardening became an essential pastime for women and has remained so ever since. That she was also an accomplished illustrator is shown in Figure 2, which shows examples of her artwork from her books.

In 1841 she published *The Ladies Companion to the Flower Garden, being an alphabetical arrangement of all the ornamental plants usually grown in gardens and shrubberies; with full directions for their culture*. In this book she defined the gardener's aquarium as follows:

AQUARIUM - A pond, basin, or cistern of water, for the growth of water plants. In a pond in the open garden, the plants may either be grown in pots, plunged to the depth of one or two feet in the water, or they may be planted in the bottom of the pond. The former is generally the best mode, because the plants are by that means kept distinct, and the stronger cannot overpower the weaker. At the same time very strong ground plants, such as the white and yellow water-lilies, do not flower freely unless in the free soil, or in very large tubs. There are few greenhouse aquatics, but a number of stove plants, which require to be grown in water; such as the Indian Lotus, or *Nelumbium,* etc., and these are necessarily grown in pots of moderate size. The most suitable soil is a rich loam. The papyrus, though properly speaking it is a marsh plant, is generally grown in an aquarium. See MARSH PLANTS.

It is clear from this definition that gardeners considered the aquarium to be any container of

Figure 2:
Examples of Jan Loudon's artwork, taken from her publications.

water - large or small - that contained aquatic plants.

I was interested in how early the term "aquarium" was applied by gardeners to water vessels containing aquatic plants since I was relying largely on Loudon's Encyclopædia. My strategy was to work my way back from its 1824 publication date and the first reference I uncovered was George Tod's *Plans, elevations and sections, of hot-houses, green-houses, and aquarium, conservatories, &c. recently built in different parts of England, for various noblemen and gentlemen*, published in 1812.

Technological improvements in sheet glass production in the eighteenth century made glass architecture more easily possible, and interest in hothouses was strong on both sides of the Atlantic for agricultural, scientific and aesthetic reasons. Greenhouses extended fruit and flower growing seasons and/or allowed cultivation and study of exotic species of non-native plants. "Winter gardens" could also be social spaces for entertaining guests in human-created Edens. In the American colonies, orangeries were built at Mount Clare and Mount Airy in Richmond County, Virginia, as early as the 1760s. George Washington's preliminary plans and construction notes for an orangery at Mount Vernon still exist. Advertisements in early New York City newspapers suggest that greenhouses were also popular there, allowing urban residents the benefits of nature and the countryside.

Tod, a British surveyor and hot-house builder, provided color illustrations and descriptions of 26 "glass houses" in his book, chiefly of his own design. However, one was titled, **"An Aquarium, executed for the Most Noble the Marquis of Blandford at Whiteknights, Berkshire."** The aquarium (Figure 3) was 36 feet in length overall, and the actual tank within was 7 x 16 feet. The depth generally was 18 inches except for two 4-foot long end sections that were 30 inches deep. The greenhouse was heated by a flue at the ground level and the tank itself also was heated by its own flue. As Loudon described it:

A cistern occupies the interior of the house, having a walk round it; it is lined with lead, and filled with a mixture of mud and water, proper for the reception and growth of such plants as require aqueous nourishment. A flue goes round, directly under the bottom of the cistern, for the purpose of keeping the water of a certain temperature. Another flue goes round the house above ground, and terminates in a chimney at the northwest corner. The bottom of the cistern, to receive the lead, is formed with slates, supported by transverse bars of cast-iron; a bottom of wood would have been more convenient for laying the lead upon, but as the flues are so near the bottom of the cistern, danger of fire was apprehended. The cistern is supplied with water by means of a pump placed at a convenient distance for that purpose.

The original specifications were published in 1806 by Josiah Taylor and since this date is close to the turn of the century, it is probable that the word aquarium in the gardener's sense was also used in the 1700's.

In 1745, England enacted a tax on glass that was not repealed until 1845, making greenhouses and aquariums such as this one affordable to only the very rich and the Marquis was no exception. Between 1798 and 1819, Whiteknights was the scene of vast extravagance and wild entertainments, all at the expense of the Marquis (later the 5th Duke of Marlborough). It became the most celebrated estate in the Country, magnificently furnished, displaying many great masters, with a wonderful wine cellar and an unrivalled library. The splendid gardens, beautifully laid out with the rarest of plants, were its greatest attraction however. It was the envy of kings. Unfortunately, the Duke went bankrupt in 1819 and had to retire to Blenheim where he lived the remainder of his life off a small annuity granted to the first Duke by Queen Anne. The Whiteknights Estate was sold off and the house, along with the aquarium, was demolished in 1840 by a mob of the Duke's angry creditors.

The Marquis' aquarium represented the highest end of the spectrum of the gardener's aquarium; a pit containing water was its lowest. An intermediate aquarium was a pond and John Loudon described one in detail (Figure 4):

The shape and size of the aquarium must depend on the extent and style of the flower-garden of which it forms a part. In all cases the bottom, if not naturally

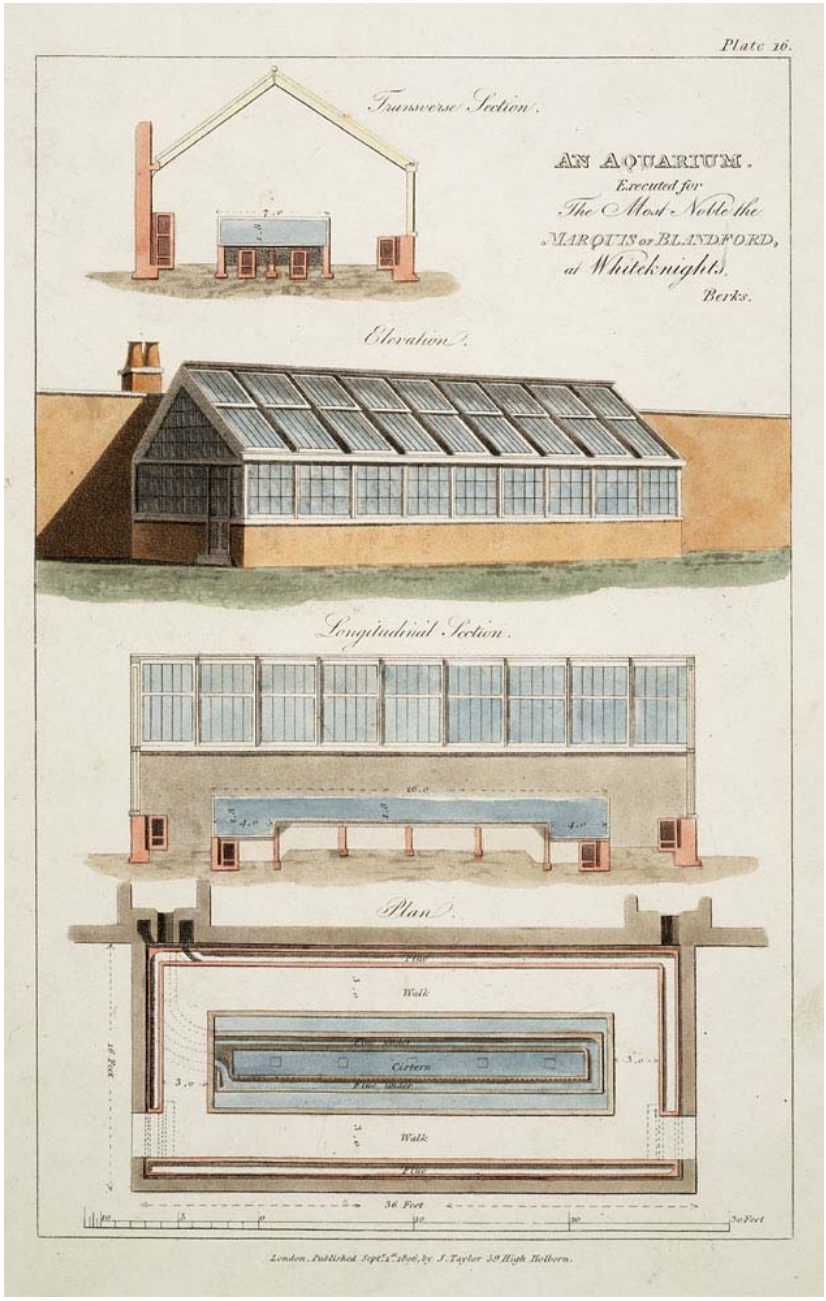

Figure 3: The Aquarium of the Marquis of Blandford,

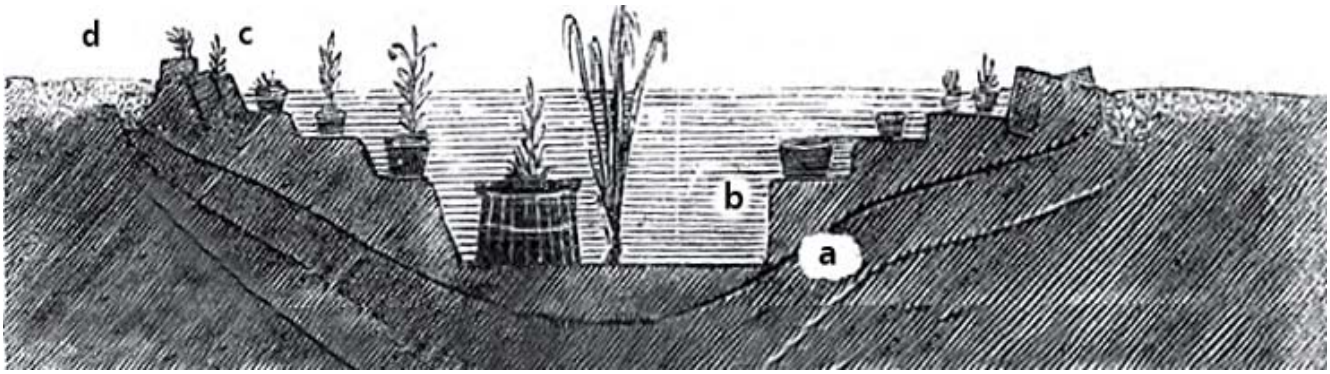

Figure 4: The pond aquarium (from *An Encyclopædia of Gardening* (Loudon, 1824).

retentive, must be rendered so by a stratum of tempered (or puddled) clay (a); the side should be formed in terraces, or steps descending towards the centre (b), to hold pots of plants which grow in shallow water, while those that require deep water, as the bulrush, typha (cattail), etc., may be planted in the ground, or in large tubs placed in deep water. The margin of the aquarium may either be finished with regular masonry or brickwork; or, what, in some situations, has a better effect, with rough stones, conglomerated vitrified bricks, or flints (c), in the Interstices of which marsh plants will thrive exceedingly. The whole may be surrounded by a drain and gravel-walk (d), raised a few inches above the level of the water. Many of the aquatic plants, as Nymphæa, Nuphar, Menyanthes, Villarsia, Butomus, Hottonia, etc., are highly beautiful; and, considering that some exotic species, as Amaryllis, Lobelia, Crinum, etc., will thrive in water in our climate, the aquarium ought not to be wanting in any flower-garden.

I have made here much mention of John and Jane Loudon in examining how gardeners used the word aquarium in the Nineteenth century. That they were remarkable people and that their coming together is a charming and touching story of true love is admittedly beside the point of this monograph.

Along these lines and reminiscent of Jane Austen's "Pride and Prejudice," there was a real Mr. Darcy in the form of the 4th Earl of Harrington at Elvaston Castle in Derbyshire. There is a botanical connection here since in 1830, William Barron was appointed to oversee the Earl of Harrington's gardens where virtually nothing had ever been done to improve or decorate the grounds. Because the Earl wanted to relocate three cedar of Lebanon trees, each 39 feet tall, Barron devised a method for moving really large trees, and was the man responsible for the relocation in 1880 of the great Buckland yew, mentioned in the Domesday Book of 1086 and reputed to be perhaps

Figure 5: Left: Charles Stanhope, 4th Earl of Harrington (1780-1851); Right: Maria Stanhope, Countess of Harrington (1797-1867). The countess was the former actress, Maria Foote.

1500 years old at the time of its moving. The tree, with a massive root ball and an estimated total weight of 56 tons, was moved approximately 203 feet to a new location and replanted where the tree has continued to thrive, a monumental feat of both engineering and surgical botany. It became by far Barron's most famous achievement.

A year after Barron had joined the Earl's service, at the age of fifty the Earl married the beautiful though promiscuous actress, Maria Foote, previously implicated in several salacious and high-profile affairs and 17 years younger than he (Figure 5). The marriage, however, was a success, and for the next twenty years, having forced to retreat from Society, the earl and his actress wife lived at Elvaston in total solitude. The earl's instructions were: "If Queen Victoria comes, show her around, but admit no one else!"

Of course the real reason that the Loudon's figure so much in this monograph is that John Loudon, more than anyone else, wrote in great detail about the gardener's aquarium, and Jane Loudon was the first one to define it. Perhaps this will make up a little for my straying from the real subject!

SO, WHO WAS THE FIRST?

Pinning down "firsts" is a perilous endeavor. One may assert that so-and-so was the first on record for doing something, only to have another researcher later uncover an earlier reference that shows someone else preceded him or her. To avoid embarrassment, I'll use qualifiers to my statements as I now, so to speak, wade in unfamiliar waters.

Since the plans for the aquarium of the Marquis of Whiteknights were published in 1806, it is safe to assume that the word was used in the 1700's and perhaps even earlier. In 1655, Olof Rudbeck (1630-1702), a professor of medicine at Uppsala University in Sweden (he discovered the lymph system) and for several periods its *rector magnificus* (Figure 6), founded a botanical garden, then situated in the center of Uppsala, close to the Fyrisån river). In later years, Carl Linnaeus named an aquatic plant, *Rudbeckia*, after him. The garden was primarily used for teaching botany and pharmacy, and by the end of the century more than 1 800 species were grown there, many of them for the first time in Sweden. The garden was largely destroyed by a fire in 1702 and since the university could not afford to restore it, it was left unattended for a period of 40 years.

Linnaeus (Figure 7) became responsible for the garden in 1741 and had it rearranged according to his own ideas, documented in his *Hortus Upsaliensis* of 1748. Under his supervision, it turned into one of the foremost gardens of its time. Through contacts with fellow scientists all over the world, Linnaeus was able to gather thousands of foreign plants in cultivation. They were grown in parterres either based on

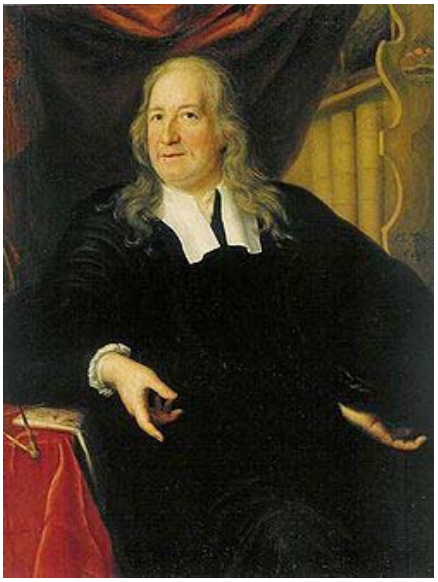

Figure 6:
Olof Rudbeck the Elder (1630-1702)

Figure 7:
Carl Linnaeus (1707-1778

AQUARIUM PALUSTRE ad latera truncos horizontales ſeu parietes habet, aquam a ſolo ſeparantes, inter illos vero & ipſam humum repletum eſt ſpatium humo limoſa e paludibus deſumta, cui inſertæ plantæ paluſtres. veluti:

Acorus, *Aliſma*, *Butomus*, *Cyperus*, *Erigeron*, *Eriophora*, *Iris*, *Juncus*, *Phellandrium*, *Sparganium*, *Scirpus*, *Scheuchzeria*, *Sium*, *Schœnus*, *Siſymbrium*, *Triglochin*, &c.

AQUARIUM FLUVIATILE fundo ſuo tenet plantas fluviatiles & lacuſtres; e. g. *Hottonia*, *Hippuris*, *Myriophyllum*, *Potamogetones*, *Sagittaria*, *Utricularia*, &c. margines vero hujus aquarii ſpecies *Caricum* ao veſtiunt.

AQUARIUM LACUSTRE ſtellata figura & artificio hortulani inſigne, non alias alit plantas, quam eas, quæ foliis natant: ut, *Nymphæa lutea*, *Nymphæa alba*, *Hydrocharis*.

Figure 8:
From Carl Linnaeus' *Hortus Upsaliensis*, Prooemium, 1742.

ecology or following the classes of the sexual system.

Although Uppsala University commissioned the famous architect Carl Hårleman to design the garden, Linnaeus was responsible for the planting, including three ponds for plants typical of streams, lakes and marshes. In his 1742 prologue to his *Hortus Upsaliensis*, Linnaeus defined the following terms under the heading of "Aquaria:" (1) Aquarium fluviatile, (2) Aquarium lacustre and (3) Aquarium palustre (Figure 8), denoting respectively a river pond aquarium, lake pond aquarium and marsh pond aquarium. If this is the earliest use of the word "aquarium" by gardeners, it is also the first time the plural of the word was used. If so, then historically the plural of aquarium should be aquaria, not aquariums. Figure 9 shows the garden as it existed in Linnaeus' time and the locations of the three types of aquaria. Figure 10 shows a sketch of the garden made in 1770 before the garden was moved from the Fyrisån river, the location being unsuitable for gardening as the grounds were very swampy.

The boldfaced lines that follow are taken from Linnaeus' *Hortus Upsaliensis* of 1748 (translated):

The Lake Pond, which is star-shaped and an excellent masterpiece of the gardener's, contains only plants with floating leaves, such as Nymphaea lutea and alba, Hydrocharis, etc. The gardener who built the pond was named Dietrich Nietzel and had been recruited by Linnaeus from Holland. In front of the pond, Linnaeus placed a statue of Venus, bought in 1758 from Piperska trädgården in Stockholm. It caused a scandal in Uppsala, as the Medicean Venus was completely naked. Common newts, *Triturus vulgaris*, prosper in the pond's sun-warmed water. Linnaeus thought that they caused much damage in Uppsala's ponds, but that they could be got rid of by pouring salt into the water. Today it is a protected species.

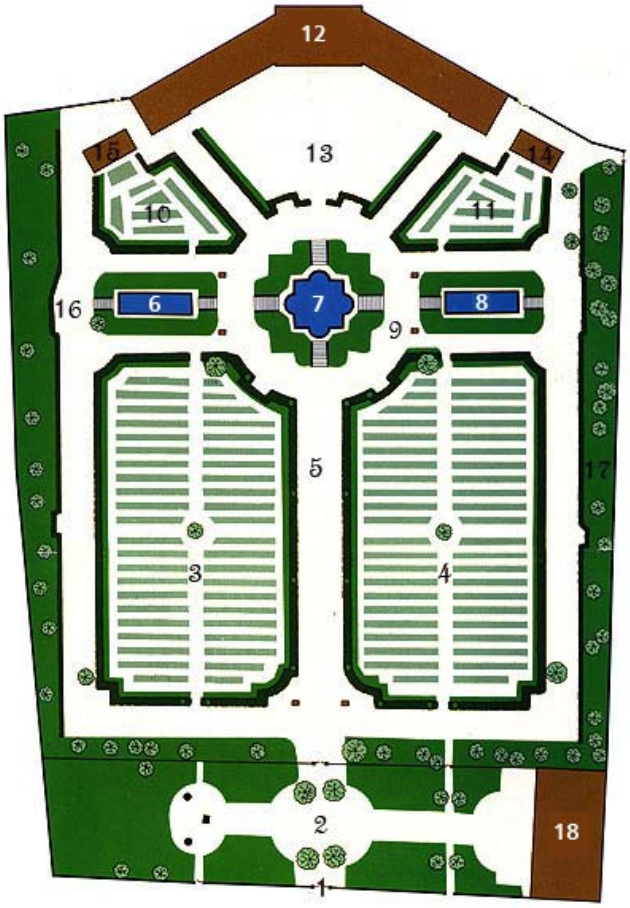

Figure 9: Sketch of the Linnaean Garden.

6 = The River Pond (Aquarium fluviatile)
7 = The Lake Pond (Aquarium lacustre)
8 = The Marsh Pond (Aquarium palustre)

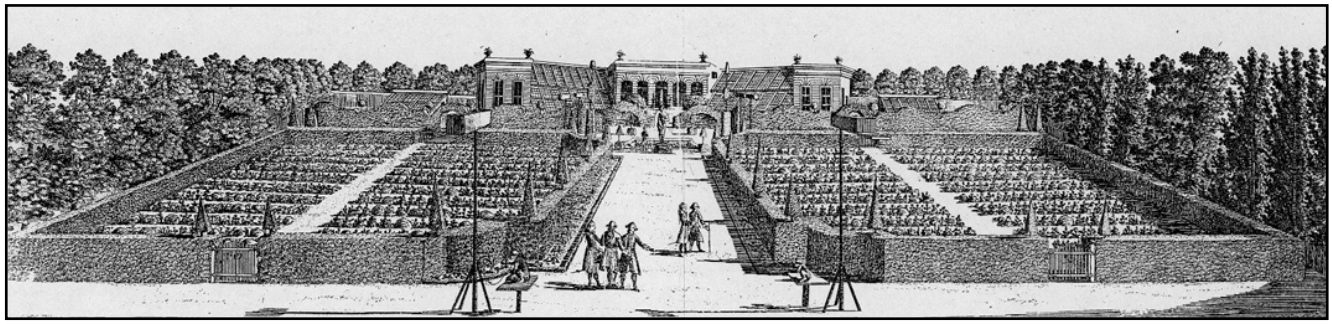

Figure 10: Linnaean Garden, engraving of 1770.

In the River Pond, river and lake plants such as Hottonia, Hippuris, Myriophyllum, Potamogetones, Sagittaria, Utricularia, etc., are grown. The sides of the pond are covered with 20 different species of Carex. The River Pond was deeper than the Marsh Pond but shallower than the Lake Pond. Different species of sedge grew along its sides, such as bladder sedge *Carex vesicaria* and cyperus sedge *C. pseudocyperus*. In the middle of the pond, mare's tail *Hippuris vulgaris*, pondweeds *Potamogeton*-species, and arrowhead *Sagittaria sagittifolia* flourished. Linnaeus argued that all cultivation should be based on knowledge of the plants' natural habitats: climate, soil and humidity. His ponds were the first-ever ecological plantations in a botanical garden.

The Marsh Pond is surrounded by walls or horizontally placed logs, which separate the water from solid ground; in between them is a space full of marsh mud, in which marsh plants have been planted. The Marsh Pond was the shallowest of the three and filled with marsh mud. Linnaeus' three ponds were fed water from a spring flowing through the garden. The water was led from east to west through hollowed-out logs which had been buried in the ground. The Marsh Pond was the shallowest of the three and filled with marsh mud. Nowadays, twinflower *Linnaea borealis* is grown in the Marsh Pond. Linnaeus had great difficulty in getting it to flourish in the garden and succeeded only in growing it in a flower pot.

The question now arises whether Rudbeck had ponds in his garden and therefore might have preceded Linnaeus in the use of the term "Aquarium." In 1675, Rudbeck published a four-volume, 2,500-page tome titled *Atlantica* (*Atland eller Manheim* in Swedish), and included in his book was a sketch of his garden (Figure 12. However, an examination of the sketch shows no ponds whatsoever. Whether Linneaus was

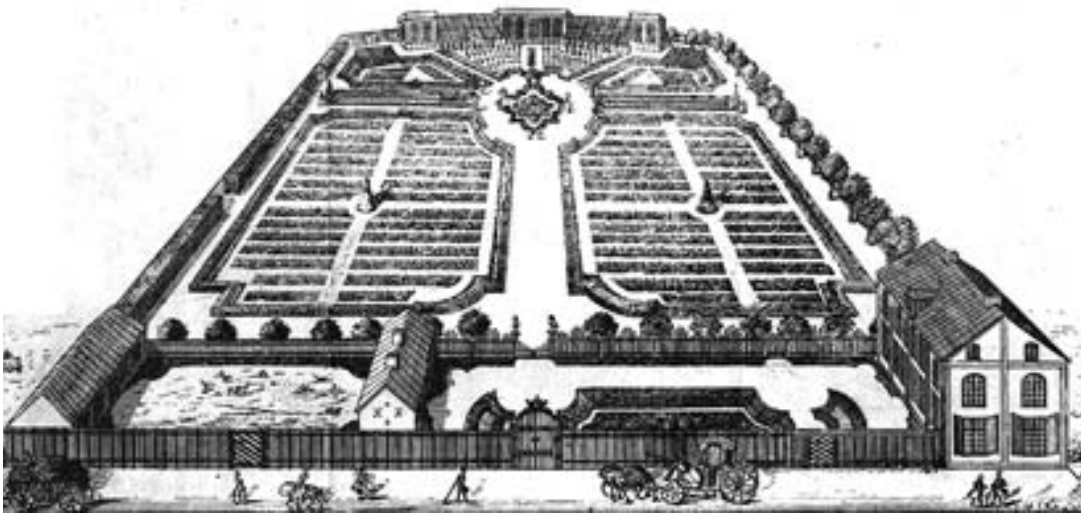

Figure 11: The Garden - two and a half acres in size - in the mid 1740's after the changes made by Carl Hårleman and Linnaeus (from Linnaeus' thesis, "Hortus Upsaliensis" 1748). His residence is the house in the lower right-hand corner and here Linnaeus spent the rest of his life.

the first gardener to use the term "aquarium" is a matter of supposition. However, considering the influence he had on the botanists of the day, it is not unreasonable to assume that his usage of the word affected them and those who followed.

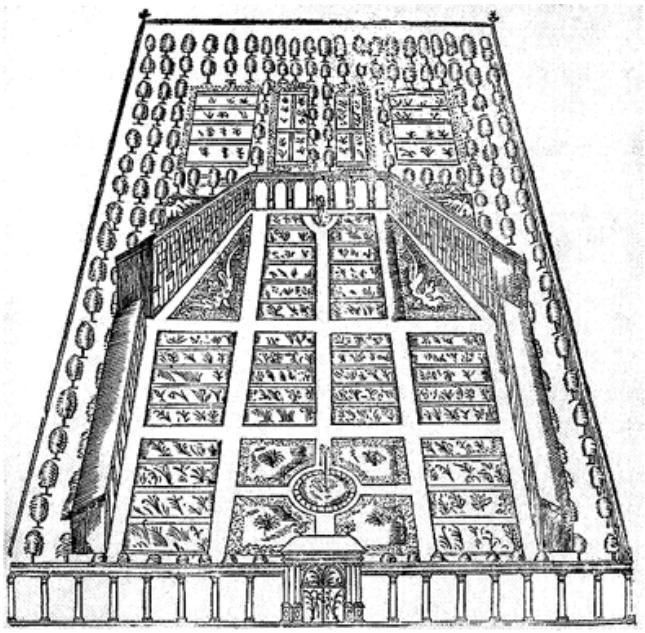

Figure 12:
Drawing of Rudbeck's Garden in 1765. It was damaged by fire in 1702 and fell into disrepair. In 1741 Linnaeus took over.

Figure 13: The present-day Lake Aquarium with the statue of Venus that got Linnaeus into trouble.

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THE "KILLIFISH" THAT ISN'T A KILLIE

By Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society, Yahoo Files, April 4, 2014)

By way of background, *Chologaster cornuta*, commonly known as the "Swampfish" and, more rarely, "Ricefish" or "Riceditch Killifish," is a freshwater fish of the family Amblyopsidae. *Chologaster* literally means "mutilated belly," referring to the poorly developed ventral fins. This fish occurs near vegetation and debris in swamps, ponds, ditches, slow-moving streams, pools and backwaters in the Atlantic Coastal Plain drainages, from southeast Virginia to central Georgia. In such habitats, its thigmotaxic tendency (i.e., the movement of an organism either towards or away from the stimulus of physical contact) is shown by the difficulty in seining these individuals from the roots and debris of their preferred habitat along edges of submerged weed banks which border sand-bottomed channels. Their habitats are rich in potential food for the fish, like amphipods, ostracods and copepods. The males are commonly 1.6 inches long, but may be as large as 2.8 inches. The fish are short-lived, i.e., only up to two years.

Now on to some history. In 1853, after his return from a tour through the southern and western states, Louis Agassiz wrote the following letter to James Dwight Dana (Agassiz, 1853):

I would mention foremost a new genus which I shall call *Chologaster*, very similar in general appearance to the blind fish of the Mammoth Cave, though provided with eyes; it has, like *Amblyopsis*, *the anal aperture* far advanced *under the throat*, but is *entirely deprived of ventral fins*; a very strange and unexpected combination of characters. I know but one species, *Chologaster cornutus* Ag. It is a small fish scarcely three inches long, living in the ditches of the rice fields in South Carolina. I derive its specific name from the singular form of the snout, which has two horn-like projections above.

This wasn't much of a description and neither the genus nor the species would be accepted as valid today, but in 1872 Frederic Ward Putnam filled in the details, thereby making both the genus and species acceptable to other ichthyologists (Putnam, 1872). I'll spare the reader the details of the description of the specimens since the following excerpt will be of greater interest to aquarists:

By the kindness of Professor L. Agassiz, who has placed all the specimens of the family contained in the Museum of Comparative Zoology in my hands for study, I am enabled to give a figure and description of this interesting species from the three specimens in the Museum, which were labelled as the originals of *Chologaster cornutus* Ag., from Waccamaw, South Carolina, presented by Mr. P. C. J. Weston, 1853. The largest of these specimens was distended with eggs and I was enabled to compare the ovary with that of *Amblyopsis*. From its being single and the eggs very large, I have no doubt that it is a viviparous fish like the other genera of the family.

With regard to his last statement, Putnam was in error. Although incubation in the buccal cavity has been reported in other members of the Amblyopsidae, such as *Amblyopsidae*, this is probably not the case for the Swampfish, as the volume of the eggs is too large to fit. In the light of the observations on the spawning behavior of pirate perch, which share the character of a jugular placed anus, it seems probable that the Swampfish likewise deposits its eggs inside root masses. Amblyopsid habitat requirements, feeding ecology, growth rates, life histories and breeding behaviors are largely unknown. For this reason, German aquarists have named *Chologaster* the "Trugkärpfling" or "deceptive cavefish."

In 1882, Jordan and Gilbert combined the descriptions of this fish by Agassiz and Putnam in their "Synopsis of the Fishes of North America (Jordan & Gilbert, 882). Up to this point, however, no common name was reported in the literature until 1896 when Jordan and Evermann (Jordan & Evermann, 1896) listed "Fish of the Dismal Swamp" as its common name. This common name, as well as "Swamp Minnow," also appeared in Smith's "Fishes of North Carolina" (Smith, 1907). The following is from Smith's report:

Although long known from Virginia, South Carolina and Georgia, this species has only recently been reported from North Carolina. Mr. Wm. P. Seal has collected the fish in a large cypress pond near Wilmington where it is "about as abundant as non-gregarious species generally are — such as *Umbra* and *Aphredoderus*"; he has also found it in tidal ditches in the same section, in company with *Gambusia* and *Heterandria*, In Lake Ellis, Craven County, the fish is common, according to Mr. C. S. Brimley; and it may be looked for in other parts of North Carolina in suitable situations. The maximum length does not exceed 2.5 inches.

Regarding the common names for *Chologaster cornuta*, viz., "Swampfish," "Ricefish" and "Riceditch Killifish," the American Fisheries Society is the recognized authority on the common names of fishes that are indigenous to North America and their name is "Swampfish" (American Fisheries Society, 2013).

Driver, in his list of names for various freshwater fishes of the United States with special reference to the area east of the Rockies, cites "Rice-ditch Fish" as its common name (Driver, 1942). The name of the dolt who added the term "killifish" is not known; *Chologaster cornuta* is a member of the family Amblyopsidae, not Cyprinodontidae. Like "Rice-ditch Fish," "Ricefish" most likely was used prior to 1942 as well.

"Swampfish," "Ricefish" and "Riceditch Killifish" all appear in current dictionaries, encyclopedias and Wikipedia accounts, the last-named and the *Columbia Encyclopedia* being the ones most usually cited. Such citations, however, do little to shed light on these names or their frequency of usage.

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When a Whale was a Fish

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Post 12457, July 12, 2014)

In 1819, the New York state legislature had recently enacted a law dictating that fish oil be inspected for quality and purity prior to its sale in order to allow better grading and to reduce the tendency of oil merchants to disguise one type of fish oil as an-other. Fish oil purveyors had to submit their barrels for inspection and, of course, pay a fee to the inspector for the privilege. James Maurice, the New York City's fish oil inspector, was suing Samuel Judd, a candle maker and seller of whale oil who had failed to submit his product for inspection; Maurice had fined Judd seventy-five dollars for buying three barrels of fish oil that had not been inspected and wanted to recover his fees and the statutory fines. In his defense, Judd argued that whale oil was not fish oil, so no inspection of his goods or payment of inspection fees was required. Both sides were represented by some of New York's most high-profile lawyers, and the public followed the case with the avidity of American Idol fans.

This somewhat trivial dispute might have been banged away by the thud of a less patient judge's gavel, but instead the trial became a media circus, in part because of a colorful array of witnesses that included a whaler by the name of Preserved Fish, but mostly because of the participation of Samuel Mitchill, New York City's most famous scientist.

Samuel Latham Mitchill (1764-1831) was an American physician, naturalist and politician. He was born in Hempstead, New York and graduated in 1786 from the University of Edinburgh Medical School. He taught chemistry, botany and natural history at Columbia College from 1792 until 1801 and was a founding editor of The Medical Repository, the first medical journal in the United States. In addition to his Columbia lectures on botany, zoology and mineralogy, Mitchell collected, identified and classified many plants and animals, particularly aquatic organisms.

He served in the New York State Assembly in 1791 and again in 1798 and was then elected as a Democratic-Republican to the United States House of Representatives, serving from 1801 until his resignation in 1804. In that year he was elected a U.S. Senator from New York and served from 1804 to 1809. He then served again in the House of Representatives from 1810 to 1813.

Mitchill strongly endorsed the building of the Erie Canal, sponsored by his friend and political ally, DeWitt Clinton. Mitchill suggested renam-

Samuel Latham Mitchill (1764-1831)

ing the United States of America, Fredonia, combining the English "freedom" with a Latinate ending. Although the suggestion was not seriously considered, some towns adopted the name, including Fredonia, New York. Some freebooters even established a short-lived republic under that name in Texas in the late 1820s.

Mitchill was a man of irrepressible energies who was not afraid to speak out loud about the loves of plants and animals; indeed, he was not a man afraid to speak out loud on most any topic. In the early nineteenth century he was one of the great polymaths of the early Republic, New York's most publicly universal gentleman, a man known variously as the "living encyclopedia," a "stalking library," and (to his admired friend Thomas Jefferson) as the "Congressional Dictionary." As a personality, he was affable but also egotistical and pedantic.

In any case, Mitchill enjoyed popularizing scientific knowledge and promoting practical applications of scientific inquiry. Among other things, he tried to teach his fellow New Yorkers the still-controversial science of Linnaean taxonomy based on classifying species according to their internal anatomical similarities, which make a whale decidedly not a fish. In contrast, according to the taxonomy codified in Genesis, which divided animals into those that swam in the deep, crept on land and flew in the sky, a whale was obviously a fish.

When the defense called Mitchill, they believed his scientific authority would make short work of the plaintiff s case. Instead, poor Mitchill was literally laughed out of the courtroom and made to look ridiculous in the court of public opinion for years to come.

For two days, Mitchill sparred with William Sampson, a respected and often wily prosecutor, trying to establish the great differences between whales and fish.

William Sampson (1794-1836) was born in Londonderry, Ireland. He attended Trinity College in Dublin and studied law at Lincoln's Inn, London. In 1790 Sampson was called to the bar in England, and then returned to Belfast where he was called to the Irish bar and as was the custom. There he gained experience working with a senior counsel, a barrister named John Philpot Curran. Curran often represented members of the United Irishmen who had been charged by the British government with criminal libel, sedition or treason and Sampson himself wrote several articles and satires for the United Irishmen newspapers, the Northern Star and the Press.

Anticipating an insurrection, the British government preemptively arrested the leaders of the United Irishmen in 1798 and William Sampson was intermittently imprisoned or exiled in Europe for several years before being allowed to emigrate to America. When he arrived in New York City in 1806, he set up a business publishing detailed accounts of court proceedings in cases with popular appeal and also successfully continued his career in the law.

Sampson's most important case in America was in 1813 and is referred to as "The Catholic Question in America." Police investigating the misdemeanor of receiving stolen goods questioned the suspects' priest, the Reverend Mr. Kohlman; he declined to given any information that he had heard in confession. The priest was called to testify at the trial in the Court of General Sessions in the City of New York; he again declined. The issue whether to compel the testimony was fully briefed and carefully argued on both sides, with a detailed examination of the common law; in the end, the confessional privilege was accepted for the first time in a court of the United States.

The plaintiff's lawyers made much of the fact that Mitchill was happy to admit that there was disagreement even among philosophers about the new classification scheme, reminiscent of creationists who use disputes among evolutionary biologists

to suggest that evolutionary theory in general is wrong. They also played on Mitchill's including man among the primates and by extension making whales more like men than fish. But equally damaging was that a whale not being a fish simply defied common sense. And, in a moment that shocked the standing-room-only crowd, Mitchill declared that "a whale is no more a fish than a man."

It's not that most people who knew anything about whales were ignorant of the features that Mitchill cited as evidence that whales were mammals, such as being warm-blooded, breathing air, lacking scales and giving birth to live young that were fed with milk. For instance, the whalers called upon to testify on the question knew that. But, those features were simply not salient to how most people classified animal life. After science was defeated on the stand, the defense took another taxonomic tack on the case that made much more sense to the jury. They argued and called merchants to testify that, regardless of whether whales were fish, whale oil and fish oil were entirely different commercial products, with different uses and sold at different prices. A customer who ordered fish oil would not expect to receive whale oil and vice versa.

In the end, though, the plaintiff won his case by appealing to regional prejudices: Many of the witnesses for the defense were "easterners" from Boston and such parts, and a jury of New York Knickerbockers proved loath to kowtow to such foreign ways of thinking and speaking. A whale, the jury foreman announced to the assembled crowd of journalists, gossip mongers and wharf dwellers, was in fact a fish. The press taunted Mitchill for days afterward. "Pray Sir, how goes it with whale oil now?" wrote New York's Evening Post. "Is it oil of fish, or of flesh, or of red herring?"

Ironically, however, the wording of the statute was changed soon after the trial to exclude whale oil from inspection, not because science finally triumphed, but thanks to the influence of whale oil merchants whose profits suffered from paying the inspection fees.

New York City, 1819. City Hall, Broadway.

A Matter of Definitions

By Albert J. Klee, Ph.D.

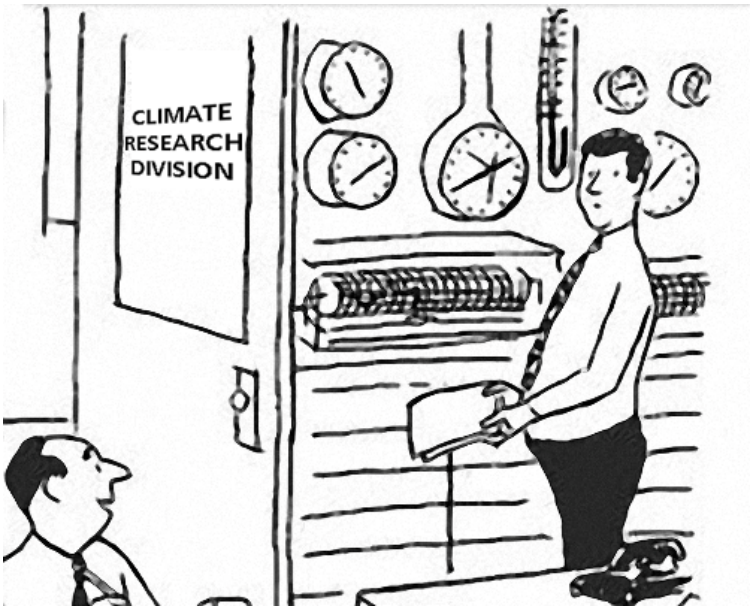
(Aquarium Hobby Historical Society, Yahoo Post 12460, July 15, 2014)

Before I started writing about aquarium history (i.e., "A History of the Aquarium Hobby in America," Aquarium Illustrated, January-February 1964, Vol. 1, No. 1), I wondered at times what was meant by "the aquarium hobby" and what constituted an "aquarist." Pressed for time, I ducked these questions for almost forty years until I started to write "The Toy Fish," published in 2003.

In Chapter 3 I wrote:

"There is also, alas, a problem with precisely what is meant by the word, 'hobby.' Consider the following dictionary definitions: (1) 'A subject or pursuit of absorbing interest, undertaken primarily for pleasure during one's leisure time,' (2) 'An individual pursuit to which a person is unduly devoted,' and (3) 'A favorite occupation or topic, pursued for amusement.' The first two definitions rfequire a stricter criterion, i.e., absorbing interest or undue devotion; the third is much less demanding. None, however, specify the number or kind of tanks a person must maintain before it becomes a hobby, nor is there any standard scale available to us by which we can measure the degree of 'absorbing interest' or 'undue devotion.' Even if such a scale existed, it would be hopeless to attempt to apply it to aquarists who lived a century or two ago. We may ask ourselves whether Anna Thynne was a hobbyist, or A.A. Maconochie, or some unknown American who maintained several jars of native fishes during the Presidency of Andrew Jackson, but the answers are in no way clear.

"It has also been customary to equate the start of the aquarium hobby with the introduction of the so-called principle of the 'balanced aquarium.' As late as 1991, for example, one writer stated: 'Gosse's concept of the balanced aquarium has been crucial in the development of fishkeeping as we presently know it.' However, this principle is neither indispensable nor even of any real importance in keeping aquarium fishes. From ancient times to the present day, thousands upon

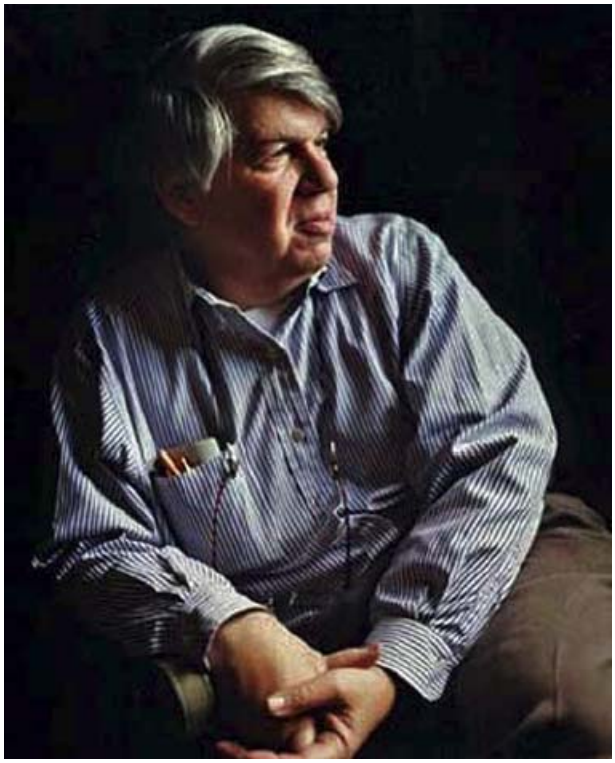


"I figure there's a 40% chance of fog and a 10% chance we know what we are talking about."

thousands of aquarists have kept fish successfully using no plants whatsoever."

At this point I argued (with myself) that since the aquarium hobby was described by my book, it perforce was defined. There the matter sat until 2005 when I re-visited the subject in a monograph I wrote for the AHHS titled "The Four Stages of the Aquarium Hobby." This material was incorporated into the Third Edition of the Toy Fish published in 2009. In Chapter 1 I wrote:

"When did the aquarium hobby start? Who 'invented' the aquarium? What do we mean when we say the 'aquarium hobby' or, for that matter, the 'aquarium'? These questions have presented difficulties for hobby historians precisely because there are no universally agreed-upon definitions. Trying to pin down a concise explanation of the meaning of a word or a term sometimes is - to paraphrase a remark of my grandmother's - akin to attempting to estimate the number of angels that can dance on the head of a pin. Even if we were to agree on these definitions, and bear in mind the line from Lewis Carroll's Through the Looking-Glass and What Alice Found There: 'When I use a word,' Humpty Dumpty said, in rather a scornful tone, 'it means just what I choose it to mean - neither more nor less,' there is no guarantee that this will take us any 'forwarder' on our quest to elucidate the hobby. It also should be recognized that, in defining an object, the definition then limits the object, and this may have unforeseen consequences.



Stephen Jay Gould (1941-2002)

"One way out of this dilemma is to avoid definitions and instead describe the major stages in the development of the aquarium hobby."

Thus, via description rather than definition, I introduced the concept of the Four Stages of the Aquarium Hobby, a construct that has served and still serves its purpose well.

One article I read with great interest while writing the 2003 edition of the Toy Fish was titled "Seeing Eye to Eye, Through a Glass Clearly," which was included in "Leonardo's Mountain of Clams and the Diet of Worms," written by Stephen Jay Gould and published in 1998. Gould (1941- 2002) was an American paleontologist, evolutionary biologist and historian of science. He was also one of the most influential and widely read writers of popular science of his generation.

Here, Gould talks briefly about Roman piscinae:

"I do not, of course, claim that this invention [Gould is talking here about Warington's aquarium] marks the first domestic display of aquatic organisms. The owner of any respectable Roman villa could look down upon the animals in his fishpond. Similarly, the simple bowl had allowed, also since classical times, the contemplation of a fish or two in the more direct, edge-on, eye-to-eye orientation (through glass, or some other transparent medium that did not always come

easily or cheaply before the last few generations)."

Gould, however, dismisses the Roman piscinae as aquariums from the standpoint of lack of stability and an eye-to-eye viewpoint:

"But these precursors are not aquariums in the technical sense, for they lack the defining feature: a stable community of aquatic organisms that can be viewed, not from above through the opacity of flowing waters with surface ripples, but eye-to-eye and from the side through transparent glass and clear water."

Actually, they are aquariums in the technical sense, as I will show later. With regard to stability, Gould contends:

"A fishbowl presents a temporary display, not a stable community. The water quickly goes foul and must be changed frequently (engendering the amusing and frustrating problem, so well-remembered by all childhood goldfish enthusiasts, including yours truly, of netting your quarry for temporary residence in a drinking glass while you change the water in his more capacious bowl - a process that can keep Grumpy the Goldfish going for a while, but surely cannot sustain a complex community of aquatic organisms). The concept of an aquarium, on the other hand, rests upon the principle of sustained balance among chemical and ecological components - with plants supplying oxygen to animals, fish eats the growing plants and snails (or other detritus feeders) scavenging the wastes and gobbling up any algal film that might grow on the glass walls. Western science did not discover the basic chemistry of oxygen, respiration, carbon dioxide and photosynthesis before the late eighteenth century, so the defining concepts scarcely existed in a usable way before then. The aquarium represents but one of many practical results for this great advance in human knowledge."

The problem here is that Gould is describing the situation in England in the 1850's. Since that time, Western science has discovered, invented or adapted aeration, filters, plastic plants, artificial lighting and silicone, to name but a few that influence what we call an aquarium. Gould, therefore, is not defining the aquarium but merely one kind of aquarium.

With regard to the eye-to-eye and from the side through transparent glass and clear water requirement, Gould writes:

"Little examples of big principles strike me as most intriguing of all - for I declare my allegiance with several common mottoes proclaiming that God, the devil, or any matter of great pith and moment, lies in the details. I believe that we can identify one of these admittedly small but 'obviously' permanent and universal modes of seeing as, instead, a direct legacy of the mid-nineteenth-century aquarium craze, and therefore not much more than one hundred years old as a Western way of knowing.

"How shall we draw marine organisms and more-general scenes of underwater communities? The answer to such an inquiry seems so evident that we may wonder why anyone would bother to pose the question at all. We always draw such scenes in their 'natural' orientation today: in the 'eye-to-eye' or edge-on view, where a human observer sees marine life from within - that is, as if he were underwater with the creatures depicted, and therefore watching them at their own level. Isn't this orientation obviously best? After all, we wish to show these creatures as they live, pursuing their ordinary behaviors and interactions. How else could we possibly draw them except from within their own marine environment?

"I can only imagine one reason for a strong convention of such strikingly suboptimal illustration. Artists must then have avoided—or not even been able to conceptualize - the eye-to-eye, within-

their-own-environment viewpoint so ‘naturally’ favored today. Illustrators must have eschewed this edge-on orientation because most people had never seen marine organisms in such a perspective before the invention of the aquarium, and the craze for maintaining such a display as a rustic adornment in the home converted the formerly inconceivable (because unseen) into a commonplace. Water is usually muddy and largely opaque when in motion. No technology of face masks, diving bells, snorkels or oxygen tanks existed - and humans do have to come up for air after very short periods of potential observation. The vast majority of Western people (including most professional sailors) couldn’t swim, and wouldn’t think of immersing themselves voluntarily in marine waters. So where, before the invention of aquariums, would most people ever have seen (or even been inclined to imagine) marine organisms in their own environments? The conventional, if uninformative, view from the shore (and down upon the waters) surely represented the ‘natural’ way of human knowing before aquariums opened a new perspective.”

This paragraph sets the theme for his “Seeing Eye to Eye, Through a Glass Clearly.” Once again, however, Gould is describing the situation in England in the 1850’s where Western science had advanced so that now the contents of an aquarium could be seen edge-on, eye-to-eye. What Gould is overlooking is that the word “aquarium” is a Latin term that simply means any container of water. In our hobby it is implied that it contains aquatic organisms, fish in particular. In fact there is a precedent for using the word aquarium in this way that dates back to 1742 when Linnaeus used it for aquatic plants. Plants were implied when gardeners used the word aquarium, analogous to fish being implied when fish keepers used the word aquarium. As the Romans might have said, “Si fractum non sit, noli id reficere” (If it ain’t broke, don’t fix it”). “Aquarium” was never broken, so there was never any need to waste time re-defining it.

There is one instance in the aquarium hobby, however, when definitions must be present and they also must be precise and that is when the question of priority arises, such as who or what was “first.” I’ll discuss two examples, starting with “Who Invented the Aquarium?” Note however, that pinning down “firsts” is a perilous endeavor. One may assert that so-and-so was the first on record for doing something, only to have another researcher later uncover an earlier reference that shows someone else has precedence.

In my monograph on this subject published here in the Files section in 2012, I pointed out that before one attempts to pin down a “first,” one must devise a set of criteria and I selected three.

The first criterion was that the water in the aquarium was neither aerated artificially nor changed. Implicit was that the basis for the aquarium was the relationship between plants and the animals, i.e., that plants absorbed the carbon dioxide that the aquatic animals generated whilst the animals absorbed the oxygen that the plants generated. Thus, like Gould, I was describing a particular kind of aquarium.

The second criterion was that the claim was published and had priority of publication, and the third was an assessment of its impact on the aquarium hobby in the Nineteenth Century. This last criterion, however, was optional and my findings were summarized both with and without it.

As a matter of simplification and in order to provide multiple credits, I considered four categories for “firsts” in the monograph: the freshwater aquarium sans fishes, the freshwater aquarium with fishes, the marine aquarium without fishes and the marine aquarium with fishes.

These criteria clearly set specific limits to the general question, ‘Who Invented the Aquarium.” However, it is highly likely that they reflected what was really meant by this otherwise meaningless query. No one would seriously consider looking for the answer to this question in the Twentieth Century or later.

My second example addresses the question, ‘Who were the first aquarium hobbyists?” Historically the contenders have included the Sumerians, Assyrians, Greeks, Egyptians, Romans and Chinese. However, even if their fishponds were used for religious, ornamental, agricultural or scientific purposes, this does not mean that these cultures had an aquarium hobby. Before one can attempt to answer this question, therefore, one must define what we mean by that term. After sidestepping this chore for decades, I was finally forced to confront the issue.

My definition is based upon Occam's razor, a principle of parsimony, economy or succinctness used in problem-solving devised by William of Ockham. I used a version here that states that among competing definitions, the one with the fewest elements should be selected. Other, more complicated definitions may ultimately prove better, but - in the absence of any certainty that they are absolutely required - the fewer elements that are included, the better. Thus the definition of the aquarium hobby I used was: “A subject or pursuit involving fishes, undertaken primarily for pleasure during one’s leisure time and to which a person is notably devoted.” Using this definition and based upon the available historical information, my answer to “Who were the first aquarium hobbyists?” was clearly the Romans. "Piscina" was merely one particular kind of aquarium, and this was their name for it.

Ockham chooses a razor

MY AQUARIUM OF BLACK BASS, ETC.

by GEORGE KAMPER

(Aquarium Hobby Historical Society, Yahoo Files, August 1, 2014

The following is an article that appeared in *Nature's Realm*, Vol. II, No. 5, May 1891, written by George Kamper. Kamper was born in Germany in 1854 and immigrated to the United States where he became a citizen in 1877. He settled in Danville, Illinois, his occupation noted in the US 1880 census as a "news dealer." He was, however, an avid angler and constructed an unusual aquarium as an attraction for his store. In addition to providing three fish illustrations, I have modified the legends in Kamper's diagram, making them larger and bolder in order to make his description easier to follow. AJK

Four years ago I built for one of the show windows of my store an aquarium for keeping specimens of the various kinds of fish caught in the waters of our county. It is built to fit the irregular angles of the window, about as follows:

Front sides, **AB** and **BC**, are plate glass; back sides, **CD, DE** and **EA**, and the bottom, are wood, lined with sheet lead. The sides are ten inches high inside and the bottom contains about eleven square feet surface. At **E** the water pipe **M** comes over the top, and under pressure from our city water-works a steady jet of water is thrown through a very small nozzle down into the tank. The water stands twelve inches deep, making a total of about eighty gallons, and overflows at **F**, four inches below the top of the tank, into the back tank, **GHI**. This back tank fills to a seven-inch depth and then the water passes from the overflow, **K**, down through the cellar into the sewer.

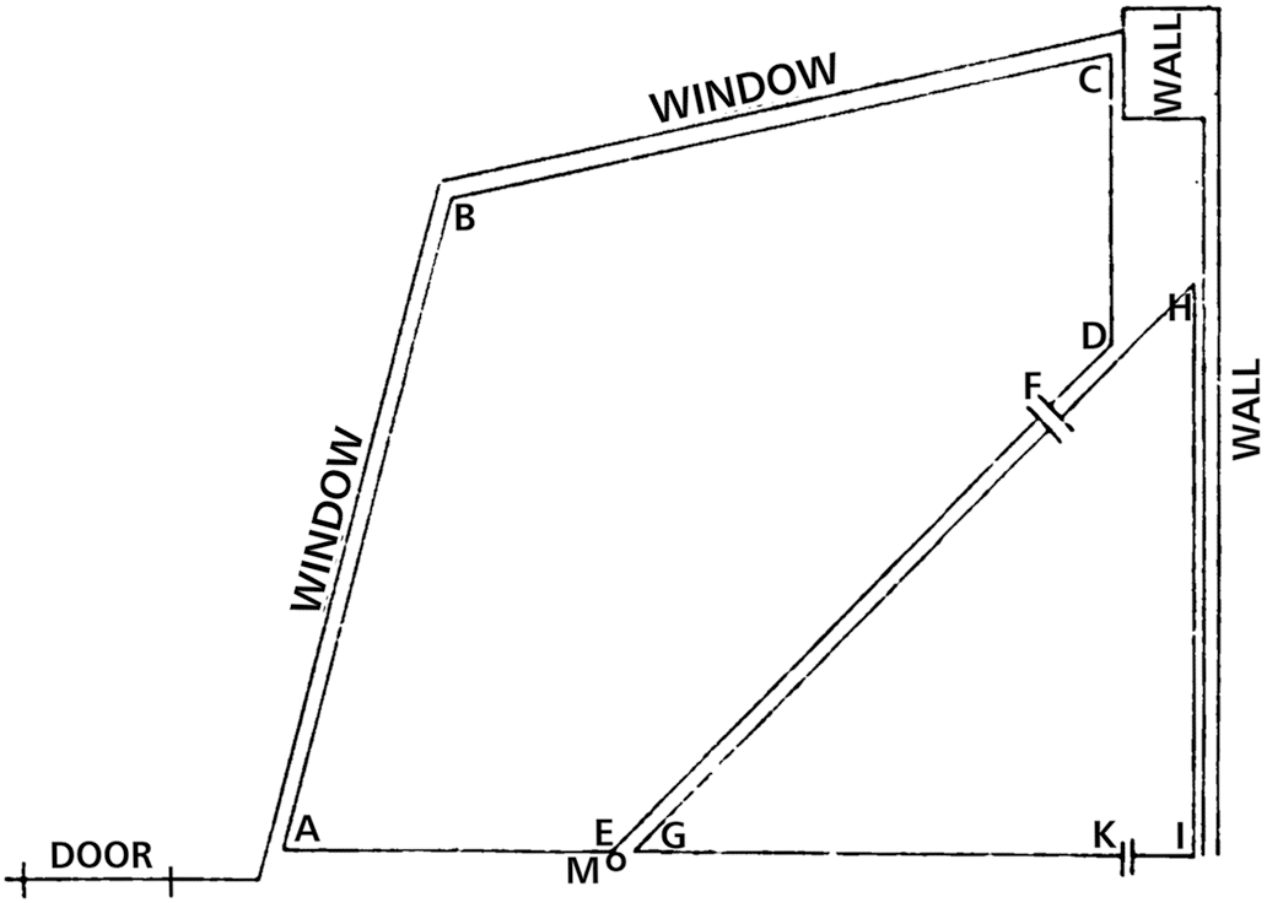
When the fish eat there is necessarily some excrement and undigested particles of food, such as minnow bones, claws of crawfish, etc. This offal tends to befoul the water, and if not removed will produce the so-called "aquarium disease." To avoid this filth disease I have covered the bottom of the tank with small rocks and pebbles, between which the sediment gathers and remains until I clean it out. I clean the tank about once a month during the summer season in the following manner: I turn the water pipe **M** to throw the water into the back tank at **G**; catch the fish with a landing net and put them in there also. Then with twelve feet of one-inch rubber hose I siphon the accumulated filth out of the main tank and wash it clean of green slime, etc. Before putting the fish back I clean them also by holding them under the strong jet of inflowing water, which cuts the slime from their bodies and makes the back tank look like a tub full of soapsuds. This cleaning must be done when the fish have empty stomachs, otherwise it will make them vomit. By these means I have succeeded in avoiding the aquarium disease among my fish, and they are in a healthy condition.

The sketch gives you a fair idea of the size and general arrangement of my aquarium, and I will now tell you something about its inhabitants, and a few incidental observations. I will begin with the statement that, excepting one large carp, which remained only forty-eight hours, no fish have ever been in my aquarium that were not caught legitimately with hook and line in public water adjacent to Danville. The first were put there in March, 1887, and the suckers were put there simply to fill up until the bass began to bite. About April 25 of the same year I had replaced the suckers with twelve small-mouthed black bass, weighing from one to three and a half pounds each ; three rock bass or goggle-eyes, two bullheads, one small channel catfish and one eel. The two largest bass were a female very heavy with eggs, weighing three and a half pounds, and a male fish a trifle longer but more slender, weighing three and a quarter pounds. The female had been caught in the Vermilion River under the Wabash Railroad bridge, and the male in the North Fork, above the dam. Near the middle of May I noticed that on warm days the male fish would take possession of the center of the tank and compel all the other fish, except the large female, to huddle in the corners. The large female

appeared to be at liberty to do as she pleased; the two had evidently decided to mate and nest, and the male seemed to do the fighting for both of them. They were a handsome couple, and naturally I was much interested in the probable outcome of their courtship.

On May 20 I was out of the city, remaining away overnight, and returned the next morning. As I stepped from the train on to the depot platform the first man I met accosted me with. “George, your fish are all dead,” and I heard the same unwelcome news several times before I reached my store, where I found the case as bad as represented. All the bass, the goggle-eyes and the channel catfish, were laid out in a row; every vestige of the color of life had left them; they were pale as ghosts - dead. Standing near them, viewing them with a sad face (he also had learned to love them), and somewhat in fear of my wrath, was my clerk, Willie. To my question, “Willie, how did it happen?” he answered: “Mr. Kamper, I hardly know. When I opened the store this morning the water was only dripping a little and the fish were dead.” Further questioning brought the information that, before closing the store the preceding night, Willie had turned down the strong pressure to enable him to draw a cup of water to drink, and he had forgotten to turn it on again. The absence of pressure had permitted a speck of dirt to lodge in the nozzle, and the flow of water stopped entirely. Soon after daybreak the policeman on this beat noticed my fish showing signs of distress, gasping for breath and rolling and tumbling as if in delirium, and also that the water had stopped. He hunted for me at my rooms and at the hotel, but I was not in the city. When Willie came at 7 o’clock life had left all of the fish except the eel and the two bullheads. These, I was told, kept their mouths near the surface, and they survived.

About the middle of May the bass in our rivers begin to nest, and as for that reason I could not immediately stock my aquarium with bass, I filled it temporari-



ly with channel catfish. The catfish were rather unsatisfactory, on account of their habit of huddling together in the darkest corner during the day, feeding only at night after all the lights were turned out and everything was dark and quiet. When bass fishing again began in August, I soon replaced the catfish with a fresh lot of bass, but none were as interesting as the large pair that was killed in the disaster of May 20.

With the approach of winter I decided that the water would be undesirable in my window during the cold weather, and I also needed the show window for holiday goods, etc., therefore about the middle of November I killed the fish, shut off the water and removed the tank. This ended the first year. In March, 1888, I again put my aquarium in the window, turned on the water and filled up with suckers and bullheads until the bass commenced to bite.

By the latter part of April I again had a lot of bass ranging in weight from one and a half to two and a half pounds each, but although some of these were heavy with eggs, I saw no signs of mating or attempting to nest, and in July the fish dropped their spawn, which went to waste.

I feed my fish principally with minnows, of which I bring two or three bucketful's at a time from the river. At the store I assort them, throwing the largest and choicest into the back tank for future use as bait, and throwing the balance to my fish for feed. After a few months of this practice I noticed that the bass appeared to understand the meaning of the rattling of the minnow buckets, and this set me to experimenting. Though they were at first somewhat timid, the bass soon ceased to fear my hand in the water near them, and before long they boldly took hold of minnows held by me, and forcibly pulled them out of my hand. When they are not hungry, they are of course beyond my control, but if they want something to eat it is different. They will then come to- my hand, permit me to chuck them under the chin, and appear to say by looks almost as eloquent as words, "Give me something to eat," and I seldom let them beg in vain.

Of course I felt proud of them, and became so attached to them that I dreaded the approach of winter, for I did not want to kill them, and could not keep them in my window during the winter months. I had plenty of room in my cellar, but how about the food supply? Could I winter my pets? Still undecided what to do, 1 noticed that as the water became colder the appetite of my fish diminished, and then it dawned on me that they might live through the winter without food.

On the day before Thanksgiving I moved my aquarium into the cellar, changed the water pipe to supply the same kind of a stream down there, and put the fish into winter quarters. On January I, 1889, during a period of mild weather, I induced some boys to go to a sheltered bluff facing south and dig some worms. They brought me a can full of choice earthworms, and I went down with them to inter-view my pets. The fish seemed to be comfortable in the cellar twilight; the slow, regular motions of their fins necessary to maintain their position, and the slight and almost imperceptible movements of their jaws and gill covers in the act of breathing, were the only signs of life about them. I held in front of them some of those long, fat earthworms, curling and twisting, but they would not touch them, though they had the previous summer taken many such out of my hand with evident relish as a change of diet. I even hung a large worm over the snout of one of the fish, but he leisurely shook it off and permitted it to fall to the bottom. Being convinced that the fish would not eat, I ceased to worry about their winter food supply, emptied the worms into the water and left them.

The following March I moved the fish upstairs again, finding them all plump and healthy, and the worms still crawling about in the bottom of the tank. As the water became warmer the fish regained their appetite and began to feed, rather slowly at first, but with increasing vigor as spring ripened into summer. The summer of 1889 was a repetition of the preceding one, in so far that the bass had lost their fear of the hand of man, and remained tame and healthy. During that summer I put in with them for a few weeks a channel catfish weighing five pounds. He was a handsome fish, with a small head, and slender,

graceful body, beautifully marked with black dots on the pale blue skin, and made a grand fight when I captured him, but the brute had no sense whatever. Any motion throwing a shadow over the water frightened him, and I found that in his fright, rushing about with horns sticking out stiff, he had injured some of my bass. 1 was compelled to take him out and kill him.

During the winter of 1889 to 1890, I kept twenty bass in the cellar, putting them down earlier than the preceding fall, and before they had entirely stopped feeding; I put with them a batch of minnows, which they ate in the cellar. When 1 again moved them upstairs in March I found that my tank was very foul, the fish were very slimy, and those that had been horned the preceding summer by the large catfish were very sore in the injured spots. I took the injured ones (four in number) back to the river, where I hope they have found a doctor to heal their wounds. The uninjured ones 1 washed carefully; with the warm weather they regained their full appetite, and the six largest are in my tank to-day. Last fall I waited until the fish had quit feeding before I put them into the cellar again, and did not attempt to winter so many, and the result is that there is not a mar or blemish on one of them. They are upstairs in my window again, and enumerate as follows:

Three rock bass or goggle-eyes, weighing between, four and six ounces each, which I have had about two years. One channel catfish, which I caught in June, 1889, when he weighed one and three-fourths pounds; he now weighs over three pounds, and has lost much of his unreasoning natural fear. Two scale carp, one weighing three-quarters of a pound, which I caught last August, and the other one caught in April, 1889, when it weighed one and a half pounds, but which now weighs three pounds.

CHANNEL CATFISH, *Ictalurus punctatus.*

Last, but not least, ten small-mouthed black bass, six of which are of the lot caught in April, 1888; one has been in my possession since September, 1889, and the other three since October, 1890. The largest one is the two and a half pound fish of the spring of 1888; he has grown very little in length, but considerable in thickness and depth, and now weighs three and a half pounds. The other nine bass weigh from three pounds six ounces down to two and a half pounds, and the aggregate weight of the ten is thirty-one pounds.

You see by above enumeration that I have not confined my attention strictly to bass, and you can readily understand that under the circumstances a thorough “fish crank” can pick up many odd bits of information on the subject of his hobby.

As my back tank is a very convenient place for fresh-caught fish until I am ready to use them, I always endeavor, when fishing, to keep my catch alive. After landing a fish I string him by carefully putting a string through be-tween the gills and the outer gill cover (never between two red gills), and then out at the mouth, drawing it through slowly, so as not to draw blood from the gills. I tie a separate loop for each fish, so they do not strain each other’s gills, and tie them in the water until I am ready to go home. If I am on foot I carry the fish home by the strings, and, if in a conveyance, they are laid down in the bottom of the wagon. When the weather is cool fish may be kept out of water an hour or even longer, and regain their health, but a carry of only fifteen or twenty minutes through a hot summer sun often kills them. Bass are more hardy and able to bear more exposure than the channel catfish. The small wound made by the hook in the hard jaws of a bass scarcely shows the next day, but in the jaws of a channel catfish the hook wound often festers and remains sore for several weeks.

Small-mouthed bass have always been quick to grow accustomed to their changed surroundings; they soon begin to feed, and soon cease to become frightened at unusual motions or shadows, but have always strenuously objected to having a landing net put un-

der them. They permit me, and apparently enjoy to have me rub their backs and sides with a stick, somewhat similar to dogs who like to have their heads scratched.

With large-mouthed bass my experience has been quite different. I have often tried to make one of them a permanent resident in my aquarium, but have not succeeded. They remain wild, refuse to eat, and finally sicken and die.

I made my last attempt with a three-pounder last summer. He had not been injured in the catching, had to bear only ten minutes of carrying on a moderately cool day, and arrived at my aquarium without showing any sign of weakness, swimming off as soon as put in the water. I never saw him feed, and at the end of three months he looked so shrunken and miserable that I took him back to the river in disgust, determined not to try any more experiments with large-mouthed bass. Catfish also have been unsatisfactory tenants in my aquarium. The bullheads and the flat-headed marbled catfish have become diseased after six months or a year, probably because they persisted in lying so close to the filth which gathers between the rocks in the bottom, and they had no mud to crawl through to clean themselves. Probably, also, I did not take as much pains to wash and clean them as I did my other fish.

Channel catfish have shown no tendency to become diseased (they are not mud rooters), but their wild and unreasoning fear, which causes them on the slightest provocation to rush about with stiff horns, added to their strength and agility, makes them rather dangerous for their neighbors. The one now in my tank was wild all of the first year, but he was not large enough to do any damage. Of pike we have only a few small ones in our river, still I have several times put a pike fifteen inches long into my aquarium. Suckers we have plenty, and I have tried them of all sizes, large and small, but the small-mouthed black bass seem to possess an inveterate hatred against pike and suckers. They swallow either if less than seven inches long, and viciously attack the larger ones, biting them till they die.

Rock bass or goggle-eyes, even if only three inches long, are permitted by their lordly and somewhat vicious neighbors to live in peace. They soon become reconciled to their new quarters, soon begin to feed, and thrive about as well as their messmates, the small-mouthed black bass. Carp are also permitted by the other fish to live undisturbed. Sunfish live all right, but unless they are more than three inches in diameter, their career ends inside of the bass. Eels live in peace and health with their neighbors (I have found the tendency to become diseased only in the bullheads and mud catfish), but they have too much curiosity, and are forever climbing out of the aquarium. Many times have I found them on the floor and put them back into the water, but invariably their final end has been to climb out at night and die before I found them the next morning. The last eel I had (thirty inches long and two and a half pounds in weight), was probably cured of his roving propensities by being very near the point of death several times before he was found and restored to the water, for he remained in the tank an entire year without climbing out.

One Sunday evening last August I happened to come to the store, and I found quite a crowd collected in front. One of my old pet bass had jumped out and died, lying between the tank and the window. I could not understand it - the bass ought to have known better. The next morning my eel was on the floor, dead.

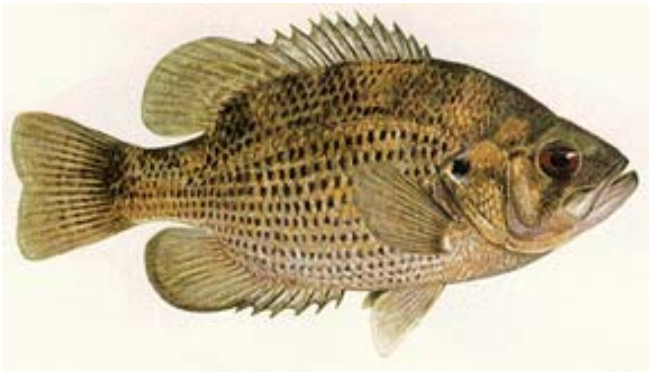
Something was surely wrong, and on investigation I found that a large snapping turtle, which I had temporarily put into the back tank until I was ready to eat him, had managed to climb over into the main tank. How he succeeded I can’t imagine, but I could hardly blame the bass and the eel for wanting to avoid the company of the ugly intruder. You may rest assured that I promptly put the big snapper into an iron cage until I was ready to kill him. This summer I intend to make one more attempt to keep an eel.

Last September the owner of a private pond presented me with a carp weighing seven pounds. I put it into the tank, but the brute was sighing for its native mud and would not be contented. It was too clumsy

to climb out, but managed to throw water ten feet high, and in less than forty-eight hours it had pounded its tail fin into shreds, knocked most of the skin from the top of its head, and had the general appearance of having been run through a threshing machine. It went from the tank into the bake oven.

During these four years of feeding my fish, I have of course paid some attention to their preferences in food, and their manner of taking it.

For bass, minnows are undoubtedly the great staple food, and of these the larger are preferred to the smaller. Whenever I give them a lot of minnows of various sizes, from two to five inches long, they always pick out the largest ones first, and take the smaller ones only after no larger ones are left. Black bass, rock bass and channel catfish will eat crawfish, but they prefer minnows. I have often found my fish eager after minnows when they ignored crawfish. One day last summer, when my fish had been without food for several days, I brought from the river a six-quart minnow bucket filled solid (without water) with crawfish, and another bucket filled with minnows. I set the bucket with the minnows into the back tank, and dumped the crawfish into the main tank. The bass immediately commenced to feed, but after twenty minutes they had quit entirely, and the bottom of the tank was still swarming with crawfish. I then emptied in the bucketful of minnows (more than a hundred shiners, two or three inches long), and the fish immediately commenced to feed again, making the water fairly boil. Five minutes afterward they had taken all of the minnows, and their bellies were a sight; bass, goggle-eyes and channel catfish, all were stuffed till it seemed their skins would burst.



ROCK BASS, *Ambloplites rupestris.*

All of my fish enjoy a few worms occasionally, and during the summer I sometimes catch a lot of grasshoppers, which are always taken quickly by the bass and goggle-eyes.

Last summer some workmen, digging under a coal house in the rear of my store, caught some mice, which I induced them to bring in and throw to my fish. Five of the mice were alive and kicking, and, as soon as they struck the water, each were promptly caught by a bass and swallowed. The sixth mouse had been killed in the catching, but before it had stopped the motion caused from throwing it, a bass had it. The fish held the dead mouse only a second or two, when he spit.it out, and it floated lifeless on the surface; none of the fish would or did eat it. A boy once brought me a live sparrow, full-feathered and nearly full-grown, which I threw into the tank. The bird was struggling in the water, and within five seconds from the time it was thrown in, one of the large bass caught it - and he swallowed it, too. The sparrow was a big mouthful for the bass, but slowly and gradually I saw the tail feathers disappear, and finally I could see a large lump in the body of the fish.

The capacity of the stomach of a fish is wonderful. My oldest bass one day came to my hand seventeen consecutive times, taking and swallowing a three-inch shiner each time, before he was willing to stay back and give the other fish a chance. Sometimes, when their stomachs are filled so they can hold no more, the bass continue to catch minnows, squeeze and kill them, and spit them out. What fisherman of any considerable experience in fishing with bait for small-mouthed black bass, has not been tantalized by having run after run, when the bass simply squeezed and killed his minnows and then dropped them? And when this tiger spirit possesses the fish, what can equal the satisfaction that the fisherman feels when he beats the bass at his own game, and captures him by spinning a dead minnow? Spinning, not with a gang of a thousand hooks, or six hooks, or three hooks, but with a plain, single Sproat hook [i.e., a fishhook having a circular bend, named after W. H. Sproat, a 19th century angler who invented it circa 1865-1870] on a single gut leader. But I am digressing from the subject of “My Aquarium.”

In August, 1889, I was attacked with sickness, and for four weeks I was unable to go after feed for my pets. Some of my friends went several times, but there were ten days when my fish had received nothing to eat, and they were ravenous. They certainly were hungry enough to eat fresh meat if they could be made to eat it at any time, so I tried them, and threw in some pieces of fresh beef. As fast as the pieces of beef struck the water they grabbed for it like a pack of hungry wolves. Every bass in the tank snatched a piece of beef, and every one of them spit it out again. The bass, when hungry, appear to be willing to swallow anything that wriggles, but they certainly refuse to swallow anything that does not show some signs of life.

My carp was neglected during the summer of 1889, and as he had to sustain life as best he could, he has learned to eat minnows. He readily takes small minnows, if killed or crippled so he can catch them. He increased very little in size during 1889, but last summer I fed him bread, and then I noticed a steady growth. The carp is a great forager, always on the move, picking up bits of food, but he does not Stuff himself as full as (he others do. The channel catfish also likes bread, and while feeding the catfish and carp last summer, I found that they can smell the bread. After first noticing this, I experimented a great many times by quietly dropping bread, kneaded into balls to make it sink, into one corner, when both fish were four or five feet away, with heads turned in the opposite direction. After the bread had been on the bottom a few seconds, the catfish and carp would suddenly turn, swim directly to the bread, and begin to feed on it. They could not have seen me drop the bread and must be able to smell it.

While the channel catfish are fond of and are expert in catching live minnows and crawfish, they are almost omnivorous, and will also eat beef, liver, bread, corn, mussels or fresh water clams, worms, and in fact anything that has not become stale and putrid.

According to my experience the bass, channel catfish and carp eat practically nothing when the temperature of the water is near the freezing point; their appetite increases or diminishes as the water becomes warmer or colder, and during the heat of summer they consume enormous quantities of food. A bass fresh from the river in the spring tastes quite different from one equally fresh from the river in the fall, and I have noticed in cleaning fish, that in April, when the scales are scraped from a bass the fish is clean, but in early November, when the water is fully as cold as it was in April, slime continues to ooze out of the fish after the scales are scraped off, and after repeated scrapings this slime still comes. I have often thought that possibly this slime or oil, which permeates the entire body of the bass after the summer period of strong feeding, but is absent after the winter's period of fasting, is the surplus vital power stored up during the feeding time, which sustains the fish during their periods of fasting.

My aquarium has been for myself and friends a source of much interest and pleasure, and if any brother angler wants to try the experiment, I shall be pleased to give him further information about details for building and managing a similar one.

Note: Kemper's report covered a five-year period (1887-1891) and provided a host of information on the maintenance and behavior of a number of species of native fishes that deserves to be recorded for posterity. He also provided information on the materials of construction of his tanks but no details of the frame or what he used to seal the sides and bottom. Unfortunately, *Nature's Realm* ceased publication with this issue so Kemper's offer to provide more detailed information never saw the light of publication.

SMALLMOUTH BASS, *Micropterus_dolomieui.*

MULERTT MISCELLANEA

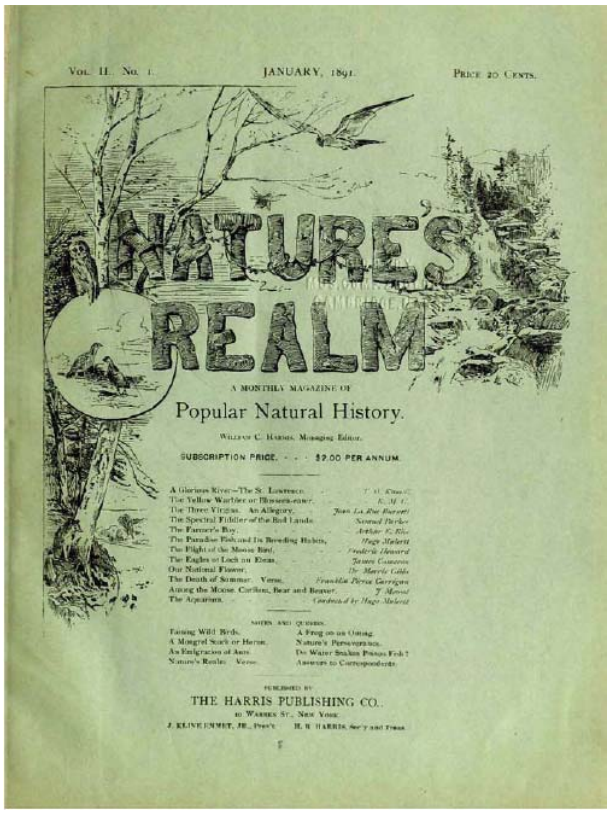
by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Miscellaneous Yahoo Posts, July-August 1, 2014)

In 1890, William Charles Harris (1830-1905) started a magazine called *Nature's Realm*. Harris was a publisher in New York City but was mostly known as a writer on angling, including the books, "The basses, freshwater and marine," "The fishes of North America that are captured on hook and line," "Salmon and Trout" and "The Practical Angler," as well as the magazine, *The American Angler*.

NATURE'S REALM

In volume II, No. 1 of *Nature's Realm*, dated January 1891, Mulertt wrote a feature article titled "The Paradise Fish and its Breeding Habits." In this issue he also started a monthly column that featured an article by him, this one being on goldfish). In subsequent issues Mulertt's article was followed by queries that he answered.



***Nature's Realm*, Volume II, No. 1, January 1891. In this issue Mulertt wrote a feature article on the Paradise Fish and also started a monthly column devoted to aquarium matters.**

Nature's Realm ceased in 1891 after 5 issues and in the following year, Mulertt started re-publishing The Aquarium after a hiatus of 12 or 13 years. It is interesting to speculate whether this would have happened if *Nature's Realm* had not ceased publication.

AN AUTHORITY

It is also interesting to note how highly regarded Mulertt was on fishkeeping in this country. The following is from the *Buffalo Evening News*, Thursday, February 27, 1902:

AN AUTHORITY ON FISH
Editor Evening News:
In "Everybody's Column" on Feb. 22, a correspondent signing 'H. K. D.' asked about trouble with gold fish, which was detailed. The aquarium expert of this country is Hugo Mulertt, 280 Fenimore street, Brooklyn, N. Y. He has published a book on "The Goldfish and its Culture," and issues a publication called "The Aquarium." The U.S. Fish Commission recognizes him as an authority. Undoubtedly he would answer an inquiry, but the possession of his book would enable an amateur aquarium keeper to solve the problem for himself.
STATE FOREST FISH AND GAME COMMISSION, Albany, N.Y., Feb. 14.

FAMILY

In 1870 Mulertt and his wife (Franciska, who also was born in Germany) had a daughter (Anna) in Virginia while he was working at the Bellevue High School. Bellevue High School, a private, classical academy for boys that was primarily attended by the sons of famous men, was established in 1866. Its first session was in 1866 and had seventy boys in attendance. The school drew students from all over the nation, especially the deep south.

It is not known whether Mulertt's wife died or they were divorced but by 1892 he was re-married. In the September-December 1904 issue of the *Oswego Palladium*, it was reported that his wife, Lena,

…has recently written a charming and dainty little book in the German language. It is called 'Der Dackel auf Reisen' ('The Dachshund on his Travels'). Mr. and Mrs. Mulertt made a trip from New York to Wiesbaden, Germany, and took the little dog with them. The dog is supposed to tell in his own words what he saw on his travels. Though we are to considered it to be only dog talk, the story is told in a pure and simple German that is admirable. The little volume is specially adapted to the use of either grown persons or children who are beginning to read German. The proceeds of the sale of 'Der Dackel auf Reisen' go to the maintenance of a home for aged and invalided women teachers.

Hugo Mulertt and his dwarf dachshund.

The full title of this 63-page book was "Der Dackel auf Reisen. Seine Reise-Erlebnisse, von ihm selbst erzählt. Für die Jugend bearbeiten" ("The Dachshund Traveling. His travel experiences as told by himself. Written for young people") and it was published in Wiesbaden by R. Bechtold & Co. in 1904.

Note: Although Dachshund is a well-known German word, in modern German they are more commonly known by the name Dackel or, among hunters, Teckel. There is a discussion of Mulertt's dwarf dachshund – one third the usual size – and a picture of it being held by Mulertt is included here.

WORLD WAR I

In 1912 Hugo Mulertt ended his active participation in the hobby - some forty-three years of service - by retiring to Wiesbaden, Germany. However, World War I began on July 28, 1914. The following is from the Brooklyn Daily Eagle, Sunday, November 15, 1914:

"MADE IN GERMANY" CAUSED WAR, HE SAYS Hugo Mulertt, Former Brooklynite, Declares Jealousy Bred Conflict. "A Fight to the Bitter End." Praises Unanimity of All of Kaiser's Subjects in Striving for Victory over Foes.

George E. Saulnler of 290 Fulton Street has received an interesting letter from Hugo Mulertt, an American citizen and former Brooklynite, who is now living in Wiesbaden, Germany. He gives an interesting picture of war conditions in Germany. The writer says:

"The long-expected has come at last. I have written you a narrative letter of my personal impressions, but none other than mail written in German, and unsealed, were forwarded - Germany swarmed with spies! I could not mail it. I have it still in my possession, and shall forward it to you Hugo Mulertt and his dwarf dachshund. when carriage of mail is safe again. Since yester day we are allowed to mail English letters, but still unsealed.

"You are, no doubt, well supplied with lies and fed on misrepresentations and 'cruelties' concerning the German army, all manufactured by Germany's enemies for a purpose. I imagine that a certain New York paper especially is having 'the feast of its life.'

"But don't be alarmed by these reports. Germany is fighting its battles with a large, thoroughly trained, disciplined and well equipped army and navy, which are directed by able staffs, backed by a filled treasury. Last week the country issued a public loan for 1,500,000,000 marks at 97-1/2 at 6 per cent. Last Saturday at 1 p.m. the subscriptions closed. The result: 4,400,000,000 have been subscribed, and all this by Germany alone. There is not a single man of the enemies on German soil, save as a prisoner. These latter we have by the hundred thousand already and among them the best English battalions, as the Gordon Highlanders, including their famous colonel.

"Yes, the long-expected war is here. However, it was not made in Germany, although 'Made in Germany' made it. Preparations for it began in 1878 when United Germany rose as a new star on the horizon. Jealousy, pure and simple, came to be, The Kaiser tried his best to the last to prevent this war by being prepared to face it. He was courteous and amiable toward all nations, but England, seeing her chances to 'down' Germany vanishing day by day, 'forced the season.' We Americans know England from experience. To me their act seems suicide. As far as I can judge, Germany will come out of this conflict a Greater Germany, and we all shall be obliged to restudy the political geography of the world.

"Business goes on as usual, excepting, of course, the foreign trade, which is entirely at a standstill. (Praises be, I have laid in a goodly supply of teas.) One would not think, by the appearance of the streets, that this country is successfully defending its independence on four different fronts at the same time, not counting in the navy, were it not that the many bandaged soldiers one meets on the promenade and in the parks give proof of the severe fighting that is going on. All engaged in this gigantic struggle, including the enemies, have the conception that it means 'to the finish' this time. The losses are enormous. On about August 10 I was informed by a non-com of the quartermaster's department that they had supplied 9,000,000 men with new boots, two pairs each. This may give you an idea of Germany's forces. To the regular quota there reported 2,500,000 volunteers! We have no more political parties. All are Germans. The Socialists turned out to be just as loyal Germans as any of the rest! At one time we had about 500,000 soldiers, all in new uniforms - gray, similar to those the Johnnies had, the so-called campaign uniform - encamped here. We belong to the radius or rayon of Mayence, a stronghold of the first class.

"Let me know at once when this letter reaches you, that you received it. It goes via Rotterdam; but these boats, although Dutch and neutral, are frequently 'brought up' by English cruisers, are searched and the German mails, including papers, are seized and thrown overboard. The last mail I had from America is dated August 4. I intended to be in Brooklyn in September, but the outbreak of this war changed my programme,"

It should be noted that Mulertt was an American citizen and had fought for the North during the Civil War. (His reference to the gray uniforms "… similar to those the johnnies had…" was to the name given to Confederate soldiers by Northern soldiers during the Civil War.) The "We Americans know England from experience" most certainly referred to the Revolutionary War and the War of 1812.

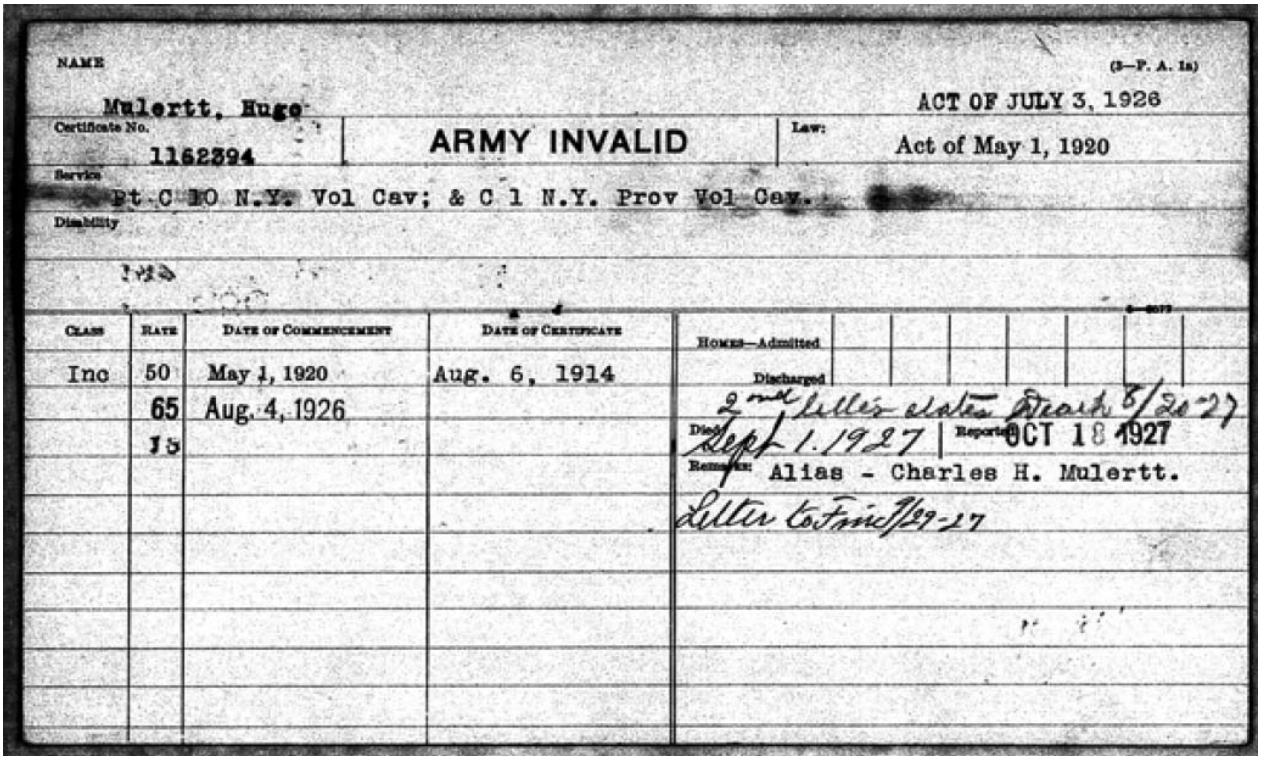
The following is from the "Annual Report of the Adjutant- General, of the State of New York for the year 1895. Registers of the First Dragoons, Oneida Independent Company Cavalry, First, Second, Third and Fourth Provisional Cavalry, in the War of the Rebellion." Under the heading of First Provisional Cavalry is the following entry:

MULERST (sic), CHARLES H. - Age, 19 years. Enlisted, January at Kingston; mustered in as private, Co. C, Tenth Cavalry, January 10,1865, to serve one year; wounded, April 7,1865, at Farmville, Va.; captured, April 9, 1865, at Appomattox C. H., Va., while in the act of capturing a Confederate battle-flag; released from prison at Lynchburg, Va., date not stated; transferred to Co. C, this regiment, June 24, 1865; mustered out with company, July 19, 1865, at Clouds Mills, Va.; true name Hugo Mulertt.

Although the immediate trigger for the war was the June 28, 1914 assassination of Archduke Franz Ferdinand of Austria, heir to the throne of Austria-Hungary, a resurgence of imperialism was the underlining cause. This New Imperialism (the qualifier "new" is to contrast with the earlier wave of European colonization from the 15th to early 19th centuries) was a period of colonial expansion by the European powers, the United States and Japan during the late 19th and early 20th centuries. The period was distinguished by an unprecedented pursuit of overseas territorial acquisitions.

Re Mulertt's reference to "made in Germany," the German Empire came to rival Britain as Europe's primary industrial nation during the latter half of the 19th century until World War I. Since Germany industrialized later, it was able to model its factories after those of Britain, thus making more efficient use of its capital and avoiding legacy methods in its leap to the envelope of technology. Germany invested more heavily than the British in research, especially in chemistry, motors and electricity.

The United States didn't join the war until 1917. In January 1917, Germany resumed unrestricted submarine warfare, realizing it would mean American entry. In the infamous "Zimmerman Telegram," the German Foreign Minister invited Mexico to join the war as Germany's ally against the United States. In return, the Germans would finance Mexico's war and help it recover the territories of Texas, New Mexico and Arizona. The United Kingdom intercepted the message and presented it to the US embassy in the UK. From there it made its way to President Wilson who released the Zimmerman note to the public, and Mulertt's Pension Record



NAME Mulertt, Hugo

(3—F. A. Is)

ACT OF JULY 3, 1926

Certificate No. 1162394 | ARMY INVALID | Law: Act of May 1, 1920

Service Pt C 10 N.Y. Vol Cav; & C 1 N.Y. Prov Vol Cav.

Disability

Class	Rate	Date of Commencement	Date of Certificate
Inc	50	May 1, 1920	Aug. 6, 1914
	65	Aug. 4, 1926	
	75		

Homes—Admitted

Discharged

2nd Letter date March 8/20-27

Died Sept 1. 1927 | Reported OCT 18 1927

Remarks: Alias - Charles H. Mulertt.

Letter to Finch 9/29-27

Mulertt's Pension Record showing Date of Death.

showing Date of Death. Americans saw it as an act or situation provoking or justifying war. After the sinking of seven US merchant ships by submarines and the publication of the Zimmerman telegram, Wilson called for war on Germany, which the US Congress declared on April 6, 1917. Oddly enough, the United States was never formally a member of the Allies but became a self-styled "Associated Power." In any event, Germany had miscalculated, believing it would be many months before American soldiers would arrive and that their arrival could be stopped by U-boats.

It is difficult to imagine Mulertt's feelings when the United States joined the war, three years after this letter was sent, involving the country in which he was born and the country in which he spent most of his life and fought for. One also wonders how Mulertt fared in Germany as an American citizen during these times.

However, Hugo Mulertt started receiving a United States Civil War pension in 1885 and this continued to be paid until his death in Germany in 1927, at which time he was 80 years old. There is no evidence that he returned to the United States for any visits after he retired to Germany in 1912.

A MATTER OF FROGS

In the May 25, 1890 issue of *The Brooklyn Daily Eagle*, an article appeared titled "The Girls Cut Up Frogs." It was a report about the Packer Institute , reputed to have the best equipped and most thorough course in natural history of any academic school in the country. After interviewing Dr. Backus, the principle of the Institute, the reporter interviewed Mulertt, his portion comprising a bit over 70% of the article:

The collection is the work of Hugo Mulertt, a German who is now on his second year of duty at the Institute. Hugo is an enthusiast on these matters. He has been an agent of the United States Fish Commission in the West and came from the employ of Commissioner Baird to the Institute. He is a Fellow of the Imperial Russian Society of Acclimation. Hugo has the unlimited resources of the Fish Commission at his command and has selected through it what he could not obtain himself. He began his exhibition of the collection by leading his visitor up to the windows of a class room where, along the frame, were arranged a row of jars, ten in all. This was his frog factory. Frogs of all sizes and varieties can be had at an instant's notice. The frog is really a wonderful creature. He has ten distinct stages of development from the egg to the finished product. He begins as an exceedingly small wog, becomes a pollywog, acquires legs and loses his tail and finally develops into the real bullfrog of commerce. Each stage of development was shown in Hugo's Jars, so that by simple observation the student could at once comprehend the wonderful process. Many varieties of frog, the cricket frog, a tiny, spunky little thing; the Presberry's tree toad, not much larger; the wood frog, the marsh frog, the green frog and the leopard frog, filled out the jars and boxes on the next window sill. Then there was a skeleton of a frog, neatly mounted, to hand around the class room. When needed, some of these frogs are given over to the physiology class and dissected. Nearby was a big case of cocoons, where the development of the moth was shown from day to day. When the scholars have seen the moths come out of the cocoons Mulertt mounts them and puts them in a frame.

Some near relatives of the frog were discovered sporting in an aquarium on a stairway landing. These were salamanders: first the common spotted newt, erroneously called water lizard in this vicinity; then a Mexican salamander, larva and adult; a water dog or dog headed salamander from Ohio, and the German salamander, a rare specimen from the Hartz Mountains. He is an orange and black little beast, of whom preposterous stories are told of his ability to put out fires. He ate an American worm that Hugo gave him with a relish for alien food that was remarkable. He is quite intelligent and comes around to the side of the jar to watch the scholars at recess. The last of the frog's relatives was found up in the natural history room. He bore the euphonious name of hell bender and he will be sacrificed

under the dissecting knife in a few days by a member of the advanced class of comparative anatomy. It may be stated that the aquariums of the institute contain specimens of all the varieties of fresh water plants from Florida to Maine and California. A marine aquarium in the same room nourishes star fish, sea anemones, of which seventeen have been dissected this term, crabs, corals, sponges and other marine life. A lonesome crayfish or fresh water lobster, occupies a jar all by himself. A dragon fly hatchery stands in the window. The flies hatch under water, come up and dry and spread their wings under a wire netting. Pond waters from Tennessee, Virginia, Florida, Ohio, Pennsylvania and many other States make up a collection for microscope work. There is also a collection of growing plants for the botany class, which were raised from the seed by the young botanists themselves.

Most interesting among the fresh water plants is a fish eating plant, which grasps the little fishes just out of the egg and destroys them. The properties of this plant were discovered five years ago by Hugo and some follow workers. The Fish Commissioner, Eugene Blackford, now denies this attribute of the plant and Hugo has got plants and fish in preparation to demonstrate the truth of his asseveration to the great fisherman. The ascertaining of this fact is of great commercial importance in the propagation of fish. Where this plant is, there is no use of placing fish spawn. The most elaborate single exhibit of Hugo's collection is his salmon hatching trough, where in a great basin of running water the pupils may watch from day to day the origin of salmon. Hugo has this year hatched the ordinary salmon, the landlocked salmon, salmon trout and California salmon.

Besides the living, Hugo has collections of specimens preserved in alcohol, large cases of stuffed birds, beasts and reptiles, and the like. When the teachers desire any particular animal or plant, or part of either, for demonstration in class work they call upon Hugo, who goes forthwith and gets it. He showed two requisitions, as they are called in the class room, for ox eyes, to be used in the study of the eye in the physiology classes of next week. He goes to the butcher's and gets the eyes. In the same manner he has provided rabbits, cats, pigeons, snakes, codfishes and turtles, all of which have been dissected by the students this term. A dozen or more pigeons were thus sacrificed to a better knowledge of anatomy last week. Often a chicken or a partly hatched egg is called for. The Institute has a very complete set of microscopes, both for the use of the biology and botany classes; sets of dissecting tools and section cutters of the latest pattern. Advanced text books are used and the branches of study especially those of biology and comparative anatomy, are carried well along into the work of the best of our colleges.

The last and particular pride of Hugo are his Japanese gold fishes, which have been in the large aquariums in the main hall all Winter, but are now relegated to the fountain basin in the yard. Her he has "comets" and "fantails" imported directly from Japan, the latter being exactly like those pictured on Japanese fans, and "nymphs" of his own raising, but of Japanese extraction, of undoubted parity and aristocratic lineage.

MULERTT VERSUS BLACKFORD

The Eugene Blackford mentioned in this article and also referred to as "the great fisherman" was Eugene G. Blackford (1839-1904), born in Morristown, New Jersey. He was educated in the public schools and when about twenty-five years of age embarked in business as a fish-dealer in Fulton market. Through his efforts the red snapper, whitebait, pompano and other varieties of fish were first introduced into the New York market and, through him, the methods of freezing, shipping and storing fish were improved. His one stand grew to thirteen, elegantly fitted up at a cost of about $22,000, with aquariums built of marble, hard woods and glass, and filled with live fishes. In 1872 Blackford began to give attention to the history and propagation of fishes. He early made the acquaintance of Professor Baird of the Smithsonian Institution, who was then United States

Eugene G. Blackford (1839-1904).

Commissioner of Fish and Fisheries. When the American Fish Culturists' Association was organized he became a prominent member and their treasurer. At their annual dinner in 1876 he procured and prepared for the banquet no less than fifty-eight kinds of fish. He was in charge of the fish exhibit at the Centennial Exhibition in 1876. The year before, he began an annual trout exhibition at his establishment in New York, which attracted admiring crowds from all parts of the country. He collected and shipped 130 tons of exhibits to the International Fishery Exhibition held in Berlin in 1880. In 1878 a species of fish from Florida, which was first described scientifically by Professor Good and Dr. Bears of the Smithsonian Institution, was named *Lutjanus Blackfordii*, in honor of him. Besides being the most extensive fish merchant in New York City at the time and perhaps in the world, he was appointed one of the four commissioners of fish and fisheries of the State of New York in 1879, and was instrumental in establishing a hatching station for sea and fresh-water fish at Cold Spring harbor on the north shore of Long Island. He conducted an investigation into the decrease of oysters in the waters of New York, and published papers in the Reports of American Fish Culturists' Association on whitebait and other fishes, and the question of legislative protection of ocean fisheries. He was most influential in supporting the establishment of the museum of the Brooklyn Institute of Arts and Sciences, and in 1877 he referred to the necessity of an aquarium in New York City and he expressed the hope "… that a public enterprise might be started which would be a free public institution." It is always interesting to note that biographies and obituaries are frequently positively slanted toward their subjects, leaving out material that provides a better understanding of them. With regard to Blackford, I'll discuss four examples.

From The World: New York, Friday, May 24, 1872:

A TURTLE'S TRIALS

Mr. Bergh Prosecutes a Fish Dealer - Cruelty to a Turtle - Interesting Testimony and Fishy Evidence - Why the Fins Should be Tied - The Jury Disagree. In the General Sessions Wednesday one of Mr. Bergh's cases occupied the attention of the court for the greater portion of the day. The charge was one of alleged cruelty to animals, the victim on this occasion being a turtle. The defendants were Eugene O. Blackford, a dealer in fish and turtle, and Lawrence Green, a man employed by him to drive a cart. Assistant District- Attorney Fellows conducted the prosecution and the defendants were represented by John H. Authon and G. W. Blunt. Recorder Hackett presided. The indictment was framed under two or three different sections of the law against cruelly transporting or wickedly and inhumanely torturing any living creatures.

The issue here was tying the turtle's flippers and placing them on their backs during transportation. Bergh testified that the back of the animal in question was broken and very much shattered, that blood was trickling from its belly and from holes in its fins [flippers] that were tied together with cords and therefore arrested both men. Blackford maintained that it was necessary for the good of their health to have this done (and this, in fact, was true). However, he further testified that the turtle was in a sound, Eugene G. Blackford (1839-1904).

healthy condition, with no damage done to its back shell, leaving it up to the jury to decide who was telling the truth.

The jury retired, being unable to agree on a first counting of noses, and after some two hours' absence they returned to court. The foreman said they had not yet agreed, and asked the court for some explanation as to the question of intent. The court said that intent, if any existed, was to be gathered from the evidence. Another brief consultation among the jurors, and still no agreement followed. There being no prospect of their agreeing, as the foreman stated, they were discharged from further consideration of the case. They stood ten for conviction to two for acquittal. Blackford had barely squeaked by.

From: The Yonkers Statesman, Westchester County, December 11, 1885:

OPPOSITION TO EUGENE BLACKFORD
Albany, Dec. 11 – The opposition to the reappointment of Eugene Blackford as Fish Commissioner does not diminish. Charges have been brought against him by the St. Lawrence Anglers' Association, the chief complaint being that Mr. Blackford has looked too much after his own interests.

There had been objections from many to his reappointment and all were dutifully recorded in the newspapers of the day, this one just being a single example. In the following year, the outgoing Governor of New York State did not re-appoint Blackford. Blackford and his supporters argued that his replacement was not legal (a matter of meeting a requirement as to the appointee's official domicile); however, it clearly was in the Governor's powers to not reappoint him.

From: The Press, New York, May 2, 1894:

BLACKFORD SUED FOR LIBEL
Considers the Fisherman's Telegram Defamatory, Senator William H. Reynolds of Brooklyn has instructed his counsel, Mr. Shenstone, to begin a suit for criminal libel against Eugene G. Blackford, formerly State Fish Commissioner. The latter, who is the leader of the movement to secure the abolition of steam railroad traffic on Atlantic Avenue, sent a telegram to the young Senator during the recent session of the Legislature. It had reference to the bill to carry out Mr. Blackford's wishes, and read as follows: "Are you buncoing me on Atlantic Avenue Railroad Bill? There seems to be nothing in the way of passage except want of action on your part. Your district will hold you responsible for its fate. Eugene G. Blackford." Mr. Blackford ignored the Senator's request for a withdrawal of the language used, and the suit will follow. Mr. Reynolds says he fought for the bill against great odds. It is a matter of note that the Long Island Railroad Company, which fought the bill, had an agent in the Senate chamber for two weeks. He went away only when assured that the bill would be strangled.

It is interesting to note that the reporter's last two sentences were a subtle way of suggesting that Reynolds indeed was sabotaging the bill. Blackford's attorney filed a demurrer stating that buncoing was not a defamatory word but it was overruled by a Supreme Court judge who said:

The words used are easily capable of being construed as imputing to the plaintiff as a member of the Legislature that he was not acting in good faith to the defendant and the public, but that he was duping or deceiving them by covertly and actually opposing a bill which had been introduced in the public interest, and which he had promised and was pretending to further. Such conduct on the part of a legislator would be very dishonorable, and, therefore, a writing falsely attributing it to him would be a libel per se. That the defamatory suggestion is conveyed in the form of a question does not save it from being libelous. The question conveys the meaning that the plaintiff was making the defendant and his constituents generally victims of his duplicity, and thus victimizing them, which is a recognized meaning of "to bunco."

However, the fact that Reynolds was a public figure and the libel laws applied differently to him

and the claimed libel was in a private communication - a telegram - the case ultimately was dismissed.

From: *The Rome NY Daily Sentinel* 1885:

FUN IN THE MARKET.

An Eel That Couldn't Be Held Even as Well as an Ordinary Eel "Anyone who lifts that eel out of the tank may have it," said Eugene Blackford yesterday to a crowd of persons who stood in Fulton Market before an open aquarium watching a large eel moving gracefully about in the water. It attracted attention because it was not a common looking eel, such as may be bobbed for any day at low tide in Newtown Creek. A hardy-looking fisherman, who had probably caught many eels in his time, asked Mr. Blackford if he was in earnest, and being assured that the offer was made in good faith he tacked up the sleeves of his pilot - jacket and after briefly explaining to the crowd the precise manner in which an eel should be grasped to prevent it gliding through the fingers he plunged his hands into the water to practically illustrate how the thing was done. He seized the eel very artistically, but, with a sharp explosion of blasphemy, he let it go again before he had brought it to the surface. The eel swam around indifferently. It had evidently grown accustomed to such experience. The fisherman followed it with his eyes. "It stung me bad," was the only explanation he cared to offer to the wondering spectators. Just then a whistling boy came up, and looked at the eel because the others were looking at it.

"I don't see anything uncommon in him," he said, contemptuously. "I've ketched bigger ones than that."

"Say, Bob" said the fisherman, struck with an idea, "pick that eel out of the tank and follow me down to South street with it, and I'll give you a quarter." Without stopping to make any inquiries as to the legitimacy of the offer, the independent lad grasped the eel. He liberated it immediately and uttered a yell that brought in the policeman who twirls his club just outside the fish market to see what the matter was."

Later in the day many persons touched the eel and tested its curious powers. After the contact some shrieked, some laughed and some looked frightened; but none essayed to meddle with it a second time. New comers continued to touch it, until Mr. Blackford, fearful that its vitality might be exhausted, put it into a high closed tank, and pasted this legend upon the glass: "Gymnotus, or Electric eel." The tank contained several "hellbenders," and the eel shocked them very much and caused them to spring around in the liveliest manner. It was given to Fish Commissioner Blackford by Mr. Donald Burns, who received it early yesterday morning from the Amazon River. Captain Bears brought it with him in the steamship Finance. He is rather a handsome creature, and a great point in its favor is that it keeps its mouth always shut, except at meal times, and seems to breathe through two rows of holes on its head and neck. It is about two and one-half feet long, and rather disproportionately thick. It has a heavy fin, like the keel of a boat, running along the belly the entire length of the body. The throat is of orange color, and the head, though short and clumsy, is ornamented with two little flaps that look like ears. It can ad-

An Artists Rendition of "FUN IN THE MARKET."

minister an electric shock as powerful as that of a small battery. A man yesterday touched it with a steel fish-knife and he felt the shock as forcibly as if he had touched it with his bare Hands.

This clearly was outrageous on the part of Blackford, who obviously thought it was a great joke. That he subjected a small boy to the shock of an electric in such a manner would nowadays have placed Blackford beyond bars for a few years and/or a stiff fine.

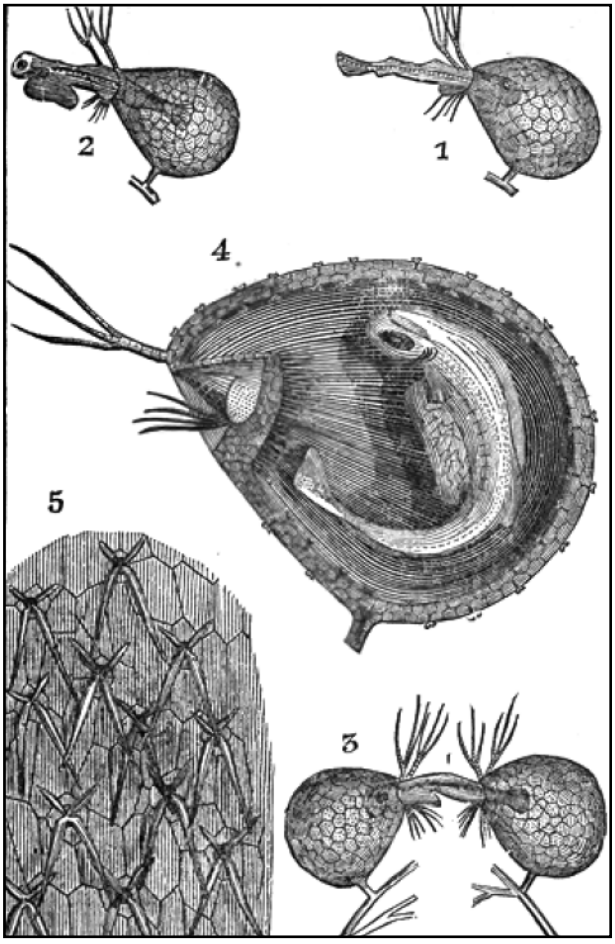
THE ARGUMENT IS WON

Because Blackford was much more known to the public than Mulertt, it might be supposed that the argument was a sort of David and Goliath confrontation and, as results go, so it was.

In "Practical Carp Culture," by L. B. Logan and published in 1888, Logan includes two articles concerning piscivorous plants, the first by E. Halperine that was published in the *Bulletin of the United States Fish Commission*, Vol. V, No. 23, September 15, 1885 and one following by G. E. Simms, Jr. (of Oxford, England), the latter being first published in the *Fishing Gazette* in May 31, 1884 (and also published two months later in the *Bulletin of the United States Fish Commission*, Vol. IV, No. 17, July 30, 1884). On this subject, i.e., the fish-eating habits of the Greater Bladderwort, *Utricularia vulgaris*, Simms has the priority. However, Logan prefaces the Halperine article with the following:

Among the strangest and most interesting enemies of the carp, are a class of carnivorous plants, that until recent years were not known to capture any other animal life than that of Insects and plants captured young fish, was Hugo Mulertt, so often quoted in this work, and it is but justice to call attention to this fact, while we give the description and illustration of another taken from the Bulletin of the United States Fish Commission.

That Mulertt was already recognized as an expert in this area, it also should be noted that in the Eighteenth Report of the Commissioners of Fisheries of the State of New York published in 1890, Bashford Dean says with regard to his information regarding the behavior of the Greater Bladderwort in aquaria, **"I am indebted for much valuable information to the kindness of Mr. Hugo Mulertt."** At the time of the Packer Institute article, Mulertt had known about the Greater Bladderwort for six years, while Blackford apparently was unaware of all the information garnered by Mulertt and others during this time. In scientific circles Blackford is cited as being an "ichthyologist" but he had little impact in this field and I, for one, would not have characterized him as such. He was a fisheries man and, in that field, he did make significant contributions. When came to the aquarium, however, he should have listened to the real expert of the time.



Details of the mode of capture of a fish by *Utricularia vugaris*, from Halperine, Bulletin ofthe United States Fish Commission, Vol. V, No. 23, September 15, 1885.

A Summer Cruise on the Coast of New-England

by Albert J. Klee

(Aquarium Hobby Historical Society, Yahoo Files, September 8, 2014)

PART I: DRAMATIS PERSONAE

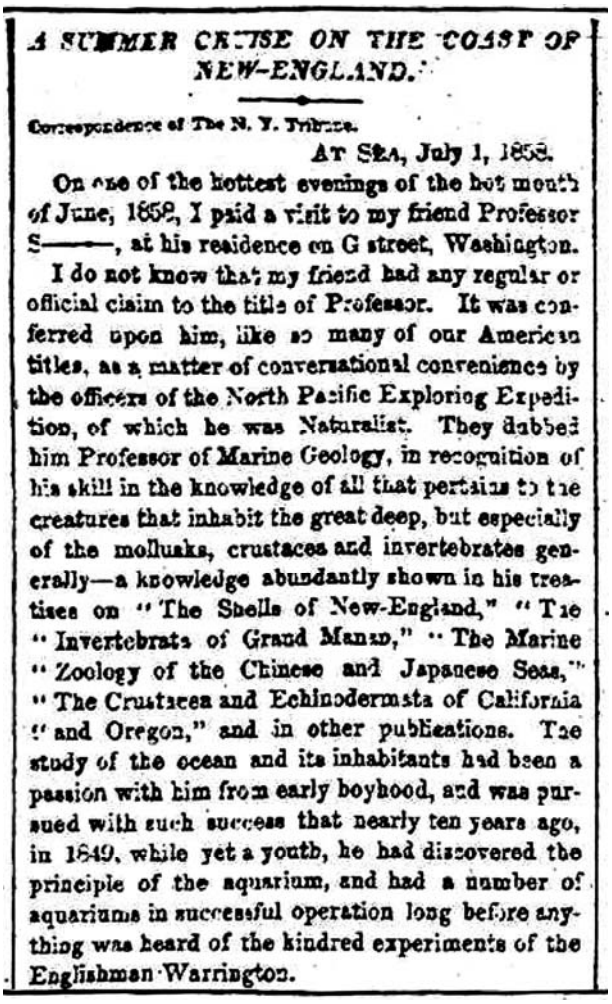
While I was examining past issues of the *New-York Daily Tribune*, I came across a report by one of their correspondents in their July 17, 1858 issue titled "A Summer Cruise on the Coast of New-England." In it the author referred to **"the Professor" who, "...in 1849, while yet a youth, he had discovered the principle of the aquarium, and had a number of aquariums in successful operation long before anything was heard of the kindred experiments of the Englishman Warrington (sic)."** He also wrote, **"I do not know that my friend had any regular or official claim to the title of Professor. It was conferred upon him, like so many of our American titles, as a matter of conversational convenience by the officers of the North Pacific Exploring Expedition, of which he was Naturalist."**

The North Pacific Exploring and Surveying Expedition, also known as the Rodgers-Ringgold Expedition, was a United States scientific and exploring project from 1853 to 1856. It was a naval and commercial survey of those parts of Bering Straits, the North Pacific Ocean and the China Seas frequented by American whaling ships and by trading vessels in their routes between the United States and China. Extensive natural history collections were made on the expedition, mostly by William Stimpson, its Chief Zoologist. Voila! The Professor was uncovered and my interest in this series of reports now knew no bounds.

ROBERT CARTER

The author was Robert Carter (1819-1879). In brief, Carter was a United States editor, historian and author. He was also involved in the formation of the Republican Party and, as I will show later, an avid aquarist.

Carter was born in Albany, New York, and received a common school education and passed one term in the Jesuit college of Chambly, Quebec. At 15, he was appointed at the state library at Albany as assistant to the state librarian, who was also his guardian. In 1841 he went to Boston where he formed a lifelong friendship with James Russell Lowell, and together they began *The Pioneer, a Literary and Critical Magazine*, a monthly magazine which the *Cyclopædia of American Literature* said was "of too fine a cast to be suc-



A SUMMER CRUISE ON THE COAST OF NEW-ENGLAND.

Correspondence of The N. Y. Tribune.

AT SEA, July 1, 1858.

On one of the hottest evenings of the hot month of June, 1858, I paid a visit to my friend Professor S———, at his residence on G street, Washington.

I do not know that my friend had any regular or official claim to the title of Professor. It was conferred upon him, like so many of our American titles, as a matter of conversational convenience by the officers of the North Pacific Exploring Expedition, of which he was Naturalist. They dubbed him Professor of Marine Geology, in recognition of his skill in the knowledge of all that pertains to the creatures that inhabit the great deep, but especially of the molluaks, crustacea and invertebrates generally—a knowledge abundantly shown in his treatises on "The Shells of New-England," "The "Invertebrata of Grand Manan," "The Marine "Zoology of the Chinese and Japanese Seas," "The Crustacea and Echinodermata of California "and Oregon," and in other publications. The study of the ocean and its inhabitants had been a passion with him from early boyhood, and was pursued with such success that nearly ten years ago, in 1849, while yet a youth, he had discovered the principle of the aquarium, and had a number of aquariums in successful operation long before anything was heard of the kindred experiments of the Englishman Warrington.

The first appearance of Robert Carter's "A Summer Cruse on the Coast of New-England, New-York Daily Tribune, July 17, 1858.

cessful." Nevertheless, its want of success was due, not to the editors, but to the publisher who mismanaged it and failed when but three numbers had been issued. Among the contributors were Edgar Allan Poe (Poe's "The Tell-Tale Heart" first appeared here), Nathaniel Hawthorne, John Greenleaf Whittier, John Neal (author and literary critic) and Elizabeth Barrett (later Elizabeth Barrett Browning).

Carter next spent two years in editing statistical and geographical works, and writing for periodicals. His story, "The Great Tower of Tarudant," ran through several numbers of the *Broadway Journal*, then edited by Poe. In 1845 he became a clerk in the post office at Cambridge, and from 1847 to 1848 was private secretary to William H. Prescott, widely recognized by historiographers to have been the first American scientific historian.

Carter joined the Free Soil Party in 1848. The Party was a short-lived entity in the United States, active in the 1848 and 1852 presidential elections, and in some state elections. Founded in Buffalo, New York, it was a third party, single-issue party that largely appealed to and drew its greatest strength from New York State. The party leadership consisted of former anti-slavery members of the Whig and the Democratic Parties. Its main purpose was opposing the expansion of slavery into the western territories, arguing that free men on free soil comprised a morally and economically superior system to slavery. They opposed slavery in the new territories and sometimes worked to remove existing laws that discriminated against freed African Americans in states such as Ohio.

In 1850 Carter wrote a series of articles for the *Boston Atlas* in reply to Francis Bowen's attack on the Hungarian revolutionists. The Hungarian revolution of 1848 started when Hungarian patriots organized mass demonstrations in Pest and Buda (today Budapest) which forced the imperial governor to accept their 12 points of demands. This resulted in von Metternich, the Austrian prince and foreign minister, resigning. In turn, Emperor Ferdinand promised Hungary a constitution, an elected parliament and the end of censorship. The revolution grew into a war for independence from the Austrian Empire and the new government was initially successful against the Habsburg forces but eventually, after one and a half years of fighting, the revolution was crushed when Russian Tsar Nicholas I marched into Hungary with over 300,000 troops. Hungary was thus placed under brutal martial law and the Austrian government restored. Carter's articles were republished in the pamphlet, "The Hungarian Controversy: An Exposure of the Falsifications and perversions of the slanderers of Hungry" (Boston, 1852) and caused the rejection of Bowen's nomination as professor of history at Harvard.

From 1851 to 1852 Carter edited the *Boston Commonwealth*, the chief exponent of the Free Soilers and for two years he was secretary of the state committee of the Free Soil Party. In the summer of 1854, he obtained the consent of the committee to call a convention, which he did without any assistance, sending out thousands of circulars to men whose names were on the committee's books. The convention met in Worcester

Robert Carter (1819-1879)

on July 20 and was so large that no hall could contain it; hence its session was held in the open air. A short platform drawn up by him was adopted, together with the name he proposed - "Republican" -and on his motion a committee of six was appointed to organize the new party, John A. Andrew being made its chairman. (Andrew was an American lawyer and politician in Massachusetts and in 1860 was elected Governor of Massachusetts. He led the state's contributions to the Union cause during the American Civil War and was a guiding force behind the creation of some of the first African-American units in the United States Army, including the famed 54th Massachusetts Infantry.) Thus was born the Republican Party.

In 1855 Carter edited the *Boston Telegraph* and in 1856 he edited the *Atlas*. In 1857 the *Telegraph* and *Atlas* were united with the *Traveller* and after the failure of the *Traveller* he removed to Washington, where he was special correspondent to the *New York Tribune* until 1859.

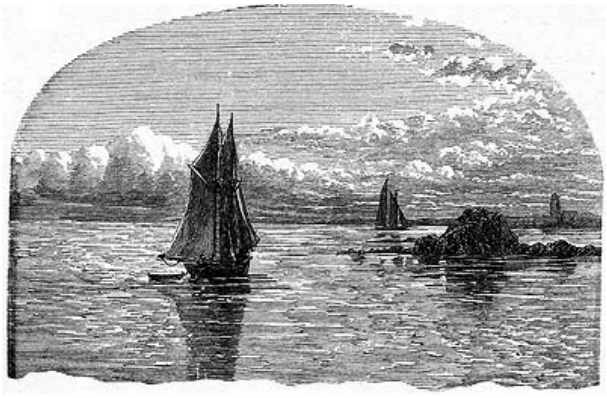
Carter's next activity was with George Ripley and Charles A. Dana on the first edition of the *American Cyclopædia* (1859 to 1863) in which many important articles were from his pen, including "Egypt," "Hindostan," "Mormons," and the history of the United States. In January 1864, he was appointed private secretary of the treasury agent whose headquarters were at Beaufort, South Carolina; and from July of that year until October 1869, he edited the *Rochester, New York, Democrat*, doing such work for it as was seldom done on any but metropolitan journals.

When news came of the assassination of President Lincoln, he wrote, without consulting any book or memoranda, an article giving a brief but circumstantial account with dates of every celebrated case of regicide. He was editor of *Appletons' Journal* from 1870 to 1873, and then became associate editor for the revision of the *American Cyclopædia*, writing articles on "Jefferson Davis" and "The Confederate States of American." In 1874 impaired health compelled him to discontinue his literary work, and in the next three years he made three tours in Europe. His "A Summer Cruise on the Coast of New England" (first published in Boston, 1864) passed through several editions, the last being published in 1888.

WILLIAM STIMPSON

William Stimpson was born in Roxbury, Massachusetts in 1832, the son of Herbert Hathorne Stimpson and Mary Ann Devereau Brewer. The Stimpsons were of the old colonial and Revolutionary stock of Massachusetts, the earliest known member of the family being James Stimpson, who was married in 1661 in Milton. William Stimpson's father was an ingenious inventor and a leading merchant of Boston in the mid decades of the nineteenth century. It was he who invented the "Stimpson range," famous in its day throughout New England. He also made improvements in rifles, devised the first sheet-iron cooking stove and suggested the placing of the flange on the inside of railway car wheels instead of on the outside as had been the custom. His son was to inherit his energy, love of social life, enthusiasm and brilliant wit. Indeed, in so far as we are now able to determine, the qualities which gave character to Stimpson's spirit were all present in his father. Of his mother we know little, for she died at an early age.

In William Stimpson's boyhood his father moved



from Roxbury and built a house in the charming village of Cambridge, and in the green fields and shaded groves of this region young Stimpson was to mature that love of nature which seemed born within him and which throughout life was to dominate his every thought and action. When fourteen years of age he read with delight Edwin Swett's work upon geology, and soon after this a copy of Gould's "Invertebrata of Massachusetts" filled him with an exultant enthusiasm.

In school he was a brilliant pupil. He graduated from the Cambridge High School in 1848, winning the gold medal, the highest prize of the school. In September, 1848, he entered the Cambridge Latin School, and that he did well in his studies we have good evidence in the mastery he displayed in the use of Latin in the description of marine animals in his "Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit W. Stimpson" of 1860.

His father looked with disfavor and even with alarm upon the son's tastes for the natural sciences, realizing that there was no "living" to be made through such studies. Thus it was that in 1849 the boy agreed, obedient to the paternal advice, to enter the engineering office of Fletcher and Parker of Boston. Here, though his heart was elsewhere, his head was efficient for he made a true calculation of the cost of constructing the Boston and Lynn Railroad. It is amusing, however, that his estimate was rejected as being too costly, but when the road was completed it was found to be correct. This surely must have pleased his father, who was at the time the President of the Cambridge Horse Railroad, but his opposition to the son's career as a naturalist was only overcome when William Stimpson received the appointment as naturalist of the North Pacific Exploring Expedition in 1852.

In 1848 he had begun the study of shells with William G. Binney, a distinguished malacologist. The year 1849 was memorable, however, for things other than Stimpson's attempt to force himself to become an engineer as he joined the American Association for the Advancement of Science and also became a member of the Boston Society of Natural History, to whose volumes he was soon to contribute many notable papers. In October, 1850, he broke finally away from the distasteful affairs of engineering, and became a student under Louis Agassiz at Cambridge.

In September, 1849, Stimpson had made his first attempt at dredging, and in July, 1851, he visited Eastport (Maine) and Grand Manan (an island in the Bay of Fundy) for this purpose, this being the beginning of that long series of expeditions which were to entitle him to be recognized as the first naturalist systematically to dredge along the

Foreground: Stimpson is seated on the left, across from fellow Megatherium club member Henry Bryant (1820-1867). Standing directly behind Stimpson is Robert Kennicott (1835-1866), his arm about the shoulders of Henry Ulke (1821-1910).

American coast. Those who accompanied him never forgot the enthusiasm, cheerfulness, and brilliant, always kindly, wit of Stimpson, genial lover of mankind and of nature as he was. As we shall see, a reflection of his rare and lovable spirit appears in the "Summer Cruise on the Coast of New England."

No hardship ever deterred Stimpson in this labor of his heart's desire, and in 1849 he enlisted as a member of the crew of a fishing smack in order that he might dredge off the Newfoundland Banks.

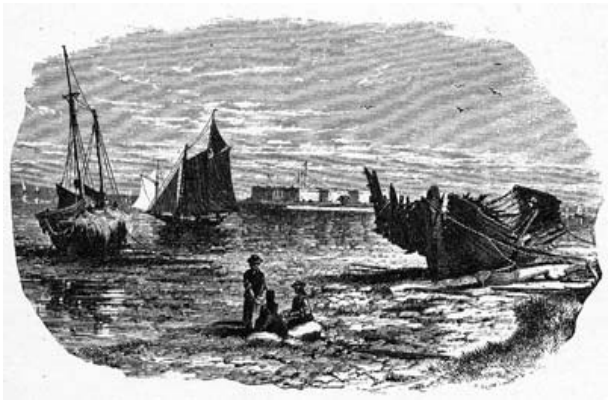
Wherever Stimpson went stories arose respecting his ready recourse, his energy, decision of character, and kindly wit. It is said that when in the Solomon Islands he wandered dangerously far along the shore, savages suddenly attacked him with spears and finally knocked him down. Realizing that they cared more for his tobacco pouch than for his life, he threw it a full twenty feet away, and while his tormentors rushed for the prize he made his quick exit toward the ship.

That Stimpson was also quite a diplomat we have evidence that, although a Northern sympathizer, he courted and became engaged to Miss Annie Gordon, of "Font Hill," near Ilchester, Maryland, daughter of a prominent Secessionist family of that State. Indeed, whenever a Southern victory occurred, Stimpson's prospective father-in-law came himself to announce the fact, while he invariably sent his Negro valet to announce "Yankee" successes. This difference in viewpoint, however, did not prevent the marriage of Stimpson to "Miss Annie" on July 28, 1864.

In 1868, at the early age of 36, he was elected a member of the National Academy of Sciences, having already become a corresponding member of the California Academy of Sciences, the Academy of Natural Sciences of Philadelphia, the New York Lyceum of Natural History and other associations I have already mentioned. In 1860 the Columbian University (now the George Washington University) expressed its appreciation of his services to science by conferring upon him the honorary degree of Doctor of Medicine, this being the only collegiate degree he ever received.

After returning from the North Pacific exploration in 1856, Stimpson studied at the Smithsonian Institution in Washington, devoting his energies to the arranging and description of his collections; he also visited England, where he dredged along the coast. His influence upon the social side of the scientific life of Washington was profound, for he was the founder of two scientific associations. The more social was the Megatherium Club, of which much has been written about the excesses in drink and revelry that attended the informal meetings of the club. The stories are probably all true, including the fact that Joseph Henry, Secretary of the Smithsonian, evicted them from their quarters at the Institution because they were too loud, ran sack races in the great hall on days when inclement weather kept them inside, and serenaded his daughters!

Stimpson also instituted other more or less temporary "organizations," among them the Polymythian Society of Monosyllables, which, despite its humorous name, contributed 9 per cent of the *Proceedings of the Academy of Natural Sciences of Philadelphia* in 1861. A more serious organization was the Potomac-side Naturalist's Club, the first biological society in Washington and the forerunner of the Washington Academy of Sciences.



VIEW FROM SOUTH BOSTON

When fellow club member Robert Kennicott left his post as director of the Academy of Science in Chicago, Stimpson went to that city to take his place. There he gathered one of the most extensive natural history collections in the United States. The academy was destroyed in the Great Chicago Fire of 1871 (later rebuilt), and almost all of Stimpson's works and specimens were lost. He died the following year of tuberculosis while suffering a deep depression.

THE PROFESSOR, THE ASSYRIAN AND THE ARTIST

In his account, Carter supplied sobriquets to his three companions: "the Professor," whom we know was Stimpson, another dubbed "the Assyrian" and the third called "the Artist." The Assyrian, so-called by Carter because of his striking resemblance to the type in face and beard was Francis Henry Underwood (1825-1894), an American editor and writer, and the founder and first associate editor of *The Atlantic* in 1857. Underwood worked in Kentucky from 1845 to 1850, but his hatred of slavery caused him to quit the state and became an ardent supporter of the Free Soil Party. He was later appointed American Consul at Glasgow in Scotland. He and Carter were very close friends.

The identification of the Artist, however, is much more of a mystery. In his memoir of Stimpson, Alfred Goldsborough Mayer, a noted marine zoologist and entomologist who knew him, writes (Mayer, 1918):

A reflection of his rare and lovable spirit appears in the "Summer Cruise on the Coast of New England," by Robert Carter, published in Boston in 1888, wherein "The Professor" is Dr. Stimpson, and the artist is his friend Robert Kennicott.

Kennicott (1835-1866) was an American naturalist and herpetologist, a founder of the Chicago Academy of Sciences and who served the Smithsonian where he was an active field investigator; he died tragically young, only 32 years old, while on an expedition to the Yukon.

However, I was puzzled by this identification. For one thing, references to the Artist on the trip described him making sketches, not fishing. Kennicott's interests would have been similar to that of Stimpson and not in making drawings of the type mentioned by Carter.

For another, Carter arrived in Boston on July 3rd where he met Stimpson and Stimpson's friend, Samuel Tufts, Jr. where they boarded the rented sloop and sailed to Swampscott to make certain necessary arrangements for the trip. From there, Stimpson and Carter sailed to Plymouth and, arriving on July 5th, collected Underwood and the Artist. If Kennicott had been the Artist, it seems more likely that he would have accompanied Stimpson to Boston and met Carter there.

The 1888 edition of The Summer Cruise had an introduction by Robbiter Johnson so I consulted

"The Assyrian, Francis Henry Underwood (1825-1894)

this with a hope that he might have some information about the Artist. This, however, was to no avail since his introduction was about Carter, not his book. The 1888 edition of The Summer Cruise had an introduction by Robbiter Johnson so I consulted this with a hope that he might have some information about the Artist. This, however, was to no avail since his introduction was about Carter, not his book. I next examined the 1977 edition, edited with a foreword by Daniel Ford and here things got interesting. Here is what Ford had to say:

As for his shipmates on that immortal cruise, they have been identified by F.M. O'Brien, antiquarian bookseller of Portland and one of Carter's many admirers. O'Brien happened upon a first edition, in-scribed by "the Professor" in 1865 and naming all who were aboard: The Professor was Dr. William Stimpson, who joined the North Pacific expedition at the age of twenty, and who spent many years thereafter classifying the materials he had gathered at the Smithsonian Institution. The Artist was a certain Henry Carey, who is otherwise unidentified. And the thirsty Assyrian was Francis Henry Underwood. Lawyer, editor, novelist and consular official, he helped establish the *Atlantic Monthly* as the voice of the anti-slavery movement in New England.

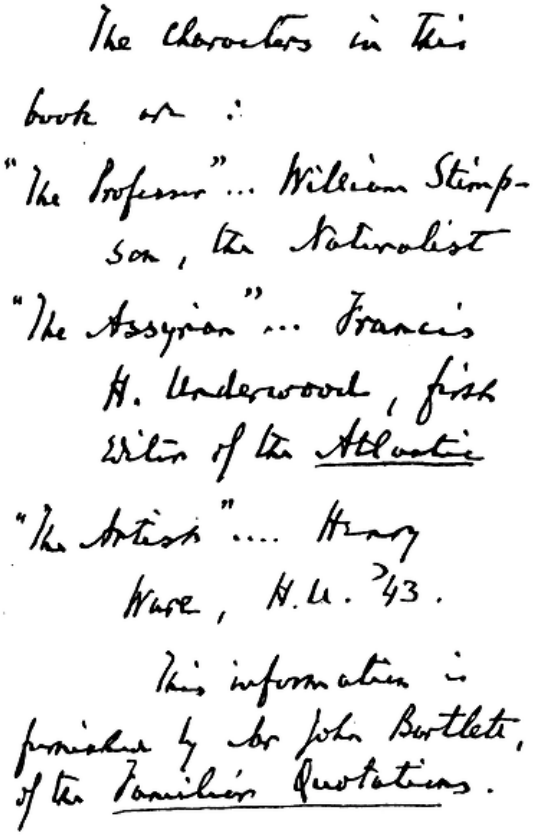
Now either William Stimpson wrote this inscription or he did not. If he did not, then any remarks concerning the Artist in the inscription are worthless since we do not know if the author is authoritative.

If Stimpson did write this inscription, then either his identification of the Artist as "Henry Carey" was correct or incorrect. As I will shortly show, his identification was incorrect. Clearly he did not remember the Artist well – save for his first name, which he had to have used frequently on the trip – since he provides no information about him, something he did do with Carter and Underwood. It is my contention that Stimpson did write the inscription but remembered so little about the Artist that he stated his last name incorrectly, as no one with the name "Henry Carey" has ever been shown to be associated with Carter or Underwood. This, then, was another dead end. I then proceeded to examine other editions to see if anyone else had tried to identify the Artist and Voila! I found my missing Artist.

The book in question was an 1864 edition (the first edition) in the Harvard University library, given to it by an unknown donor. Written on a flyleaf was the following (see the accompanying figure):

The characters in this book are: "The Professor… William Stimpson, the Naturalist; "The Assyrian"… Francis H. Underwood, fish Editor of the Atlantic; "The Artist"… Henry Ware, H.U. '43. This information is furnished by Mr. John Bartlett, of The Familiar Quotations."

John Bartlett (1820 - 1905) was an American writer and publisher whose best known work, "Bartlett's Familiar Quotations," has been continually revised and reissued for a century after his death. He compiled a massive concordance of


The characters in this book are:
"The Professor"... William Stimpson, the Naturalist
"The Assyrian"... Francis H. Underwood, fish Editor of the Atlantic
"The Artist".... Henry Ware, H.U. '43.
This information is furnished by Mr John Bartlett, of the Familiar Quotations.

Written by an unknown donor on a flyleaf of the Harvard University's copy of "A Summer Cruise on the Coast of New England."

Shakespeare, published in 1894, that is still the standard work of its kind. Bartlett was born in Plymouth, Massachusetts. His father was a descendant of Mayflower Pilgrims, Love Brewster, a founder of the town of Bridgewater, Massachusetts; Elder William Brewster, the Pilgrim colonist leader and spiritual elder of the Plymouth Colony; and John Alden, who was hired as a cooper in Southampton, England, just before the voyage to America and who along with the Brewsters were signers of the Mayflower Compact.

A very bright boy, he was reading at age three and had read the entire Bible by nine. He finished school at age sixteen and went to Cambridge, Massachusetts, where he worked for the University Bookstore that served Harvard. He rose to be the firm's senior partner in 1878 and retired from the firm in 1889. In addition to work on quotations (he oversaw nine editions of his book), he wrote on fishing and chess. In 1892 he donated his collection of books on angling, fishes and fish culture (some 1014 books and 269 pamphlets!) to the Library of Harvard College. Known for his memory for quotations and trivia, “Ask John Bartlett” became a byword in the community when someone was stumped.

As it turns out, however, the unknown donor got the wrong end of the stick in identifying Henry Ware. The donor’s reference to “Henry Ware, H.U. ’43” was to Henry Ware, Jr. (1794 - 1843), an influential Unitarian theologian and early member of the faculty of Harvard Divinity School. This, however, was the wrong Ware since he had died 16 years before the cruise.

One of Henry Ware Jr.’s brothers was William Ware, (1797-1852), an American romance who achieved literary recognition chiefly from his authorship of two historical romances, “Zenobia, or the Fall of Palmyra” and “The Triumph of Aurelian.” One of his sons was Henry Ware (1825 - 1885), named after his grandfather, the most famous of the Wares and influential in the formation of Unitarianism and the American Unitarian Association in the United States. This is the Ware that Bartlett had in mind in his reply to the donor.

The following is from Underwood’s memoir on the poet, James Russell Lowell (Underwood, 1893):

For some years between 1853 and 1859, Lowell received a few of his Cambridge friends on Sunday afternoons in his study, a front room in the third story. On Friday evenings there was another gathering, ostensibly for whist, at the house of each of the party in turn. Of those who were members of the whist-club, Dr. Estes Howe, Robert Carter, Henry Ware and Lowell are dead; the survivors are John Holmes, John Bartlett, and the present writer. In social meetings Lowell was naturally the leading spirit, and the one whose talk no one was willing to miss; yet he was never the imperious Johnson of the club; everyone had his chance. The conversation took a wide range over literature and art, as well as the field of politics, on which lines of battle were forming, then little suspected. In the tranquil, peace-loving North “coming events” did not “cast their shadows before.”

All these men had much in common - an appreci-

John Bartlett (1820-1905)

ation of humor, a love of books and mellowness, and individual hobbies which made them interesting to themselves and to their fellows. Henry Ware's hobby was music and sketching. From John Holmes's letters about the club (Holmes was the younger brother of Oliver Wendell Holmes, Sr.) it might inferred that they were epicures, but their epicurism was innocent, and their relish for a dish or for a bottle of "the rosy" seems to have been an echo of the talk of bygone clubmen in books. The importance of their little circle lay in the fact that it afforded the best conditions for strengthening friendship.

The cruise must have been a lively topic of conversation in the Whist Club both before and for many months afterwards. Bartlett, of course, was a member of the club and had a keen memory for details. It explains why Underwood and Ware joined the cruise in Plymouth, which as the crow flies is only 33 miles away from Boston where these two good friends lived.

Ware graduated from Harvard in 1847 with a degree in law. In 1855 he took a position as Legislative Clerk in the Massachusetts State House and from 1862 to 1865 was the Military Secretary, with the rank of Major, for the Governor of Massachusetts. From 1867 to 1869 he was Assistant Adjutant-General in the Massachusetts Militia, with the rank of Lieutenant-Colonel. Afterwards he was secretary to the United States Senate at Washington, D.C. After retiring from his law practice in Cambridge in 1875, he became the Keeper of the Bates Hall Department in the Boston Public Library. In 1877, effective in May of the following year, he was removed from that position.

Following Justin Winsor's resignation as Librarian in May of 1877, Dr. Samuel Abbott Green, one of the Trustees of the Boston Public Library from 1868 to 1878 and the high-handed and extremely cantankerous Librarian of the Massachusetts Historical Society from 1868 until his death in 1918, was placed in a temporary position as "Trustee in charge" that continued for more than a year.

One can gather enough about the formidable Dr. Green from scholars who met him at their peril in later years at the Massachusetts Historical Socie-

From left to right: John Homes, Dr. Estes Howe, Robert Carter and James Russell Lowell.

ty, he was hardly the ideal successor. Obviously the library ran along, for it was not only well organized, but Winsor had persuaded his valued assistants to restrain their natural inclinations to resign also. Even the newspapers were worried about "fresh progress to be set on foot" and the *Sunday Herald* of December 1877 made some sharp observations concerning the Trustees' experiments "in the direction of incommoding its patrons, di-minishing the circulation, and impairing the usefulness and acceptability of the library" that had involved the removal of Henry Ware, Keeper of Bates Hall, and Arthur A. Brooks, Assistant Keeper of the Lower Hall, both of whom victims of Greene's policies. The *Sunday Herald* suggested to the Trustees "that they let well enough alone until they are in position to offer the vacant superintendency to a man qualified to carry on the institution, and leave the change and new experiments to him." The advice was not promptly heeded, for no appointment was made until the fall of 1878 and by this time a great deal of damage had been done to the library, including Ware's dismissal.

Note: Additional support for the confirmation of Ware as "the Artist" appeared in George Street's history of Mount Desert (Street, 1905).

SAMUEL TUFTS, JR.

Samuel Tufts, Jr. (1817-1902) was born in 1817 in Wilmington, Massachusetts, an inland town about 16 miles northwest of Boston. When a young man, he was apprenticed to a shoemaker in nearby Woburn. Tufts left that town when shoemaking by hand was replaced by machine work. He moved to Swampscott and later to Lynn, Massachusetts, a coastal shoe-making city, about 9 miles north of Boston. Although shoemaking by machines also took over in Lynn, the larger industry there may have offered more opportunities. In 1847 he married Miranda Chubb, who died the following year, but within a month he married Elizabeth Ann Marshall.

Tufts spent most of his life as a shoemaker and proprietor of express and furniture moving businesses. During the 1850s, when he lived in Swampscott and Lynn, Massachusetts, adjacent seacoast communities, he collected shells and conducted an aquarium stocking business.

As I have also previously mentioned, in October 1850 Stimpson became a student under Louis Agassiz at Cambridge. Joseph Bassett Holder (1824–1888), a native of Lynn and who had practiced medicine there was a friend and colleague of Agassiz and helped Stimpson in dredging around Nahant. Holder was also a founder of the Lynn Natural History Society in 1842 and so is likely to have known Tufts. Through Holder, it is possible that Tufts became acquainted with Stimpson but like the question of how Carter first met Stimpson, this is not known with certainty.

Although Tufts' observations sometimes were published locally, they were conveyed to the wider natural history community through the publications of more prominent naturalists including William Greene Binney, whom I have mentioned previously, Augustus Addison Gould, a conchologist and malacologist of high reputation, and William Stimpson.

In Stimpson's "Synopsis of the Marine Invertebrata of Grand Manan" in the *Smithsonian Contributions to Knowledge* dated 1853, Stimpson

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wrote in his description of his new species, *Idotaea tuftsii* (now *Chiridotea tuftsii*) the following:

I have dedicated this species to Mr. Samuel Tufts, of Lynn, Mass., one of our most active marine zoologists, to whom I have been often indebted for new and curious forms of deep sea animals from Massachusetts Bay.

However, as our interest in Tufts is in his aquarium stocking business and not his shell collecting, the following is from the *Proceedings of the Essex Institute*, February 25, 1858:

The remainder of the evening's session was occupied with a pleasant conversational discus-sion about marine and fresh water aquaria, suggested by a Circular of Samuel Tufts Jr., of Lynn, and read to the meet-ing by H. Wheatland. The uses, to which, such apparatus could be applied in studying the habits of aquatic animals, insects and plants, and the best modes of constructing them and how to stock them so as to secure health and active life, came under consideration.

A small aquarium, made with a glass-dish employed by George D. Phippen, afforded him much recreation and in-struction. He alluded to his pleasure in visiting the seashore in quest of specimens and his success in keeping them alive.

Tufts also donated "Living actinia and other marine animals for aquarium" to the Smithsonian Institution in 1857 and "Living marine animals from Massachusetts, for the aquarium" in 1858. The aquarium in question was described in *Scientific American* in 1857 and most likely Stimpson was the one responsible for its placement and upkeep in the Smithsonian:

The Smithsonian Aquarium at Washington.

A fine marine aquavivarium, or aquarium, has been prepared at the Smithsonian Institu-tion, where the public can now inspect its curious contents. It is said that an eminent French zoologist, in order to prosecute his studies on marine animals of the Mediterra-nean, provided himself with a water dress, glass helmet and breathing tubes, that he might walk about under water, and mark the habits of the various creatures pursuing their avocations. Anyone who will visit the Smith-sonian aquarium may enjoy the same opportu-nities, and become acquainted with the strange animals and plants of the sea without diving to gaze on them.

The aquarium is simply a glass tank, erected on a table, and filled with sea-water, in which flourish marine plants and animals without any aid, or even changing the water.

The bottom of the Smithsonian aquarium is an imitation of the bottom of the sea, com-posed of silver sand, coarse sand and pebbles. In the center is a mass of rock, giving shelter and concealment to such animals as like con-cealment, while jotted about arc growing specimens of fuci [a type of brown algae] **and algae. In this miniature ocean cave are about three hundred specimens of animal vitality, belonging to some thirty-eight species of fishes, molluscae, crustacae and polypes. Some of these burrow in the sand, or modestly hide among the pebbles; others, like the hermit crabs, having taken possession of vacant suits of submarine armor, flourish about belligerently, ready for a fight. Some are perfectly transparent, like animated particles of jelly; others arc enshrined in their shells. The curious "horse-fish" paddles about with his filmy dorsal fin; and a lethar-gic clam protrudes its siphons, enveloped in a shaggy fringe; a solitary flounder was evi-dently annoyed when rooted out, and imme-diately burrowed himself again in the sand; while two pugnacious crabs fought gallantly over an *amphitrite auricoma*, which had been obligingly sacrificed that we might see its golden combs.**

Finally, the following are Carter's comments in Chapter III upon viewing Tufts' store on July 4th (Carter ends the chapter heading with "A Scientific Shoemaker"):

Mr. Tufts had come on board while we were at breakfast, and wishing to see his aquariums I went ashore with him in his dory. We landed on a beach in front of his shop, which is almost at the water's edge, and I spent half an hour very agree-ably in examining his tanks, of which he had several in fine condition. Mr. Tufts is a shoe-maker,

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with no more education from schools than every boy in Massachusetts receives. He has educated himself by books and observation in natural history, till he has become in his specialty — marine zoology — a very intelligent naturalist. For a year or two past he had devoted himself to collecting and selling materials for stocking aquariums, the demand for which two or three years ago was considerable in our principal cities. The Smithsonian Institution and the Boston Society of Natural History employed him in this capacity. To those who ordered from him the materials for stocking an aquarium, he sent a keg or barrel of sea-water, and a box of two compartments, — one containing the sea-weeds and some of the animals, the other containing the more delicate animals in a bottle or jar. While aquariums were in fashion he had full occupation in this pursuit, but I learn that recently he has relinquished it.

Tuft's natural history activities finally ended when he relocated to Cambridge, Massachusetts around 1860.

PART II: THE SUMMER CRUISE

THE IDEA FOR THE SUMMER CRUISE IS BORN

On one of the hottest evenings of the hot month of June, 1858, I paid a visit to my friend Professor S—, at his residence on G. Street, Washington.

I do not know that my friend had any regular or official claim to the title of Professor. It was conferred upon him, like so many of our American titles, as a matter of conversational convenience by the officers of the North Pacific Exploring Expedition, of which he was Naturalist. They dubbed him Professor of Marine Zoology, in recognition of his skill in the knowledge of all that pertains to the creatures that inhabit the great deep, but especially of the mollusks, crustacea, and invertebrates generally,— a knowledge abundantly shown in his various treatises on the marine zoology, not only of New England, but of the Chinese and Japanese seas. The study of the ocean and its inhabitants had been a passion with him from early boyhood, and was pursued with such success, that, in 1849, while yet a youth, he had discovered the principle of the aquarium, and had a number of aquariums in successful operation long before anything was heard of the kindred experiments of the Englishman Warrington.

It was a fearfully hot night; one of a long succession of hot nights and days through which I had patiently sweltered and sweated, in the vain expectation that time and endurance would gradually accustom me to being broiled and parboiled, as they are said to render eels tolerant of, if not acquiescent in, the process of being skinned alive. But a frame acclimated to the moderate heats and invariably cool nights of the sea-coast of Massachusetts, could not readily become insensible to the influence of an atmosphere which at midnight, as well as at noonday, maintained a heat greater than the average heat of the torrid zone. I sought refuge at the Professor's, because his house, though not materially cooler than the rest of the city, was intellectually and imaginatively cooler. It abounded in objects suggestive of refreshing ideas. There were crabs and shells that had been dragged from the sunless depths of the Arctic Ocean; fishing-lines and dredges that had explored the cool abysses of Kamtchatkan and Siberian seas; drawings of icebergs and glaciers; and, what particularly was wont to give an agreeable chill to my fancy, a picture of the prodigious snowy cone of the great Japanese volcano, Fusi-Yama, made by a native artist at Simoda, where the Professor himself purchased it.

The Professor, with nothing on but a shirt and the thinnest of pantaloons, was stretched on a sofa, with a cigar in his mouth, languidly smoking, and contemplating through his gold spectacles the ungainly proportions of a monstrous dor-bug he had just captured. Our conversation opened, of course, on the weather.

"I cannot stand it any longer," he said; I shall start on a cruise on the coast of Maine next week, and you had better come along, if you do not want to die of a fever. You look horribly bilious already, and a few days more of this heat will use you up entirely. Let us go and cool off at Grand Manan. I spent two months there some summers ago, fishing and dredging, and can assure you that it is the finest place on our whole coast."

WHITE HEAD, NEAR PORTLAND

"For crabs, I suppose, Professor. All places are classified by you for good or bad with relation to their production or non-production of crabs."

"For crabs, yes, - but not alone for crabs. The scenery is superb - grander than anything you will see this side of the Saguenay. Huge, rocky cliffs, a thousand feet high, rise right out of deep water, and are broken into the wildest and most romantic caves and inlets. They are the haunt of nearly all kinds of sea-birds, from the herring-gull down to Mother Carey's chickens. We shall catch there and on our way down the coast every species of fish that swims in our seas."

"Including the whale?"

"The whale is not a fish," responded the Professor, gravely, overlooking the levity of my interruption in his scientific sense of its zoological inaccuracy, "but I promise you we shall see whales in abundance. We shall also catch sharks, and kill seals and porpoises. But, in short, if you will come along, we will run into every harbor from Provincetown to Eastport, and fish and dredge till you have seen at least one specimen of every creature that swims the sea or dwells on the bottom. Then, if you will, you can write a book about the aquarium which shall be a little more reliable than that trumpery thing of Edwards's which you sent me yesterday."

"What is the matter with that?" I asked. "It seemed to me a clever and entertaining book."

The Professor launched into an elaborate and energetic criticism, the details of which I cannot now recall, and to which I must confess I paid little attention, for the amount of it seemed to be that Mr. Edwards had transferred a few species of mollusks from the English seas to ours, and was not very careful in the spelling of his scientific names.

I intimated that the orthography of these uncouth appellations was of little consequence. The Professor shook his head. The young men and maidens who were going with such enthusiasm into the formation of aquariums would be led into a shocking confusion of names and species. Besides, some of the plates were wrong. "On plate No. 5, for example, a species of *Lymnea* is figured as *Physa heterostropha*, and on — "

"That will do. I give up Edwards, on condition that you do not utter another of those jawbreakers during the entire evening. But how shall we go to the Grand Manan? "

The Professor's hint about my bilious appearance had privately decided me to take an abrupt leave of the national capital. I already felt a fever in my veins.

"I have written to my friend Tufts, the aquarium maker and stocker at Swampscott - you have heard me speak of him? To engage me a good, clean, stout fishing-smack of from ten to twenty tons, and also two experienced boatmen, one of them, if possible, old Captain Widger, who went with me on my cruise last year. I shall hear from Tufts in a day or two, and you had better get ready at once, for I shall be off like a flash the moment I can get away."

In reply to my inquiries into the nature and extent of the requisite preparations for a cruise of a month's duration, the Professor said:

"Put two pairs of pantaloons, two thick coats, and a vest or two, the oldest and worst you have, into a bag - a gunny-bag or a potato-sack will do. Put in, also, a couple of flannel shirts and drawers, and a half a dozen or a dozen of thick woolen socks, and an old felt hat. Buy a couple of the thickest red-flannel shirts you can find, a pair of thick-soled cowhide boots, a tight-fitting cloth cap, a cheap straw hat, and a pair of oilskin or India-rubber pantaloons - oilskin is best, for it doesn't smell so abominably as India-rubber. Put these, with two or three pairs of old slippers, in the bag, and tie it up tight. Put a couple of linen shirts, more or less, as you please, and a decent suit of light summer clothes, in a valise, so that you can go ashore at Salem, Portland, Eastport, and other civilized places, and see your friends if you have any. That is all the outfit you will need. I will look out for supplying the vessel with provisions and table-ware. I will also provide pens, ink, paper, pencils, and envelopes. If you want to take notes, put in your valise two or three

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blank-books - loose sheets of paper are always getting lost."

"And the damage?"

The Professor has an abhorrence of slang phrases, except those which he uses himself.

"I suppose you mean the expense," he replied. 1 cannot exactly tell till I hear from Tufts what sort of craft he has engaged, and on what terms; but if we get one or two others to go and share expenses, the 'damage,' as you call it, will be from $50 to $100 apiece."

This was satisfactory, and I made my preparations accordingly. I put nothing in the bag beyond what the Professor indicated, except a pair of India-rubber overshoes, which I subsequently found of essential service when the deck was too wet for slippers, as was frequently the case.

Two or three days later the Professor came to see me in high glee, intense delight gleaming through the perspiration that rolled down his face from the heat of a walk in the sunshine. He flourished an open letter in his hand.
"Tufts writes that he has engaged the sloop Helen and her owner, Captain Gurney, and that Captain Widger will go if we want him. The sloop was built for a yacht, is stout and tight and roomy, with four berths. She measures seventeen tons, and draws five and a half feet of water; has not been much used for fishing, and is consequently clean and in good condition."

"The price?" I suggested.

"Seven dollars and a half a day, including the two men. I shall write to have her brought to Boston on Friday next, and we will start the next day."

The book that Carter had given to Stimpson was Arthur Mead Edwards' "Life Beneath the Waters, or the Aquarium in America" that had just been published earlier in the year. That Carter was an aquarist not only is evidenced by this and by Stimpson's comment that after the cruise Carter could write a book **"...about the aquarium which shall be a little more reliable than that trumpery thing of Edwards's..."** but by Carter's desire to stop off and see Tuft's aquariums and his shop in Swampscott. It is interesting that Stimpson thought little of Edward's book. He was not alone in this as it had received unfavorable reviews from many critics.

THE TRIP

It might seem odd that Stimpson and three people of such divergent backgrounds as his got along with no problems whatsoever. However, the trip was undertaken partly for fun and partly for scientific research in marine zoology so there was something of interest for all. More important is the fact that Carter, through his interest in aquariums, knew Stimson well, both of them residing in Washington D.C. at the time. In short, as Carter was an aquarist and Stimpson was the first American aquarist of record, they had a mutual interest. It is not known how or where Carter and Simpson first met, but they were in Cambridge from 1849 to 1851 and in Washington from 1857 to 1859.

The cost of the trip was shared among the four participants. The plan was for Stimpson and Carter to travel to Boston where they would be met by Stimpson's friend, Samuel Tufts, Jr. and board the rented sloop, Helen (32 feet and 7 inches long with a beam of 12 feet, 5 inches). From there they would sail to Plymouth and collect Ware and Underwood. From there they would continue on to Marblehead, Gloucester, Rockport, Portsmouth, Portland, Mount Desert and Bar Harbor. At the time, Stimpson was 26 years old, Carter was 40, Underwood was 34 and Ware was 34. In his preface Carter describes the trip:

"The fishing voyage of which this book is a record was made in 1858, during my summer vacation from the

WHALE'S BACK LIGHTHOUSE

arduous duties of a Washington Correspondent of the *New York Tribune*, and the narrative originally appeared in the form of letters to that journal. In that shape it met with considerable favor, especially from sportsmen and naturalists; and its publication in a permanent form, at this late day, is due, in part, to the assurances I have received from high scientific authority that its sketches of the fishes of our Northern seas, of their habits and resorts, and of the methods of taking them, are not without value as contributions to Natural History. I can only say upon this point, that I have spared no pains to make my statements accurate, not only by careful personal observations, but by freely consulting and using the writings of our best American ichthyologists."

SAILING ON A SMALL BOAT

In 1984, my wife and I, along with an entomologist friend and his wife, a guide and a captain, sailed throughout the Galapagos in the 34-foot sloop, the Nixe, the smallest charter in the islands at the time. Since sloop Stimpson and his companions used was even smaller – 32 feet, 7 inches, I can well appreciate the problems in living in such close quarters. Carter's observations on this subject follow:

The sloop's cabin, which was low, but suf-ficiently broad, contained four berths, two on each side. The Professor and myself took one side, the two seamen turned in on the other, while Mr. Tufts kept watch on deck, as there was some reason to apprehend that the sloop might drift, the only anchor we had ready for use being a small one.

Late in the evening, the dory returned from Plymouth, bringing off the Artist, who, much to our surprise and pleasure, was accompanied by the Assyrian, as his friends are wont to call him, from his striking resemblance, in face and beard, to the Ninevite sculptures dug up by Layard and Botta. Their arrival completed the number we had fixed upon as desirable for the cruise, four being in fact as many as the sloop could possibly accommodate. The seamen, indeed, for the rest of the voyage slept on the cabin floor, having relinquished their berths to the new-comers.

I did not dress, for on board the Helen, during this cruise, we have undressed only when we bathed or went ashore, in which latter case, to prevent misconception, I will state that after undressing we dressed ourselves again in shore clothes; the main constituents of shore clothes being coats and white shirts. White shirts and coats we put on, however, only when visiting some considerable place, like Gloucester, Ports-mouth, or Portland. At other places we gener-ally went ashore in our sea rig, consisting of panta-loons well smeared with the slime of fish, and bleached with constant drippings and splashings of sea water, and thick red-flannel shirts, one or more shirts being worn at a time, according to the weather or the fancy of the wearer. The Pro-fessor, whose ardor in pursuit of science exposed him most to the wet, generally arrayed himself in three shirts at once; the oldest in service being worn uppermost and outermost.

Getting up, as I said, soon after daylight, and giving myself a shake by way of making my toi-lette, I could scarcely keep from laughing as I looked around the little cabin. The Professor, whose berth was on the same side with my own, was sleeping almost in a sitting posture, his back propped up by a pillow, a great coat, and a huge volume of the United States Coast Survey Re-port. He had fallen asleep while reading, for his unextinguished lamp yet burned dimly beside him, and his spectacles were still on his nose. His blanket was lying folded beneath him, and he had passed the night close to the open cabin-door, with no other protection from the cool air than his three shirts. They, however, seemed to be sufficient, for he was sleeping soundly and comfortably.

The Assyrian's berth was opposite to the Pro-fessor's. An extra mattress, which the two sea-men spread for themselves on the floor when they were on board, had been thrust on the top of his mattress during the day. He had neglected to remove it on turning in, and the space that was left between it and the ceiling was barely suffi-cient for his somewhat ample proportions. He had no pillow, and with his head thrown back and his mouth resolutely shut, he was sounding a blast with such sonorous and sustained vigor that I could almost imagine he had served as a trum-peter through all the seventeen campaigns of his famous ancestor, the mighty Temenbar, who, if he writ his annals right on the sculptured walls of his palace, was the most successful and sangui-nary of the long line of Ninevite kings and con-querors. In the

THE HARBOR FROM DORCHESTER$ HEIGHTS

struggles and contortions induced by his inconvenient posture, the Assyrian had twisted his blanket around him in such fashion, that, while a triple fold enveloped his body, his nether continuations were exposed at full length, protected only by his coarse blue pantaloons.

The Artist, on the contrary, was lying, like gray-haired Saturn, "quiet as a stone," snugly wrapped in his blanket, which swathed him as closely as a mummy is swathed by its bandages. He had converted his portmanteau into a pillow, and was taking his sleep with a resolute expres-sion of countenance, which said plainly that he was very comfortable, and did not mean to be disturbed.

I pinched the Assyrian's nose till he opened his mouth, which I have always found an effectual mode of checking a snorer, and went on deck to see the sun rise.

A LEARNING EXPERIENCE

Carter certainly received quite an education from Stimpson on the trip:

The Professor grasped with avidity the roots of the weed. After looking at it attentively a few minutes, he pointed out to me about a dozen snake-armed starfish *(Ophiopholis scolopendrica*), wound around the tendrils of the roots.

"This species," he said," is found only in deep water, and can only be got by dredging. It con-sists, you will observe, of a small central disk of about the size of a ten-cent piece, and five long, slender, spiny arms, which twine like serpents among the roots of the sea-weed. They are often very brilliant, and beautifully variegated in color. Most commonly the disk is red, with a pentagonal white spot in the middle, while the arms are ringed with red and brown."

The Professor next pointed out upon the drip-ping mass something that looked like a large drop of blood. This, he said, was an ascidian, the *Cynthia gutta.* It was a small, flat, leathery disk of a red color, of little thickness, but still sufficient to hold a variety of organs, gills, liver, stomach, intestines, etc., which may be seen upon upturning the envelope of the sac. On the upper surface there are two apertures, one for the admission, the other for the expulsion of the water which passes over the gills.

At one point, Stimpson handed him something and asked:

"What do you think that is?" said the Pro-fessor, handing me a pebble which he detached from the roots of the sea-weed. I looked at it carefully, and replied, "A pebble curiously coated with lime." "What you take for lime is a vegetable, the millipore, much of whose fabric, however, is really composed of carbonate of lime."

The Professor then took the dory and rowed away from the sloop about one eighth of a mile, where he fished for half an hour, apparently with-out much success. On coming alongside he held up to our inspection a beautiful rose-colored fish about eight inches in length.

"What do you call that?" he inquired of the Pilot.

"1 call that a humdruggan."

"A hemdurgan?" said the Professor, repeating the word as Dr. Storer spells it.

"No, a humdruggan," persisted the old fisher-man; "that's what I have always heard it called, — a hum-drug -gan."

It was a Norway haddock. The fishermen call it "rose-fish," "red sea-perch," and "snapper." It is a rare fish on our coast, and seldom eaten when taken; though on the coast of Norway, where it is caught plentifully, it is a favorite arti-cle of food, being considered a great delicacy, and eaten either cooked or dried. It is common in the seas around Newfoundland, and in the deep bays on the southern coast of Greenland it is caught in great numbers, in the way that the Professor caught it, — on baited hooks attached to long lines. It has spines on the head, which the Greenlanders formerly used for needles. The greatest length of the Norway haddock is two feet. It is caught, though rarely, I believe, as far south as New York.

The "humdruggan" or "Norwegian haddock. The Pilot and the Skipper mistakenly considered the spines of this fish to be poisonous.

The Pilot and the Skipper both expressed a good deal of dread of this handsome and apparently harmless fish. They considered the spine poison-ous, and the Skipper related several instances in which he had known persons to be dangerously wounded by handling it. The Professor pooh-poohed at these stories, though it was possible, he said, that a wound made by the spines of the fish might become badly inflamed, as was often the case with wounds made by the claws of a cat or the teeth of a rat.

Carter also learned a lot from those he encountered along the way:

"Our Pilot, as we called him, from his minute knowledge of the coast, generally officiated as steersman, and always as cook. He was sixty- eight years of age, of which fifty-five years had been spent on the sea. He was still as hale, hearty, and active as most men of fifty years. His life had not been without adventure and strange vicissitudes. In 1812, when Congress declared war against England, he was on a voyage to St. Petersburg. On the return from that port his vessel was captured by an English cruiser, and he was sent a prisoner of war to Chatham, where he remained upward of a year, and was exchanged and released just before the transfer of the American captives to the fatal prison of Dartmoor. During the rest of the war he sailed from his native Marblehead in a privateer, which made a good many captures, and had three or four engagements with armed merchantmen. He continued to make long voyages for some years after peace was restored, but finally settled down into the steady pursuit of the fisheries, in the course of which he had become familiarly acquainted with almost every bay, harbor, island, headland, reef, shoal, and rock, from Cape Cod to Labrador."

A MARINE MUNCHAUSEN

In the evening we received visits from several Swampscott skippers, whose vessels, like our own, were windbound in the port. One of these men sat with us till midnight, spinning the most mon-strous and incredible yarns, which he narrated with a serene gravity that would almost have per-suaded the hearer to believe any lie. He was a marine Munchausen of the first water, and his adventures were nearly as wonderful as those of the renowned Baron himself.

We spoke of snakes. On this topic he spread himself amazingly. He had often seen the sea-serpent, and once when cruising for swordfish off Nantucket, had harpooned the monster from the deck of his vessel, and had been towed out to sea a hundred miles in thirty minutes, when the line broke and the creature got away.

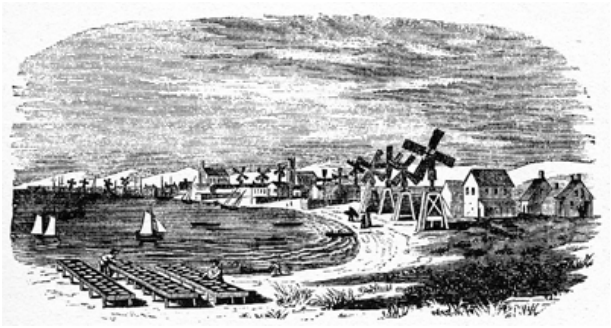
"Rattlesnakes? Yes, sir; I *have* seen rattle-snakes. Some years ago, I grew tired of the sea, and took a farm in Illinois. I had a meadow on the prairie of three hundred acres, and when it came haying-time rattlesnakes were so thick there, that of seven Irishmen I sent to mow it one morning, five were bitten so that they died instantly, and the other two were only saved by keeping them constantly drunk with whiskey for more than a month. That job cost me a barrel of good Bourbon, beside the funeral expenses of the dead men."

"And you lost your hay?" said the Professor.

"Not at all. I had seen too much of snakes to be bluffed off in that way. I had a pair of boots which had been given to me at Buenos Ayres by General Rosas, of the kind worn by the Guachos on the Pampas when they go out to hunt the jaguar. They are made of the toughest bull's hide, doubled, and I was confident that if they could resist the jaguar's claws they could the fangs of the rattlesnake. They came up to my hips, and I put them on one fine morning, and taking a scythe, went into the meadow and began to mow. The snakes came at me, a dozen at a time, and whenever they struck their fangs into the tough leather it held them fast. I took no notice of them, but kept on mowing till they hung in such numbers about my legs that the weight became troublesome, and then I stopped mowing and cut them off with the scythe. I had to do this about once in half an hour, and when I went home to dinner there were so many heads hanging to the boots that you could scarcely see the leather. The boys picked off enough to fill a peck measure heaping full, and when I came home to supper they got off as many more. I kept this up for a fortnight, and by that time, I can tell you, snakes were getting rather scarce in that particu-lar meadow."

"What became of them boots?" inquired our Pilot, who had listened to this narrative with much apparent interest.

"Them boots," said the visitor, lighting one of the Captain-General's Havanas with much deliber-ation, and rolling the weed slowly between his lips, evidently to gain time for invention, "them boots saved my life not long afterwards. You see, I soon got tired of farming and went to sea again. I bought a brig in New York and started on a trad-



PROVINCETOWN

ing expedition to the west coast of Africa. Off the Cape de Verdes we had about the worst storm I ever saw in my life, and were driven ashore in the night a little south of Cape Blanco, where the Great Desert comes down to the sea. The brig struck a reef running out under water a considerable distance. The next day a whole tribe of Arabs appeared on the beach mak-ing signals to us. I went ashore to see what they wanted, and as I did not like to expose the boat's crew to harm, before going I put on them iden-tical boots, which I had always kept with care, in order that I might wade from the boat to the beach. As the water was shallow, the boat could keep a good way out beyond the reach of the javelins and spears of the Arabs, who did not seem to have any fire-arms. As soon as I landed I was seized and hurried off over some sand-hills to their camp. Knowing enough of their language to understand most of what they said, I soon found that they meant to entice my crew on shore, make slaves of them, and plunder the ship.

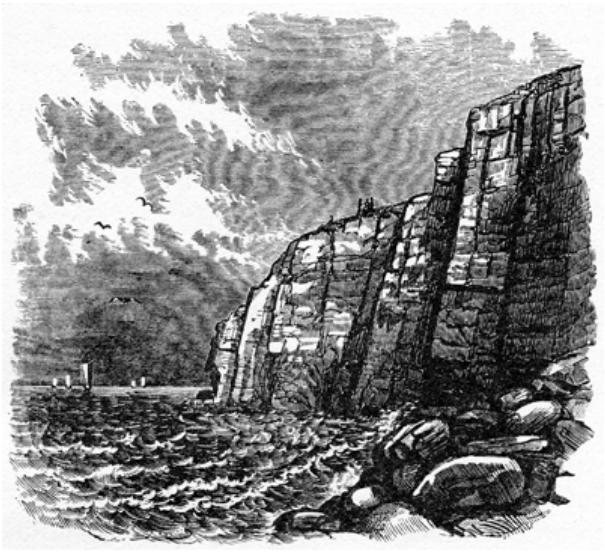
As a part of this plan, they treated me civilly for a time, only taking off my boots, which seemed to strike their fancy in a way that I could not at first comprehend. But I soon found that they were almost wholly out of provision, though they had plenty of water, and that they meant to make soup of the boots. They accordingly put them into a big iron pot, over a fire, and in about an hour invited me to partake of the broth. I de-clined, and they ate it themselves. In half an hour afterwards every mother's son and daughter of them was as dead as Julius Caesar. There was rattlesnake poison enough in them boots, sir, to destroy all the Arabs of Arabia. The next day we got the brig off without material damage, and we found gold-dust enough in the camp of the Arabs to make every one of the crew a rich man. That was on the whole the most successful voyage I ever made.

"But speaking of snakes, if you want to see snakes you must go to the East Indies. I was once lying at anchor in a little port on the coast of Sumatra, waiting for a cargo of pepper. The weather was intensely hot, and we left all the hatches open at night. I got up early one morn-ing and found the gunwales of the ship nearly down to the water's edge. Supposing that we had somehow sprung a leak and were sinking, I roused up the men and sent a couple of them down the main hatchway to see what the matter was. They did not come back, and after waiting a few min-utes I sent the mate, who looked in cautiously with a lantern, and reported that there was a serpent in the hold, and that he had probably swallowed both the seamen, as the feet of one of them were sticking out of his mouth. From the depth to which his weight had sunk the ship he was evidently a big one. Prompt measures were necessary. I di-rected the men to rig a tackle and fall, on the main yard, and let down a stout rope with a running noose right over the hatchway. I then mustered all our fire-arms and gave the snake a volley to rouse him. He soon reared his head out of the hold, I dropped the noose over it, the men ran him up, while the mate and I with axes chopped him in two. He was so long, sir, that it took the whole forenoon to haul him out by sections, cut him up, and throw the pieces overboard."

THE ASSYRIAN - A MAN WHO LIKED HIS TIPPLE

By way of introduction, in 1851 Maine was the first state to pass a prohibition law in the United States. The law prohibited the sale of all alcoholic beverages except for "medicinal, mechanical or manufacturing purposes." The Massachusetts legislature passed a "Maine Law" in 1852 but it was struck down a year later by that state's Supreme Court. Two years later, in 1855, the legislature passed a revised prohibitory liquor law to avoid the constitutional flaws of the first law. In this account, the Assyrian (Underwood), found himself in Provincetown, Massachusetts where the law was obeyed, at least on the surface; "medicinal" alcohol, however, was widely available at pharmacies and the Assyrian was not to be deterred from his usual libation.

We found the descendant of Ninus and Semiramis in an unsatisfied state of mind. As we rowed off, he gave us his opinion of Provincetown. The place, he said, was dry and dreary to the last degree, with a very repulsive-looking set of inhabit-ants. After walking about for some



CASTLE HEAD, MOUNT DESERT

time, he ven-tured to inquire of one of the natives for a tavern. The man directed him to an edifice which bore upon its front, in large letters, the words "Union House." He entered, and was accosted by a dentist, the sole occupant, who offered to pull his teeth on moderate terms. On learning, however, what his visitor wanted, the dentist directed him to a neighboring apothecary as the only man in town who kept for sale anything to drink. The Assyrian, in his usual confident way, demanded a cocktail. The apothecary looked at him for some moments with the air of a person who is too much astonished to speak, and then replied, with grave deliberation, "1 do not know what you mean by a cocktail."

The Assyrian, in his turn, stared with astonish-ment. Here was a depth of ignorance hardly credible. At length he intimated that he wanted something to drink. He was offered soda-water, qualified, at his choice, with lemon, strawberry, pineapple, sarsaparilla. He shook his head. Was there nothing else? "Nothing."

A bright idea flashed on the Assyrian. He de-scribed to the apothecary the method of concoct-ing a cocktail. The apothecary listened like one to whom a new science is unfolded. Gradually light dawned upon his mind. He produced, from some dusty shelf, an almost forgotten solitary bot-tle of sherry bitters. The Assyrian seized it with alacrity. In the absence of anything better, cocktails could be made with sherry bitters. The other requisite materials were on board the sloop.

Supper was ready when we got on board. We found the flounder savory, the lobster was boiled enough, and before turning in at nine o'clock we drank with the Assyrian a cocktail of his com-pounding to the speedy enlightenment of Prov-incetown in the knowledge of national beverages.

A TRIP NOT DEVOID OF THRILLS

Soon after passing Dread Ledge, the scene of numerous shipwrecks, the Professor, who was basking in the sunshine on the taffrail of the sloop, watching the medusae floating by, was suddenly startled by the apparition of a large shark within a foot or two of his elbow. The creature was probably attracted by the sight of the Professor's red shirt, for, before starting this morning, we had discarded our shore clothes, and reduced our integuments to panta-loons and red-flannel shirts. The shark remained alongside but for a minute or two, after which he was not seen again.

Just at midnight we were all roused from sleep by a great crash in the cabin. Tumbling out of my berth in a hurry, I found the little sloop tossing and pitching furiously. The table, which ex-tended the whole length of the cabin, and which we had left, on turning in, covered with books, cups, lamps, and miscellaneous articles, had got unfastened, and at length upset by the rolling of the vessel. The Skipper and the Pilot were al-ready on deck, where, by the uproar, it was evident that something was going wrong. Fol-lowing them I learned that the tide was setting strongly up, while a northwest wind was blowing strongly down the bay. The conflict of these two forces produced a rough sea, under the effect *of* which our craft was dragging her anchor and drift mg toward a not very distant reef. The sky was overclouded, and the darkness was relieved only by the intermittent flashes of the revolving-light. The seamen were at work forward trying to pre-vent the vessel from drifting, in which they at length succeeded, though only partially; for the Pilot muttered as he went below, that if the wind did not freshen, he guessed she'd not drift much before daylight.

The temperature lowered very rapidly. There was a gust of rain, and then suddenly we were engulfed in a dense fog, which, however, did not rise high above the surface of the water; for I was struck by the strange appearance in the air of the topmasts of the surrounding vessels, while their hulls were entirely hidden. Gradually the fog turned into rain, and by nightfall the weather was so cold that we were fain to go to bed at dark to keep ourselves warm. The wind was north- east, and blowing pretty hard, and I noticed, be-fore turning in, that the Skipper and the Pilot were busy rigging a large anchor, which we had on deck, but which we had not yet had occasion to use. They predicted that the wind would increase in the night, and, as it was blowing di-rectly into the harbor, we should be likely to need an addition-

PIGEON COVE

al anchor. The old Pilot said that he remembered a north-east storm, many years ago, in which every vessel in the harbor was driven ashore.

The prediction of the seamen was verified. About midnight we were roused by an outcry on deck, and, turning out, found that the wind was blowing almost a gale, and that the sloop, in spite of her additional anchor, was drifting under the impulse of wind and waves directly upon the great black rock which rose from the water a hundred yards southwest of us. She drifted slowly, and we watched her progress with some anxiety. Fortunately, when we were about fifty yards from the frowning rock, our anchors caught in the moorings of another vessel and arrested our dan-gerous progress.

THE PRACTICAL JOKERS

As the Skipper said that this was a good place for fish, we got out our lines while the Pilot was getting dinner. Before we had caught anything the meal was ready, and we went below, leaving our lines in the water, in hopes of finding that some fish had been foolish enough to hook himself during our absence.

It so happened that I was first on deck after dinner. I tried the lines, but found nothing caught. The Assyrian's line was over the stern, and, as the tide was running very fast, he had let it out to its whole length of several hundred feet. I hauled it in to see that it was still baited, and as no one had yet followed me out of the cabin, I was enticed by the opportunity to play the Assyrian a trick. A huge stone jug weighing many pounds, and capable of holding several gallons, stood near me on the deck empty. It was our principal water-jug, and the Skipper had placed it there to have it handy, intending to take it ashore and fill it after he had cleared away the dinner-things. The temptation was irresistible. I quickly tied the end of my friend's line to the handle of the jug, and lowered it overboard. The strong tide swept it far along until it had gurgled full of water, when of course it sank plumb. I returned to my own line, and presently caught a large cod, the sound of whose flapping on deck brought out my comrades with the exception of the Skipper, who remained to put the cabin to rights a little.

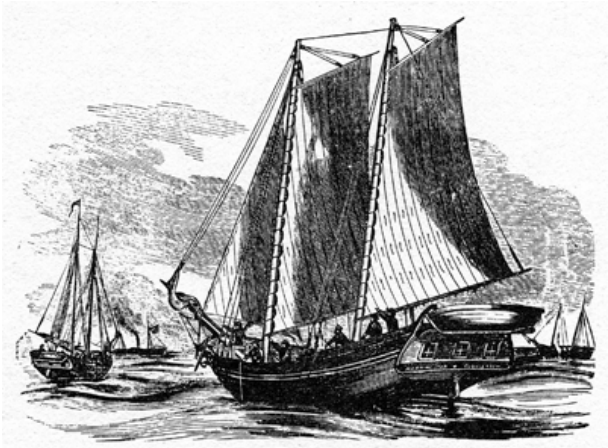
The Assyrian, cigar in mouth, sat down on the taffrail, and gently fingered his line with the air of a man who has had a satisfactory dinner, and does not yet care to exert himself to catch fish for supper. Presently, however, he had a bite, and began languidly to pull up his line. The unusual weight soon made itself felt. The Assyrian grew suddenly excited. He said nothing about halibut, for previous disappointments had made him reticent of expression on that point, but halibut was evidently in his mind, by the gingerly way in which he handled his line, holding it in readiness to yield judiciously in case the monster should suddenly put forth his strength. We gathered round to witness the struggle. The gentleman from Nineveh tugged and tugged, growing gradually more and more astonished at the weight of his capture, and the passive nature of his resistance, for the halibut, as the fishermen often told us, never yields without a desperate and powerful contest. At length his prize reached the surface. Without remark the Assyrian quietly lifted it on board, amid roars of laughter, and as he passed into the cabin to relight his cigar, good-humoredly nodded to me, saying,—

"I'll pay you for that, my boy, before you are much older." He kept his word.

By and by the Skipper put the jug into the boat, and the Assyrian and I went ashore with him to a fisherman's cottage, the only house in sight…

The men of the fisherman's family were away, but there were several women at the house, who received us kindly, and gave us milk and berries. The Assyrian speedily made himself at home with the ladies,—and when I proposed to go to the beach, about two hundred yards from the house, to take an ocean bath, he refused to accompany me, but offered to wait where he was till I came back. The Skipper had gone to his sloop with his jug of water, to invite the Artist and Professor on shore to partake also of milk and berries. So I went alone to the sea, and strolled along the beach till I came to a convenient pile of rocks, out of sight of the house, and took off my clothes, and went in.

The water was awfully cold, though the air was warm,—and being unable to swim, and so not daring to plunge boldly, I endured fearful torture in the heroic efforts to get a thorough bath. A few rods farther along from where I went in, there was a large rock almost covered by the water, to which I determined to go, calculating that by the time I could reach it, and return, I should



COD-FISHING SCHOONERS

have had as much sea-bathing as it was desirable, or, for me, possible to endure.

I reached it easily enough, and after clinging to it for a moment thoroughly chilled, turned to go to the shore.

Conceive my consternation at beholding, as I looked around, a woman approaching along the beach from the direction of the house. A tall, elderly female, wearing a veil, and carrying a parasol. Evidently she was bent on a sea-side stroll. She must have seen me if she had looked in my direction, for the distance that separated us was inconsiderable. But she walked with her eyes cast down, either wrapt in thought, or searching for shells and pebbles, I could not determine which. Nor did it much matter. I was nearly dead with cold, but of course could not quit the shelter of the water while the lady was in sight. If she only kept onward, however slowly, I thought I could hold out, for, thank heaven!, there was a rocky point at no great distance which would conceal her, or rather me, from view as soon as she should pass it. So I crouched behind the rock to which I was clinging, shuddering with anguish as the chill waves rolled in succession over me.

The lady was provokingly slow. She lingered, she stopped, she stooped to examine every shell and every pebble. I grew almost frantic with suffering, and was twenty times on the point of crying out, and warning her off. Still, I trusted she would pass without seeing me, and thought I could endure a little longer.

At length she reached the rocks, among which I had deposited my clothes. She did not notice the garments apparently, but, after pausing for a minute, coolly sat down, and, to my horror and despair, pulled a book from under her shawl, and began to read.

I could stand it no longer. All the tales I had ever heard of persons who had died from staying too long in the water rushed upon my memory. I felt convinced that I was not only blue around the mouth, but blue all over. It seemed as if I had been in the water at least two hours. I should certainly die. But death itself was preferable to this infernal cold, which caused my very bones to ache. Positively I could stand it no longer.

I began by coughing, gently at first, afterward more vigorously. It did no good. She was absorbed in her book, some foolish novel, doubtless,—confound the author! I hemmed, hawed, hooted.

I splashed the water. All to no effect. A horrible thought flashed across me: perhaps she was deaf,—as deaf as Dame Eleanor Spearing. I tried to get a stone from the bottom to throw at her, or rather near her, in hopes of attracting her attention, but found I could not reach bottom without putting my head under water. It suddenly occurred to me that the tide was rising, and that my post would no longer be tenable even if I could stand the cold. That settled the question.

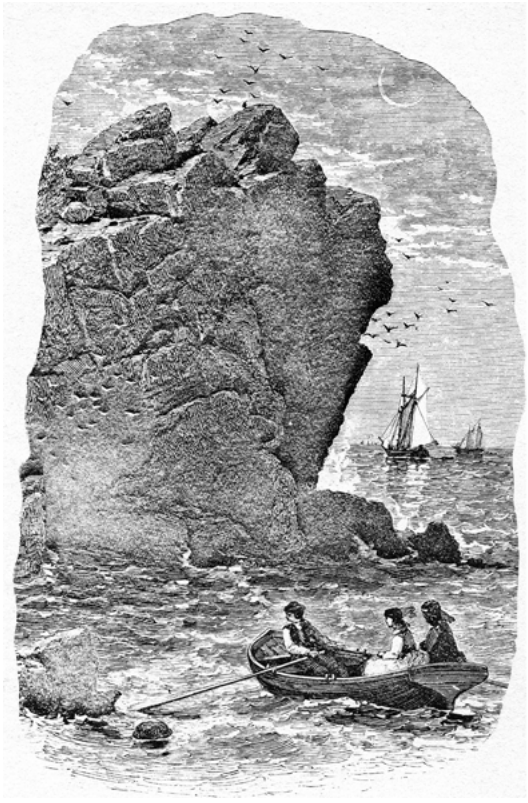
"Hallo! hallo there!" I shouted, with all the force of my lungs.

"Hallo, yourself! What are you making such a row for? Aren't you ashamed to yell at a lady in that way?"

I recognized the voice at the first word, and was beside the speaker before the sentence was finished. Throwing up the veil, which had concealed his features, the Assyrian burst into a laugh, in which, though at first I thought of stoning him, I finally joined. He had persuaded the women at the cottage to lend him his disguise, in order to repay me, as he had promised, for the affair of the jug. I forgave him for the sake of the provocation, though he had put me to direful torture,—but we entered then and there into a compact to desist from such pranks for the future.

CONCLUSION

"A Summer Cruise on the Coast of New-England" is a fascinating read and I recommend it highly. (It can be downloaded free from the Internet.) From it I learned more about William Stimp-



son, the man. I was introduced to Samuel Tufts, Jr., an important historical figure in the aquarium hobby. And finally, I learned that one of the founders (and by many considered to be the most significant) was an aquarist. What a wealth of treasure from a single book! One last excerpt from the very end of Carter's book:

The next day I embarked on the steamer for Rockland and Boston, while the Artist and the Assyrian left the island by way of a bridge, which; at its northern end, connects Mount Desert with the mainland. The Professor and the seamen, after we bade them farewell, hoisted sail with a fair wind for Edgemoggin Reach, and thence back to Portland and Swampscott, where they arrived in due time.

It is related of the Caliph Abdalrahman, the mightiest and most magnificent of the Moorish monarchs of Spain, that he wrote toward the close of his life the following declaration:
"I have now reigned above fifty years in victory or peace; beloved by my subjects, dreaded by my enemies, and respected by my allies. Riches and honors, power and pleasure, have waited on my call, nor does any earthly blessing appear to have been wanting to my felicity. In this situation, I have diligently numbered the days of pure and genuine happiness which have fallen to my lot; they amount to *fourteen. O man I place not thy confidence in this present world!"*

The Caliph Abdalrahman must have been hard to please. For my part, I can confidently say that during our cruise I enjoyed at least twice as many happy days as fell to the lot of his Majesty during his whole reign; and such, I am sure, would be the avowal, on their part, of my friends the Professor, the Artist, and the Assyrian.

PART III: THE ISSUES

CHARLES E. HAMMETT, JR.

In 2007, the husband/wife team of Fred and Juditha Burchsted wrote an article about Samuel Tufts, Jr. titled "Samuel Tufts, Jr. (1817–1902), a Massachusetts shell collector and aquarium stocker" (Burchsted, 2007). The following is their introductory paragraph:

The lives of minor naturalists are poorly documented, yet much of the development of local natural history depended on such individuals. For each prominent naturalist, author or explorer, there were many minor workers who dredged in the town harbor or collected butterflies in local woodlots. A full picture of the history of natural history requires the excavation of the lives of this significant component of the natural history community. These more local naturalists sometimes published their results, but more frequently sent specimens or information to more major figures, often professionals with limited time for fieldwork (Keeney, 1992; Welch, 1998). While a vast literature documents the lives of prominent naturalists, working-class naturalists who collected, published local lists, and explored the natural history of their own localities, are little known.

Barring one exception I agree wholeheartedly; the sentiment should be circulated more widely and more often.

The Burchsted's examination of Tuft's life with regard to his shell collecting activities is par excellence and I recommend it to all interested in the history of marine invertebrates. However, with regard to his aquarium stocker activities they make several serious errors, including the assertions that:

1. Tufts is the only known American aquarium stocker of the 1850s;

Charles E. Hammett, Jr. (1822-1902).

2. Tufts is the only American aquarium stocker of this era whose methods have been recorded;
3. Carter's description of Tufts provides the only known example of the activities of an American aquarium stocker of the 1850s craze.

None of these assertions are true and so we come now to Charles E. Hammett, Jr. (1822-1902), born in Newport, Rhode Island in 1822. A notable resident of the city, in 1844 he started in business as a grocer and two years later he sold out and opened a bookstore. Hammett, besides looking after his book and stationery business, at different times engaged in various other branches such as tuning pianos and sewing machines. For many years he conducted a bookbindery, which gained a reputation for solid and artistic work. At another time he was extensively engaged in the manufacture of envelopes and paper boxes; then in the mounting and framing of pictures; in inventing games and manufacturing them for the trade; in making maps; and in the publishing of books and pamphlets, the translation of some of which from the French and German was done under his direction. Hammett amassed one of the largest libraries in Newport; the published bibliographies of which are owned now by the Newport Historical Society's library collection.

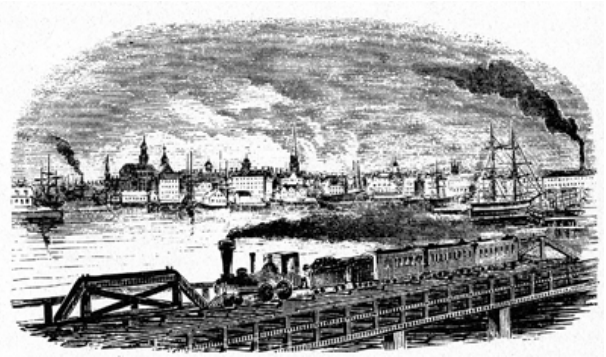
Somewhat of a Renaissance man, to all of these interests Mr. Hammett gave the closest personal attention, and frequently he took a hand in the manual work itself. Mr. Hammett was also identified with the public life of Newport. He was for years a member and chairman of the school committee, he was one of the original members of the park commission, a trustee of the Savings Bank of Newport, a director of the Redwood Library, a trustee of the Newport Hospital and one of the original incorporators of the Newport Historical Society in 1854. Mr. Hammett was the first bookseller in Rhode Island, if not in New England, to employ women as assistants. Added to all this, at one time he was an aquarium stocker.

The following is part of an article that appeared in *Scientific American* in 1857. It was written by Hammett and titled, "The Aquarium or Aqua Vivarium":

My first attempt was with gold fish (*Cyprinus*); but not being able to obtain the proper plants, I stocked a confectioner's glass jar with a few other plants from the sea, and there soon appeared a large number of small animals, which, viewed by lamplight, were very interesting. I have found that very deep and narrow tanks, of various shapes, have not succeeded so well as those having a much greater breadth than depth. The tank which I successfully stocked was of an octagonal form, of thirty inches in diameter and about eight in depth. Excepting the great difficulty of rendering it tight, this tank has succeeded admirably. After being in use for a long time, the rockwork is still covered with vegetation, and crabs, minnows, eels and mollusca still sport and wrangle in the home which they have so long occupied.

The study (for study it is) of Aquaria is yet in its infancy in this country; and we may reasonably hope that when those who are close observers of Nature become interested in this matter, we shall learn much more of the "private life" of the inhabitants of the ocean than we have ever hitherto known. Probably no such facilities for the study of natural history have ever been offered as are now presented by the Aquarium. We have in our rooms, where we may examine it at our leisure, a sort of section of the ocean, whose inhabitants may be examined in their natural abode, and under most favorable circumstances. With such facilities it will be easy to learn more in a few months' observation than we have heretofore been able to learn by years of examination of dead or dying specimens.

Tanks may be made of various forms. The simplest are made of confectioners' jars or any open-mouthed glass vessels. These will answer very well for small specimens; but the best kind, most proper for the fish, and well suited for observation, are those made in a rectangular form, with four glass sides. It has been found very diffi-



PORTSMOUTH

cult to make these permanently tight, and at the same time free from the taint of cement. This has, however, been remedied, I believe, by some of the dealers in tanks, so that they may now be purchased so constructed as to be put into use without fear of leakage.

In a fresh water tank we have no anemones nor hermit crabs; but we have newts, the stickleback which builds its nest beneath the waters, the water beetles, the tadpoles, and numberless others, which fully compensate for the absence of those that are found only in seawater.

The speedy popularity of this piscatorial and botanical "institution" - the Aquarium - is undoubted. All that is needed is to exercise patient perseverance, regular attention, and, above all, perfect cleanliness. No decayed matter, animal or vegetable, must be permitted in the tank. A strict care to not overstock or crowd the animals and a determination to overcome obstacles will insure success; and the Aquarium will become - what it has already become to thousands in Europe - a "new pleasure."

Appended to the article was the following editorial comment:

Mr. Hammett's modesty forbids his intimidating in the above article that he is prepared to furnish Aquaria tanks of superior construction (an improvement of his own) to such persons as may desire to try their skill in raising the pisces, molluscs, and articulates of the mighty ocean, and to derive instruction from serving the life and habits of those curious creatures.

In July 1858, Annie Rebecca Coggeshall – the first female American aquarist of record – wrote her second article on the aquarium (Coggeshall, 1858a). The following is an excerpt:

We trust that many of our readers, stimulated by the account of an Aquarium which was given in our number for February, are proposing to set one up for themselves. The best tanks, so far as we know, that are made in this country, are those of Mr. C.E. Hammett, of Newport, Rhode Island. But the tank is of little importance, if one cannot get the water, the seaweed, and the stock; and therefore Mr. Hammett undertakes to supply these also. He will send, not the water itself, but the salts obtained by evaporation from the quantity of water necessary for each aquarium. These are to be dissolved in clear spring-water, (previously boiled, to insure its containing no injurious living matter,) and then the aquarium, having first had a bed of cleanly-washed sand put upon its bottom for about an inch or an inch and a half in depth, and this in turn covered with a thin layer of small pebbles - though these last are not essential - is to be filled with it. Then the seaweed, which is sent so packed as to preserve

Hammett's book store, circa 1898.
Hammett is standing outside in the photograph.

its freshness, is to be put in. It will be attached to small bits of rock, and these should be supported by or laid upon other pieces of stone, so raised as to secure a free passage for the water about them, and so afford places of retreat for the animals. The stock will be sent, if it is to go to any distance, in jars, and anemones, crabs, shell-fish of various kinds, and many other creatures, will be found among it.

The *Bulletin of the Newport Historical Society* provides us with a more intimate view of Hammett's aquarium activities (Powel, 1915):

True, we were finally only wedged and taken to see Mrs. Berry's pretty little aquarium after our woes were ended, and the descent from Avernus was not so bad, while the tall, black haired, rather sad gentleman dismissed us from the top of the stairs.

That little aquarium of Mrs. Berry's came from the maker or inventor of improved aquariums in the United States, a member of this Society who long outlived its foundation, and who contributed to local literature one of the most practical, wise compilations ever made in the City of Newport—Mr. Charles E. Hammett and his "Bibliography" [the reference here is to Hammett's "A Contribution to the Bibliography and Literature of Newport, R.I., 1887]. My first remembrance of Mr. Hammett—owing to the greater attractions of the sealing-wax, wafers, pens and pencils, and ruled paper, including also unattractive school books of Mr. Barber, the bookseller—was not in the Main Street, but energetically finishing, with his own bands, the interior of a gigantic sea-water aquarium that he had been requested to provide and construct for the Academy of Natural Sciences in Philadelphia, a great honor indeed.

Well, the iron-framed aquarium was being set up in state, in a large library room near a window, a dusty one too, on the rear lower floor, a curtain or blind was going up, (and the sea-water was coming in casks from Cape May) and Mr. Hammett was daubing putty or something here, there and everywhere within the glass box. A lot of my father's scientific friends passed in and out, quite curious. Sometimes Mr. Hammett, on his knees, peered over the top—the tank was about six or seven feet long and half as high—and asked for something, and every one scurried to help.

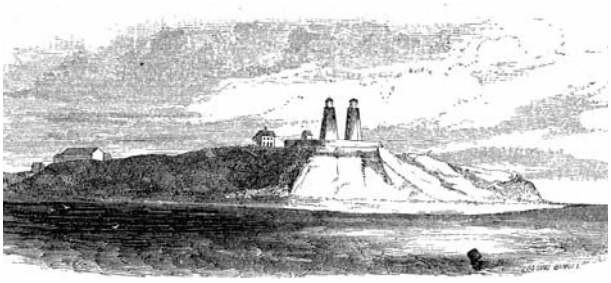
Now my father so often said that Mr. Charles Hammett had one of the most classic cameo-like heads that he had ever seen, that fox years after, when I saw Mr. Hammett moving to and fro, within the oval counter formerly in his book store, I privately considered him "Neptune, the God of the Sea." Did any one ask Mr. Hammett about any book that he did not know of or any topic for which he could not advise a good one?

The aquarium Hammett was building for the Philadelphia Academy of Natural Sciences was commissioned in March 2, 1858 and this is probably the year Powel is writing about. If Powel's reminiscences are accurate, the tank must have been somewhere in the area of 100 gallons, assuming the width was half the height. It is interesting to note that Arthur Mead Edwards - the author of the first aquarium book published in the United States – also commented on Hammett's tanks (Mead, 1867): **By far the best aquaria I ever saw were made by the well-known publisher, C.E. Hammett, of Newport, R.I.**

Lastly, here are some details - with an amusing commentary - of Hammett's aquarium business (Smith, 1859):

Aquaria.—Mr. Charles E. Hammet [sic] makes and furnishes Aquaria at Newport, R. I. His agent in Philadelphia is J. W. Queen, 924 Chestnut Street. It is rather amusing to read his list of prices of the living contents: Green weeds are 10 to 12 cents each; Sea Anemones, (Actinia) 12 to 75 cents; Star Fish 12; Serpula 12; Crustacea 12 to 37; Molluscs 12 cents to $4.50 per doz.; Fish 6 to 50 cents each: all "according to kinds and quality." All appliances are to be had: as, net on copper wire with handle, 25 cents; copper hook on handle for arranging objects, 12 cents; spoon on handle for removing objects, 20 cents; real sea water, per gallon, 10 cents, and so forth. Soldier Crabs, King Crabs, Flat Fish and Sticklebacks, with "small Sheep's Head," and "small Lobsters," at "reasonable prices." It must be a novel feeling to those long neglected marine wonders to find themselves in "a lady's parlor," and the pets of a fire-side. At best it is only a little to be preferred, some experiences prove, to being boiled at once, for want of proper care.

Hammett was in an ideal location for providing both marine and freshwater animals and plants. S. Jacob, who had an aquarium stocking business in Newport a quarter century after Hammett got out of the business, wrote (Jacob, 1886): **Say about what**



you want and I will guarantee you satisfaction, having the Atlantic Ocean at my front door-step and the Narragansett River at my back door.

Annie Coggeshall knew Hammett well. She was born in 1819 in Newport and lived in that city when Hammett also lived there. Her father was David M. Coggeshall (1772-1847), a banker who was a trustee of the Long Wharf Public School and a benefactor of the Redwood Library, both of Newport. After her father died she moved into a house owned by her cousin, Mary A. Coggeshall. Annie (named after her mother) was a school teacher while Mary managed the home; they remained together, unmarried, for many years until Mary died in 1894. Annie died just three years later, in 1897. In addition to the previous article cited, Hammett was also mentioned in an article she wrote about Aquidneck Island: (Coggeshall, 1858b):

By following the advice of some experienced person, you may avoid all those failures which are apt to attend the experiments of a tyro. I will direct you to our pioneer in aquarian science, Mr. Charles E. Hammett. He can furnish you with all you want, give you most efficient aid, and add thereto a great amount of practical information.

Hammett undoubtedly provided Coggeshall with a great deal of information on the maintenance of fish and other animals in the aquarium and most likely introduced her to the hobby.

With regard to Samuel Tufts, Jr., Carter remarked that **"For a year or two past [Tufts] had devoted himself to collecting and selling materials for stocking aquariums."** This means that Tufts was definitely in the business in 1857 but not for certain in 1856. However, clearly the same can be said for Hammett. The Burchsteds (Burchsted & Burchsted, 2007) mistakenly claim that **"...Tufts is the only American aquarium stocker of the 1850s,"** overlooking the fact that Charles E. Hammett was in the business at the same time as Tufts.

When one is deciding who was first for something, that something ought to be clearly defined, in this case what is meant by "aquarium stocker." My definition is: "One who supplies aquariums, aquarium equipment and live animals, including fish, to the public." Using this definition, Hammett is definitely the first aquarium stocker; all we know about Tufts is that he supplied "sea-water… sea-weeds and "animals."

Finally, it should be noted that pinning down "firsts" is a perilous endeavor. One may assert that so-and-so was the first on record for doing something, only to have another researcher later uncover an earlier reference that shows someone else preceded him or her. Caveat, lector!

ISABELLA JAMES

Isabella Batchelder was born in 1819 in New Ipswich, New Hampshire, four months after Queen Victoria's birth. James died a few months after the Queen, and thus lived through the whole Victorian era. Her grandfather, Samuel Batchelder, was a Minute-man and rode with his father, Jonathan Batchelder, from their home at Riall Side, Beverly to Lexington on the Alarm, April 18, 1775. Her father was a wealthy industrialist, known as the "Nestor of cotton manufacturing," Isabella was a member of the upper middle class and was tutored

Isabella Batchelder James (1819-1901)

privately. Consequently, she knew almost everyone of importance in the literary and artistic fields of the time. As Isabella recalls,

In 1824 I went to Concord, New Hampshire, to the house of my Aunt West, as my mother was to have her portrait painted by Morse, afterwards the inventor of the electric telegraph. He was then thought to be an excellent portrait painter, his execution was very fine, and delicate, and is now considered too much so for effective work in oils. I was allowed to run about the room at my pleasure and Morse would let me watch his work, which seemed to be wonderful as I saw the face growing upon the canvas. The likeness was good, excepting the mouth, and Morse promised to improve that at some future day as he did not consider the picture finished. He was called away to paint, for New York City, I think, a portrait of Lafayette, who had just arrived in this country on his last visit to the scene of his early labours.

In 1851 she was married to Thomas Potts James, a botanist of some standing. In her writings, therefore, she afterwards signed them "Isabella James." James died in 1901 at the age of 82.

In their bibliography, the Burchsteds list Isabella James' article in the *North American Review* of July 1858 as "Anonymous." This is unfortunate as Isabella James was the first authoritative writer of record on aquarium matters, besting David Cheever by three years.

The information that William Stimpson kept aquaria as early as 1849 appeared almost simultaneously in July of 1858 in the writings of James and Carter. Although Carter's account was somewhat briefer, his description was similar to that of James, even down to the misspelling of Warington's name as "Warrington." It is clear that Carter's information came directly from Stimpson; where then did James obtain hers?

It is unlikely that James obtained it from Stimpson for three reasons:

1. They never were in proximity at the same time;
2. They circulated in entirely different social circles;
3. They had no interests in common.

Regarding the last, James' interests were primarily in botany and early American history; Stimpson's was primarily in marine invertebrates. How then did she come to write her article on the aquarium? Was it because she knew Robert Carter?

As it turns out, James and Carter were in proximity at the same time, they circulated in the same social circles and they held interests in common.

Isabella James first met James Russell Lowell in 1841, just after he had graduated from Harvard Law School. Over the years they became close acquaintances, to the point where she called him "Jim." The following are excerpts from her reminiscences of Lowell (James, 1937):

I have been reading the biographical sketches of Russell Lowell, as he is now called, but who was when I was so well acquainted with him, familiarly known as Jim Lowell. So many errors have crept into the press that I am tempted to set some of them right. He was a few months my senior and we both belonged to the same "set" in the university town of Cambridge, Massachusetts, to which I went as a young lady.

The circle in which he moved was what Cabot Lodge has styled "respectable Boston." Nathan Hale, Senior, at whose house I so often met him, was the editor of the "respectable Daily" otherwise the *Boston Advertiser*.

Many a pleasant evening can I recall when Lowell and W. W. Story, now the celebrated sculptor, displayed their histrionic talent in the then fashionable game of "Charades" in which they both excelled, while "Questions and Answers" brought out to perfection Lowell's powers of brilliant repartee.

After Isabella James was married, she and her husband moved to Brattle St., Cambridge where they lived with her father, Samuel Batchelder, who was well-known to the members of Lowell's whist club (Holmes, 1917) James also knew John Holmes quite well. In the 1870s, she was the chairman of the Organization of the Ladies' Centennial Committee of Cambridge, Massachusetts, a group that oversaw the publication of an account of Cambridge as it was in 1776 (Gilman, 1876). Not only was James one of the contributors, Holmes was also.

Like Carter, Isabella James was an abolitionist. She worked during the American Civil War for the United States Sanitary Commission, a private relief agency created by federal legislation in 1861 to support sick and wounded soldiers of the U.S. Army. During the war she visited military hospitals and afterwards served as president of the Pennsylvania branch of the Freedman Commission of the Protestant Episcopal Church, which sent teachers to the South to open schools for former slaves.

As I mentioned at the beginning of this monograph, in 1841 Robert Carter went to Boston where he formed a lifelong friendship with James Russell Lowell, and together they began *The Pioneer, a Literary and Critical Magazine*. Indeed, Lowell called him "his true friend and brother" (Hale, 1899) and was affectionately dubbed by him in the Whist Club as "the Don" (Underwood, 1893). There is no doubt that through Lowell, James and Carter were known to each other as more than just passing acquaintances. They all shared similar views and met frequently, and held this close association over the course of many years.

Because of his interest in the aquarium, it is understandable that Carter was the one who persuaded James to write a paper about it, passing on to her all of his information he had about William Stimpson.

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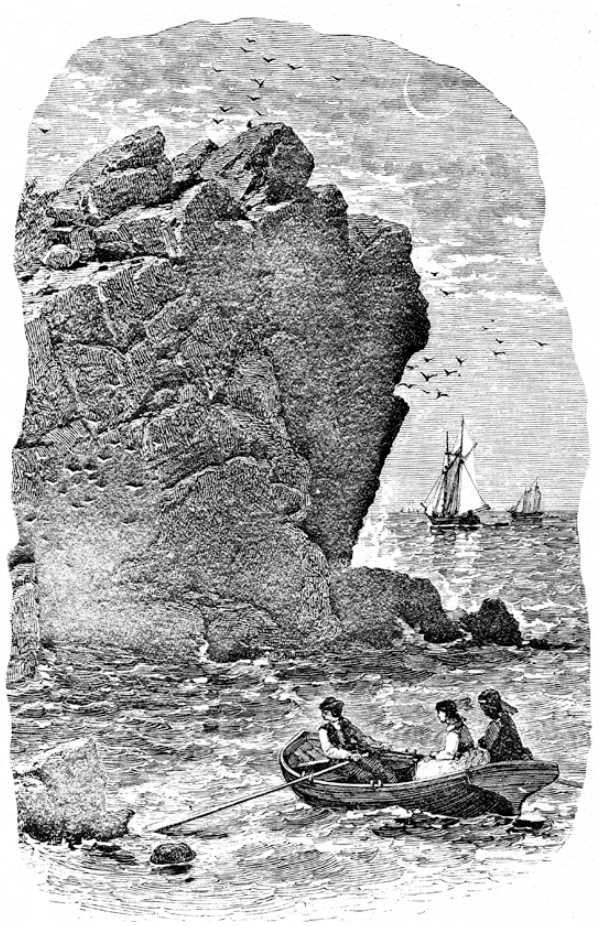

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THE NORTH AMERICAN REVIEW

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Message 12530, September 14, 2014)

One of the magazines that gave me much trouble when researching aquarium hobby history was the *North American Review* (NAR). The publication was founded in Boston in 1815 by its first editor, William Tudor (1779-1830) and other members of the Anthology Club (or Anthology Society). The club was organized in 1804 in Boston, Massachusetts by the Rev. William Emerson, father of Ralph Waldo Emerson. It was their intention to rival the leading British magazines and until the *Atlantic Monthly* was founded in 1857, the NAR was perhaps the foremost magazine in the US.

The collection of issues can be searched via key words and when I entered "aquarium" I was led to the following article that began:

ART. VI.— 1. The Aquarium, an Unveiling of the Wonders of the Deep Sea. By Philip Henry Gosse, A. L. S., etc. London: John Van Voorst. 1855.

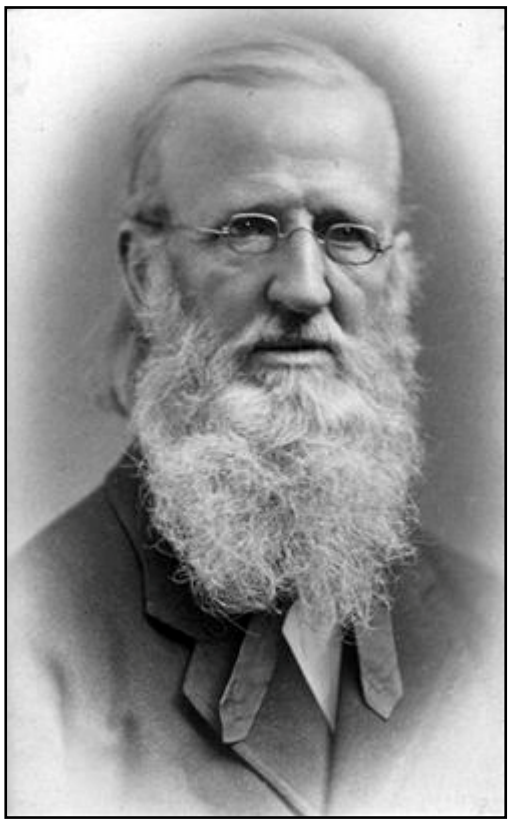
2. The Book of the Aquarium and Water Cabinet. By Shirley Hibberd. London: Groombridge and Sons. 1856.

There was, however, no author. As it turned out, the first seventy-seven volumes were published anonymously, and this included both authors and editors. The editors were selected by a committee of advisers and by design remained anonymous while acting as editor. All reviewers also remained anonymous. However, the names and affiliations of the authors of submitted manuscripts were known to the editor, but were not known by the external reviewers during the review process. By this policy the NAR hoped to avoid selection bias in the submission process, to limit any actual and or perceived bias in the review process, and to test the premise that quality submissions can be drawn to the NAR journals without relying on the identity and affiliation of the journal's editor and or reviewers.

In short, the NAR was sadly in need of a thorough index. Fortunately, such an index was prepared by William Cushing. He was born in Massachusetts in 1811, graduated from Harvard in 1832 and entered the divinity school there in 1839. He preached until 1857 when he removed to a farm in Clinton, Massachusetts. He went back to Cambridge in 1868 and became an assistant librarian at the Harvard library. He left in 1878 and thereafter engaged in literary pursuits. His published works include "Index to the North American Review" (1878), "Index to the Christian Examiner" (1879), "Initials and Pseudonyms" (1885-1888), and "Anonyms, a Dictionary of Revealed Authorship (1889)." Cushing's scholarship was not only invaluable, it was nothing short of amazing. Cushing died in 1895.

In the introduction to his Index, Cushing writes:

The fullest sources of information, in regard to the past and present writers, have been opened to me by the past



William Cushing (1811-1895)

and present editors, by the late and present publishers. I am able to furnish the names of the writers of nearly all the principal articles; and of nearly all the critical notices, except during the editorship of Dr. Palfrey, who is too infirm to give me any information. Note: John Gorham Palfrey was editor from July 1836 to January 1843.

Thus, using Cushing's Index I was able to identify Isabella James as the author of the article in question.

However, as readers of the *North American Review* know, the books placed at the head of an article serve often, like the preacher's text, merely to suggest the subject of the article. In this case it appeared that the article was simply a review of books by Gosse and Hibbert. The article actually contains little mention of these two books save for a quotation or two. The article is actually a tour de force on the principles of and the practical aspects of establishing and maintaining an aquarium. For example, at one point James observes:

There is one important fact which all aquarians must learn sooner or later, though they may not at first know the scientific reason for it, and will perhaps refer their success to mere chance. The pleasant writer of My Aquarium, in the Atlantic Monthly, does not appear to know why her third attempt succeeded after two failures, although the fact of the presence of the Infusoria is distinctly stated. If we will only learn of nature, each stagnant pool in our country-walks may teach us that these lower forms of life are the scavengers of the water.

The reference here is to Annie Rebecca Coggeshall's article in the February 1958 issue of *The Atlantic Monthly*; James had explained the problem in a previous paragraph:

Sea-water contains the spores of plants, and the germs of many forms of animal life, which may have development in the tank; and when these births occur, it is a special gratification to the possessor. But such germs may also decay and cause putrescence; and if a tank is neglected, the water is liable to get cloudy, the stones black, the sides of the vessel semi-opaque, and the animals diseased.

James, who had a serious interest in botany, also took issue with Gosse:

We cannot agree with Mr. Gosse in his opinion, that the vegetable kingdom is an appendage to the aquarium which must be tolerated on account of its use. To the eye of most persons, the soft green of the Ulva, and the delicate crimson tracery of the Dasya and Delesseria, are quite as beautiful as the fishes and mollusks which sport under their branches. A taste for gathering and arranging these lovely forms of nature has been prevalent of late years, and no one can deny that, when the delicate fronds of the sea-weeds are expanded and fastened upon paper, they form a more exquisite picture than any which the hand of man can make. Why, then, should we not admire them even more, spread out in their native element, where the grouping of graceful forms is more striking than that of the terrestrial flora?

Cushing's Index is in two parts: (1) Given the reference, the author is listed and (2) Given the author, his or her articles are listed. Using the latter I found that James had written five articles for the NAR (listed here in bibliographic citation form):

James, Isabella, "Darlington's Memorials of Bartram," *North American Review*, Volume 70, Issue 146, January 1850.
James, Isabella, "Michaux's North American Sylva," *North American Review*, Volume 86, Issue 179, April 1858.
James, Isabella, "The Aquarium," *North American Review*, Volume 87, Issue 180, July 1858.
James, Isabella, "Gray's Botanical Text-Books," *North American Review*, Volume 87, Issue 181, October 1858.
James, Isabella, "Prince Gallitzin," *North American Review*, Volume 88, Issue 183, April 1859.

As I have mentioned, Isabella James was not only deeply interested in botany, she helped Darlington with his illustrations when he was writing his book on John Bartram. Furthermore, at the time she was writing these articles she was corresponding with or married to Thomas Potts James, a botanist noted as the "Father of North American Bryology." The following is from "A Biographical Sketch of Thomas Potts James," by J. T. Rothroch, read before the American Philosophical Society on May 19, 1882:

"In December 1851, he married Isabella Batchelder. This most fortunate union was the result of an acquaintance which began but fifteen months before, and which grew out of a correspondence between Dr. Darlington, Miss Batchelder, Mr. James, and Dr. Gray, relative to the publication of the letters of John Bartram. For more than thirty years Mr. James found in his wife a sympathy in all his work, and a cultured mind capable of appreciating and aiding in his own literary labor."

In Meehan's Monthly of October 1901, her obituary includes the following:

Mrs. James was also a botanist of rare accomplishments. In knowledge of mosses, she ranked among the leading American authorities; and, though of an unpretentious, modest disposition, had an extensive correspondence with those who were desirous of learning all about these beautiful plants.

In the Library of the Gray Herbarium there is a polished manuscript by Isabella James containing biographical descriptions of botanists, generally 1 to 3 pages on large sheets. It was intended to be accompanied by portraits, autographs and flowers, but only a few pressed plants bearing the names of botanists are with the present manuscript. James' biographies were intended to be a "Flora's Valhalla." For each botanist there was to be a biographical sketch, a portrait or view of birthplace or residence, a figure of a plant dedicated to the botanist and a facsimile of an autograph letter. She started this collection in 1850 and worked on it for some years. According to a preface written by her in 1860, she "had to do a lot of research to assemble the biographies."

Since three of the five articles are about botany, this is further evidence that Cushing's information can be relied upon. In the criticism of Gosse's comments on plants, the author of the aquarium article demonstrated a knowledge of marine botany that was absent in the popular magazines of the time. Isabella James, however, did have that knowledge.

James wrote for a number of different magazines and I cite the following:

James, Isabella, "Trees and Pleasure Grounds in Pennsylvania, *The Horticulturist*, vol. 5, no. 6 pp. 251-255, December 1850.

James, Isabella, "Our American Silva," *The American Exchange and Review*, in 12 parts from Vol. VI, No. 6, p. 376, February 1865 to Vol. VIII, No. 6, p. 405, February 1866.

James, Isabella, "American Forests," *Lippincott's Magazine,* Vol. 1, pp. 596-602, June 1868.

It is interesting to note that both *The Horticulturist* and *The American Exchange and Review* followed the policy of not identifying their authors (*The Horticulturist* attributed her article to "A Massachusetts Subscriber," although the editor did give part of the game away by his comment, "We thank our fair correspondent for making so fine a specimen of ornamental planting known to us." However, by the time wrote her article for *Lippincott's Magazine* in 1868, the practice was falling into disfavor and she was acknowledged as its author. Her series of 12 articles in *The American Exchange and Review* was a tour de force in that she practically wrote over half of the magazine published from February 1865 through February 1866.

I have read all of the 19 articles I have cited in this monograph and have come to recognize her writing style down to its nuances and do not hesitate in claiming that she, indeed, was the author of "The Aquarium" article.

Lastly, it is interesting to note that in Cameron's book on Thoreau's readings (Cameron, Kenneth Walter, "Henry Thoreau's Reading, A Supplement with Areas for Fresh Explorations," Transcendental Books, Hartford, CT, 1991), his entry for the aquarium article in the year 1858 does not list the author as "Anonymous" but as "Isabella James." In my view, therefore, "James should be credited with authorship of the aquarium article directly, not buried in a footnote.[1]

[1]Cushing consulted Francis Bowen to determine that Isabella James was the author of the 1850 article, and Andrew Peabody for the other four articles. The editors of the NAR most assuredly knew who their authors were.

FRANCIS BOWEN (1811-1890)
NINTH EDITOR OF THE REVIEW

The successor of John Gorham Palfrey to the editorship of the *North American Review* was Francis Bowen, who became the ninth editor, and also the proprietor in January, 1843. The outstanding feature of his successful connection with this publication was the fact that during the ten years of his editorship he contributed more than a fourth of the articles in the periodical. He was born at Charlestown, Massachusetts, September 8, 1811, and was educated at Phillips Exeter Academy and at Harvard College, where he graduated in 1833. Two years later he was invited by the University to become instructor in intellectual philosophy, a position he held until 1839, when he resigned in order to have leisure for travel and study in Europe. He lived some time in Paris, where he met the distinguished scholars of the day.

ANDREW PRESTON PEABODY (1811 - 1893)
TENTH EDITOR OF THE REVIEW

Andrew Preston Peabody was an American clergyman and author. Born in Beverly, Massachusetts, Peabody was descended from Lieut. Francis Peabody of St. Albans, who immigrated to Massachusetts in 1635. He learned to read before he was three years old, entered Harvard College at the age of twelve, and graduated in 1826, the youngest graduate of Harvard with the single exception of Paul Dudley (class of 1690). In 1833 Peabody became assistant pastor of the South Parish (Unitarian) of Portsmouth, New Hampshire; the senior pastor died before Peabody had been preaching a month, and he succeeded to the charge of the church, which he held until 1860. In 1853 to 1863 he was proprietor and editor of the *North American Review*. Peabody was preacher to Harvard University and the Plummer professor of Christian morals from 1860 to 1881, and was professor emeritus from 1881 until his death in Boston, Massachusetts, shortly before his 82nd birthday.

POSTSCRIPT

The last publisher of *North American Review* during its initial run was Joseph Hilton Smyth, who purchased the publication in September 1938. Within a couple of years Smyth also purchased *Living Age, Current History* and *The Saturday Review of Literature*.

From the September 14, 1942 issue of *Time Magazine*:

One of the mysteries of contemporary publishing has been a cadaverous onetime pulp writer named Joseph Hilton Smyth...Last week the FBI solved the mystery. Publisher Smyth, arrested with two cronies, pleaded guilty to charges that he got $125,000 from the Japs in four years, paid by Manhattan's Japanese Vice Consul Shintaro Fukushima. The down payment on June 21, 1938, was $15,000.

It turns out that between the initial 1938 payment and December 1941 the Japanese government had paid out over $125,000 to Smyth and associates to establish or buy publications for the purpose of spreading Japanese propaganda. Again, from the same issue of *Time*:

Thereupon Living Age promptly denounced the Open Door as a perfidious British invention, sugared Jap aggression, pooh-poohed the U.S. stakes in the Far East." The article closes "If convicted the three face ten years in jail, a $10,000 fine, or both.

In its October 1942 issue, *Current History* maintained that Smyth during the months that he held an ownership interest in the publication did not control editorial policies. He pleaded guilty and in November of 1942 was sentenced to seven years in

Joseph Hilton Smyth (1901-1972)

Federal prison, the judge commenting that if the crime had been committed after the outbreak of war he would have imposed the maximum sentence of ten years in jail and a fine of $10,000. After his release Smyth returned to writing spy novels and other pulp fiction under the shortened name of Joseph Hilton.

In 1943, Alan Hynd wrote "Betrayal From the East: The Inside Story of Japanese Spies in America" (Robert M. McBride and Co., New York, 287 pages, 1943). The following is from a review of the book that appeared in *The Pittsburg Courier*, Saturday January 8, 1944:

A noteworthy tribute is paid to Negro Americans in an account of the activities of Joseph Hilton Smyth, Irvine Harvey Williams and Walker Grey Matheson and the Tokyo -financed propagandist publication, The Living Age.

Writes Mr. Hynd: "In the meantime Smyth had also organized a Negro news syndicate to service Negro papers throughout the country. This came to light when the FBI received complaints from Negro newspaper editors that Smyth's service contained Japanese propaganda. When the FBI looked into some of the columns that had been emanating from Smyth's service they saw something far more dangerous than had yet appeared in the columns of The Living Age. The material that Smyth was writing would have, had the astute editors not seen through it and refused to publish it, sown the seeds of discord among Negro readers and probably produced race riots like those in June 1943. Smyth's columns openly praised Japan and stated that the Negros were getting a raw deal from the United States. It was further indicated, if one read when Japan would rule the world."

In 1945 the book was made into a movie starring Lee Tracy and Nancy Kelly.

THE EARLY HISTORY OF THE MANATEES OF THE NEW YORK AQUARIUM:

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, January 10, 2015)

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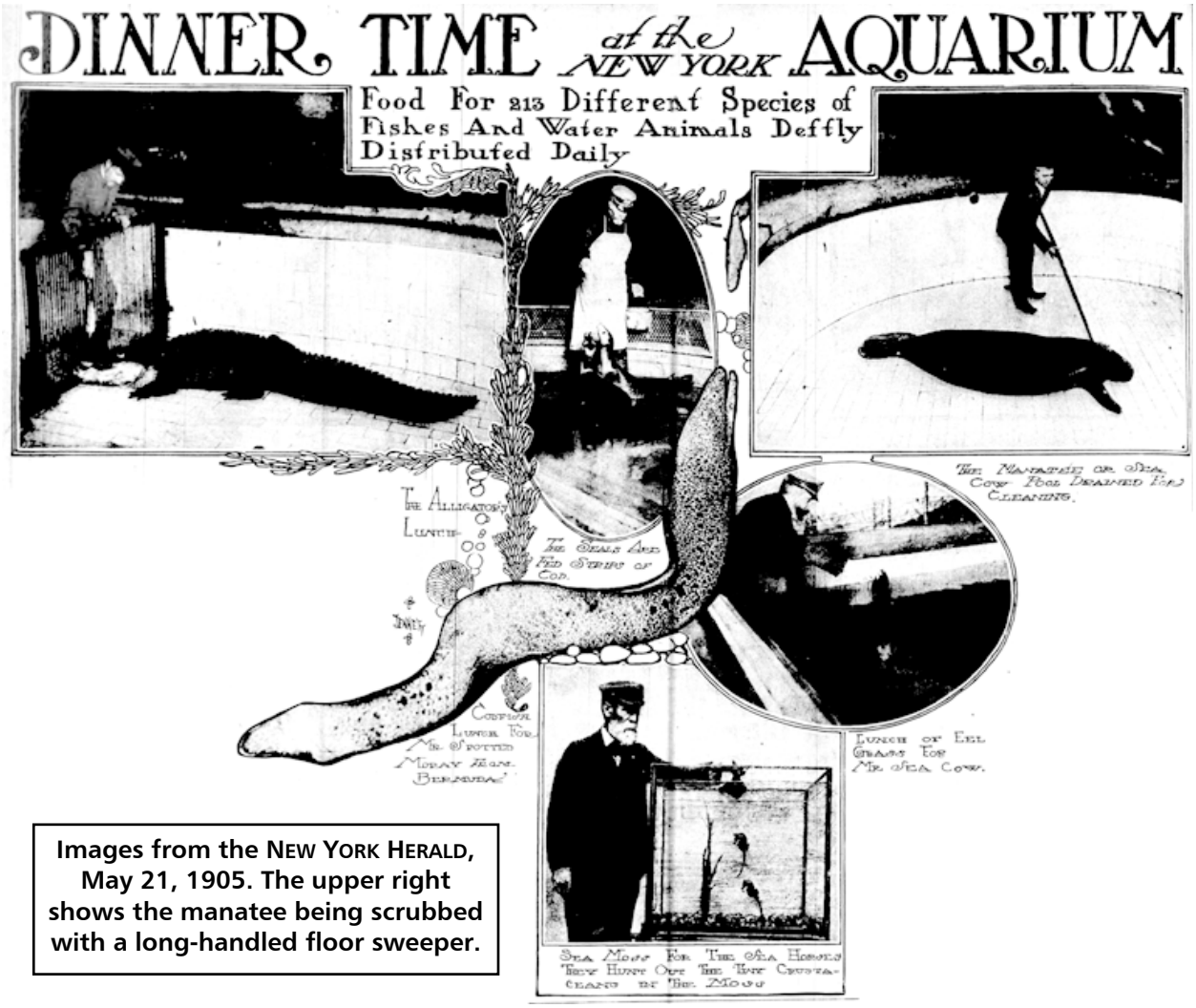

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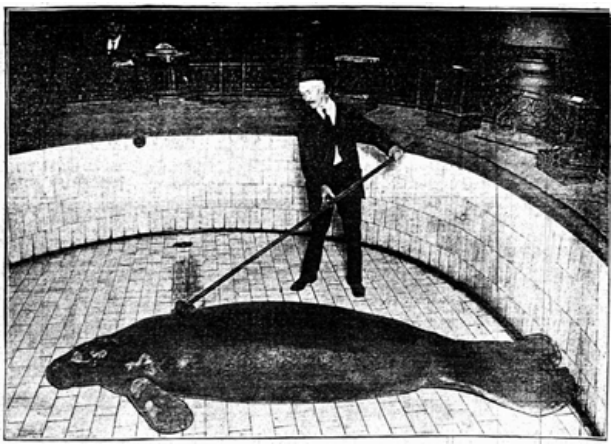

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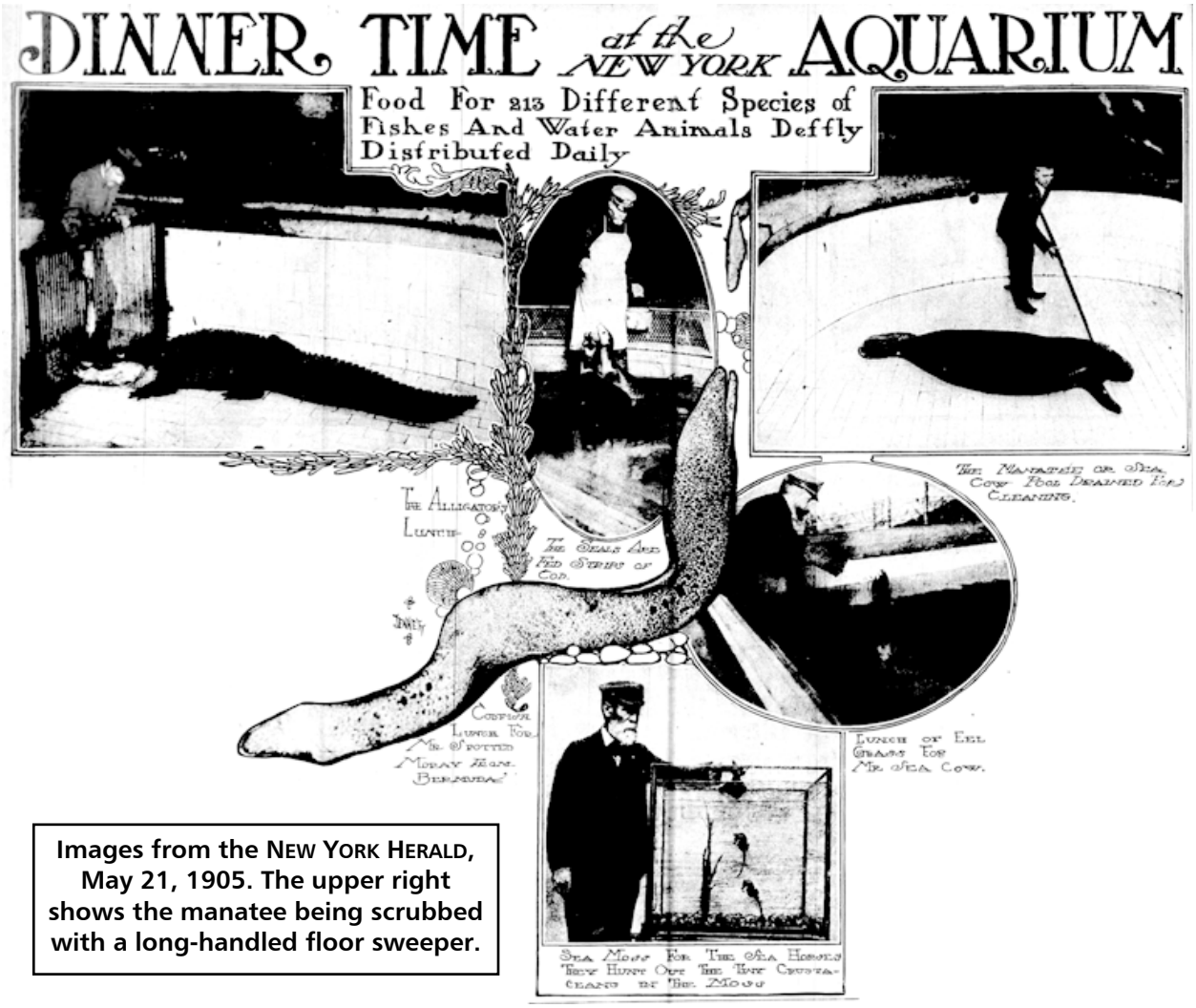

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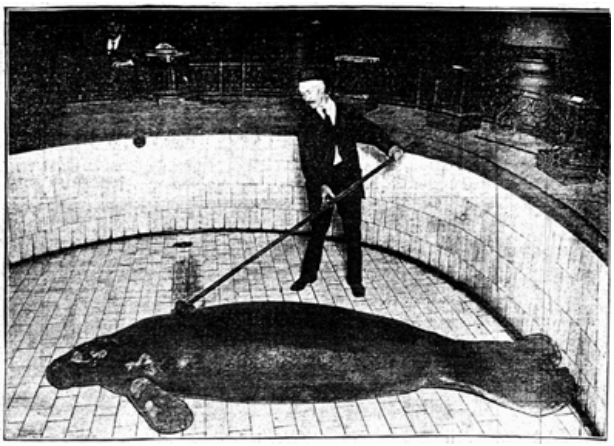

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ago last Monday she was taken at once to the Aquarium and put in one of the biggest of the marble-lined pools in the building. It was while feeding her that an employee noticed the hole in her back. The officials of the New York Zoological Society were promptly notified, and three doctors hurried down from the Bronx to perform an operation. The manatee was manacled, and nearly a foot underneath the outer hide the doctors found a .38-calibre rifle bullet. The wound was cleaned and everybody thought that the worst was over,

Wednesday morning, however, when the man who had the job of feeding the sea cow went to her pool he noticed that she was ill. The doctors were summoned and the illness was diagnosed as blood poisoning. Everything that could be thought of to relieve the manatee was done, but it was of no use, and the sea cow grew rapidly worse. At 1 o'clock yesterday morning she sank into a coma, from which it was impossible to rouse her. Three hours later she died.

Although the exact price paid for the manatee has never been made public, no one connected with the Aquarium has ever denied that the report that it was in excess of $3,000 was wrong. As she was on exhibition not quite eight days, the sea cow, therefore, cost the City of New York about $375 a day. The hide of the sea cow will be mounted and presented to the Museum of Natural History. Whether the Aquarium will buy another is not known, but if one is procured it is certain that it will not have a bullet hole in its back if the Aquarium can help it.

The article was quite critical of the Aquarium, raising the issues of why the purchasing agent did not discover the hole in the manatee's back and especially that of the high price paid for the animal, which was quite a lot for 1906, i.e., the equivalent of about $65,000 today.

As it turned out, the $3,000 amount mentioned in the article was not true and the Director of the Aquarium, Charles H. Townsend replied in the August 11, 1906 edition of the NEW YORK TIMES:

THE AQUARIUM'S SEA COW.

It Was Presented to the City by Mr. Dimock, Who Didn't Pay Any $3,000.

To the Editor of the New York Times:
Will you have the kindness to correct an error which has been making the rounds of the newspapers to the effect that the large sea cow which has just died at the Aquarium cost $3,000. As a matter of fact, the animal cost the city nothing. It was presented by Mr. A. Dimock of Marco, Fla., and was transported to New York by the Florida East Coast Railway Company and the Clyde Steamship Company absolutely free of charge.

I think you will agree with me that it is not quite fair to Mr. Dimock and the officers of the transportation companies who have been so generous to allow the report to become current that it was purchased.

As the usual price of a Florida sea cow (or manatee) is $100, the statement that this specimen cost the city $3,000 is somewhat of a reflection on the judgment of those who purchase for the Aquarium.

The animal was very large and. heavy, and died from injuries probably received during capture. It was 10 feet 4 inches long and weighed 910 pounds. The specimen has been turned over to the American Museum of Natural History in Mr. Dimock's name.
C. H. TOWNSEND.
Director of the Aquarium.
New York, Aug., 10, 1006.

This brings us now to Mr. Dimock. A.W. (Anthony Weston) Dimock was born on August 27, 1842 in Yarmouth, Nova Scotia, Canada. Dimock was a Wall Street speculator in the 1870s-80s and at age 23 had dominated the gold market. He was also a steamship line owner, sportsman and early promoter of Florida game fishing. After an astonishing career on Wall Street, Dimock retired and became an author, writing adventure books for boys (Dick among the lumber-jacks, 1910, Dick among the miners, 1913) and magazine articles about outdoor life and nature subjects (Book of the tarpon, 1911, Florida enchantments, 1926). His autobiography, "Wall Street & the Wilds" (1915) is a fascinating read and is available on the Internet as a free download. Dimock died on September 13, 1918.

In 1887 Dimock began photographing wild life in earnest when in the winter and spring he exposed several hundred 5x8 dry plates in the Florida wilds and on the west coast where he had close

encounters with bears and other animals. With regard to Florida, Dimock wrote:

> **I pictured birds of many kinds, on their nests and in flocks, soaring in the air like osprey and man-o'-war hawks, diving for their prey like pelicans or stalking it in the shallows like the great white heron. The roll of the porpoise, or dolphin, and the head of loggerhead and green turtle as they came to the surface to breathe were caught by the camera. The cottonmouth coiled among the mangroves as well as the slow-growing oysters on their branches became food for the camera. The leap of the tarpon, the struggles of the stricken sawfish, and the wing tips of the sportive devil fish as they played above the surface were reproduced on the sensitive plate.**

On September 12th, 1893, Dimock entered the Hunter's Cabin of the Chicago Exposition, where a hunter was exhibiting photographs of wild animals. He was addressing a group of visitors and as Dimock approached him the speaker said:

> **I was the first to take photographs of wild animals in their native surroundings," then pausing a moment and extending his hand toward me he continued, "excepting that man whom I met years ago in the Rockies and again in Florida engaged in the same work.**

Dimock also wrote about the manatees he caught for the Aquarium:

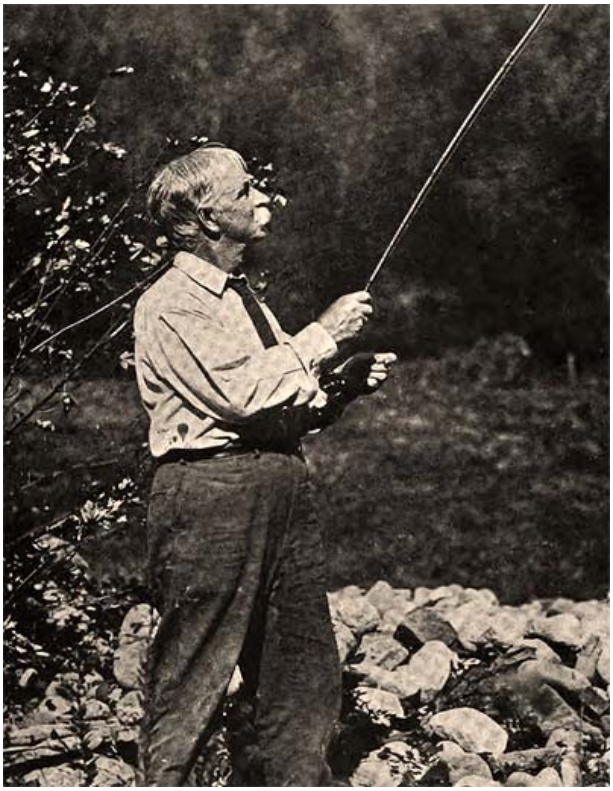
> **We captured manatees for the New York Aquarium and caught crocodiles and pelicans for the Zoo. It was chance that brought the shipment of the manatees, or sea cows. I had looked for them during twenty years without finding one. Then it chanced that I struck a strange creature with my light harpoon, just off of Madeira Hammock. It proved to be my long-sought manatee, eleven feet long and of massive proportions. We were swamped four times while working him into shallow water, where we went overboard with him and handled him until he was unafraid. We made a harness of rope and leaving him fastened to an anchor by a two hundred foot line, in a pasture of manatee grass, sailed for Miami and a telegraph office. I gave the manatee to my friends of the Zoo and of the Aquarium by wire and with great difficulty secured official permission to ship the creature. But when I returned to where I had left my prize I found that he had broken his bonds and shipped himself to parts unknown. Returning to Miami I wired my apologies and the promise to find another manatee if it took me a year, which it did.**

Dimock kept his promise to send another manatee. The following is from the September 8, 1906 issue of the NEW YORK HERALD:

> ***NEW SEA COW IS COMING.***
> ***Florida Man Donates Another Manatee to Replace One Which Died at Battery Park Recently.***
>
> **For a new manatee, or sea cow, which is expected to arrive at the Aquarium any day, a special tank was filled yesterday. A few weeks ago a female manatee, which had become quite an attraction at the "fish theatre," had the bad taste to die.**
>
> **The news of the cow's death reached Florida and A. W. Dimock, of Jacksonville, was so moved that he donated and shipped the manatee, which is en route to this port and destined to become a Battery attraction.**

On October 9, 1906 the new manatee had arrived and the NEW YORK EVENING POST described how Director Charles H. Townsend described the new procedures intended to keep it alive, since it was the fourth manatee received by the Aquarium since 1903:

> **HOPE FOR MANATEE IV.**
> **Aquarium's Latest Specimen is Young and May Avoid its Predecessors' Fate.**
>
> **Director Townsend and his assistants at the Aquarium are lying awake nights devising precautions the new manatee, recently arrived from Florida, alive during the winter months. This is the fourth sea-cow the Aquarium has had, and none of its predecessors has lived more than a few months. They were all full grown, however, and had been injured in capture. The present specimen is young and lusty. A week after its taking, one of the attendants discovered a hole in its side. A veterinary diagnosed the hurt as a gunshot would. He probed, found a bullet imbedded in the cow's blubber and extracted it. Since then manatee is being carefully watched and attended, its wound is healing slowly.**
>
> **"I hope to make a recorded with this manatee by pulling it through the winter and if I succeed in that, there is every reason to hope we can keep it**



Anthony Weston Dimock (1842-1918)

alive and well for two or three years," said Director Townsend to-day. "The great danger is from pneumonia. The manatee comes to the surface every eight or ten minutes to breathe, and the minute it gets a sniff of frost-laden air, over it goes with pneumonia and there's one chance in a million of saving it. It is easy enough to keep the water at the proper temperature, but we are likely to have winter storms that render it difficult to maintain the atmosphere in the building at the proper height. Then, too, there is danger of the night attendants becoming negligent and permitting the temperature to get too low. To guard against this, I intend to cover the manatee's big pool with glass to exclude all drafts, and I shall take other precautions which ought to insure its living."

"It will be a pity if we lose this sea-cow, for we don't know when we could procure another. When we secured its predecessor, the statement was published that it had cost the Aquarium several thousand dollars, and now all the fishermen on the Florida coast are demanding fabulous sums for capturing the animals. As a matter of fact, that and the one now at the Aquarium were presented to us by A.W. Dimock of the Florida East Coast Line, both the railroads and the steamship company furnishing free transportation from Florida to New York."

The reason that the bullet hole wasn't discovered right away was that it was embedded in the manatee's blubber and was causing it no discomfort. In any case, the surgery was successful and two years later, things were looking good for the new manatee. The following is from the February 2, 1908 issue of the NEW YORK SUN, and although it only pertains in part to the manatee, I reproduce it here in its entirety:

SEA DWELLERS AT DINNER. FEEDING THE CAPTIVE FISHES AT THE AQUARIUM.
The Crocodile the Most Indifferent of the Sea Boarders - Fishes That Insist on Certain Delicacies - The Manatee's Shampoo—Spice or Variety In the Menu.

One of the most picturesque sights at the Aquarium in Battery Park is the serving out of the daily rations to the 2,000 captive sea dwellers, little and big. The 100 wall tanks and spacious floor pools are said to shelter the largest colony of fishes - 213 different kinds - ever gathered under one roof in the world. The fact that 2,131,333 persons passed through its doors during the last year, an average of over 5,.000 dally, stamps it as one of the most popular show places in the world.

Getting up the daily menu for the fishes requires more labor and expense than one might suppose. One attendant devotes about half of each day to the preparation of the food, and several others

Dimock captioned this image "There isn't any real danger in clinging to the flipper of a thousand-pound manatee while he slings you around in the water, but it makes a picture quite irresistible to the magazineman."

are kept busy the remainder of the afternoon in feeding the fishes. The food is varied to suit the fishes, and includes beef - sliced, chopped or minced - liver and fish, cod and herring mostly. Minnows, when procurable in abundance, are provided at the rate of ten or twelve quarts daily, and are simply thrown alive into the tanks, where the larger fishes soon dispose of them. Shrimps to the extent of about fifteen or twenty quarts a week, four or five bushels of mussels a year, small crabs, such as fiddler crabs, stone crabs and young blue crabs, by the thousand, marine worms at the rate of 500 or 600 a month, small soft clams in quantities of from 10,000 to 12,000 during the summer season, are also on the menu. The average board bill for the Aquarium's guests for a month is $100.

Among the chief attractions of the Aquarium at present, from the fact that it is comparatively new and rare here, is the curious tea cow, or manatee, from Florida, the only one in captivity in this country. It was presented to the Aquarium by A. W. Dimock and has survived eighteen months, which is the record time for a manatee to live in confinement.

The sea cows in their wild habitat are especially shy and cautious of man, diving and disappearing immediately on his approach. Being of tropical origin, the manatee requires special treatment and care. The water in the pool is kept at a suitably warm temperature, between 70 and 72 degrees. Eel grass and lettuce leaves are its chief fare. The former is used chiefly when obtainable.

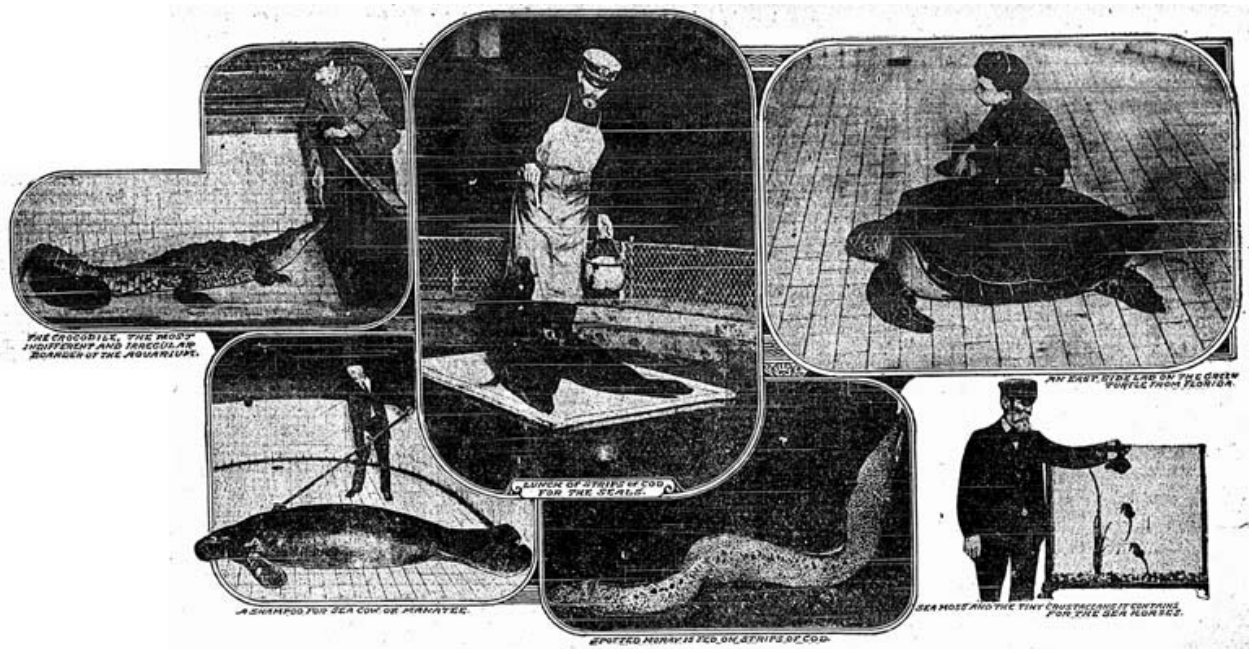
The sea cow was captured in a large drag seine. Numerous attempts to take one had been made at different times for a month, and many broke through the net and escaped before one was finally obtained.

The manatee has considerable swimming space in its tile lined pool, which is twenty feet long by thirteen wide, with a depth of four feet of water. The water is renewed dally.

The feeding of the sea cow is watched with interest by the visitors. The best view of the animal is obtained when the water is run off in order that the pool may be cleaned, thus leaving the whole form or the manatee strikingly outlined. A very clear view of this strange creature is shown in the photograph here reproduced, which was taken after 5 P. M., when all visitors were out.

The picture shows the manner of giving this animal a shampoo. In this process *a* long handled brush is used to brush off the day's accumulation of various substances. The manatee seems to enjoy its daily rubdown and the inflow of fresh water, after which it will settle down in one corner of the pool for slumber.

Another star attraction of the Aquarium is the silver bedecked spotted moray. This extraordinary eel inhabits the caverns, grottoes and coral reefs



"SEA DWELLERS AT DINNER." From the February 2, 1908 issue of NEW YORK SUN.

of Bermuda, and is one of the most interesting of the many strange sea marvels from this tropical isle, which is celebrated for its gorgeous colored fishes.

A whole tank is given up to the display of this brilliant coated moray. The picture here reproduced shows the long serpentine creature in a characteristic attitude as it is about to receive a strip of cod for luncheon. This, the favorite food of the moray, is passed to and fro close to its open mouth, till the animal suddenly gulps the tempting morsel.

In the ocean depths the morays are voracious, even cannibalistic in their habits, and are the terror of the other fishes. With their long bodies partly concealed by being wound around some ledge or crevice they lie in ambush, their jaws with lance-like teeth open half a foot or more, in readiness to dart at and swallow the first unsuspecting victim that swims by.

They are caught in traps and also on hooks. The native Negro fishermen lose no time in cutting off the head of one as soon as it is landed in the boat. If a big specimen happens to get loose a panic is likely to start among the crew and they will jump overboard on the instant.

Of all the Aquarium's boarders the little sea horses, six inches long, are the most fantastic in appearance. They are so named from the close resemblance of their head to that of a horse.

The food necessary to whet their appetite is somewhat odd and hard to obtain. It has been found that they can be kept in good condition only when they are well supplied with grammarus, a very minute crustacean procured by gathering bunches of fine sea moss, which it inhabits
In feeding the sea horse's mouth is placed near the prey, for which it constantly searches, and is suddenly opened. The cheeks being inflated at the same time, the food is captured with the inrush of water. When bunches of sea moss are dropped into the tanks the fish immediately scamper to the bottom and pick out the minute life from the weeds.

The sea horse is probably the only fish having a prehensile tail, which it uses in a monkey-like fashion, constantly anchoring itself to weeds, stones and slicks. The position of the body is usually vertical, especially in swimming.

These little creatures are found all along the American coast from Cape Cod to South Carolina. There is one remarkable feature about them not known generally, Contrary to the rule with the rest of the animal World, the eggs while hatching are carried by the male in a pouch, and the young are asked to return to this for shelter. Hundreds, probably thousands, of baby individuals are thus carried around by the incubating paternal member of the family in his incubating pocket while Mrs. Sea Horse, released of care, roams fancy free.

The clever maneuvers of the little harbor seals from the Maine coast share the popular interest with the sea cows. They are hearty eaters and have stripes of cod and herring for their luncheon. These are usually thrown into the pool, but oftentimes when the seals come up on the platform the food is suspended over their heads for a moment and then snapped at.

These creatures are rapidly disappearing from the Atlantic coast. Owing to their ravages upon the fish, some of the New England States now offer a bounty of from $1 to $3 a head for the destruction of these animals in order to protect the fishing industry.

L. B. Spencer has in the laboratory and in the balanced aquariums many minute fresh water and salt water forms of life which are daintily fed on bits of beef. His collection is especially rich in examples of living coral and fine sea anemones.

This nature study department, supplemented by Mr. Spencer's short lectures and object lesson talks, furnishes a popular educational attraction which is well attended by teachers and school children.

The Florida crocodile is about the most indifferent and irregular of the Aquarium's boarders, as days and even weeks will pass without its taking any food. When rations are to be served the animal is roused from stupor by being punched. Its anger is shown by growling, accompanied by opening its ponderous jaws, in which the attendant swiftly lodges a big fish.

In the floor pool containing the nine large sea turtles of four different kinds the star is a giant green turtle from Florida weighing 313 pounds. His shell is as big as a small dining table. The size may be judged from the East Side boy seated on his back.

This turtle and his mates are fed on a choice menu or clams, eel grass, lettuce and whelks.

POST SCRIPT

After having doubled its weight, the manatee ultimately died of an intestinal disorder. In 1916, the

Aquarium received an entirely different kind of manatee, one from the Amazon. These early attempts at maintaining Amazonian manatees in captivity led to the discovery of the temperature range that these manatees preferred - 78 degrees. By 1939, the Aquarium had little difficulty in keeping any kind of manatee alive for extended periods of time, and with the development of new and better technologies and quarters, the problems in keeping penguins, sea lions, seals and manatees have finally been resolved for all public aquariums.

THERE IS NO SUCH THING AS A FISH!

by Albert J. Klee, Ph.D

(Aquarium Hobby Historical Society, Yahoo Files, February 28, 2015)

Though this be madness, yet there is method in't.
--W. Shakespeare

It is certainly not the least charm of a theory that it is refutable.
--F. Nietzsche

False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a salutary pleasure in proving their falseness.
--C. Darwin

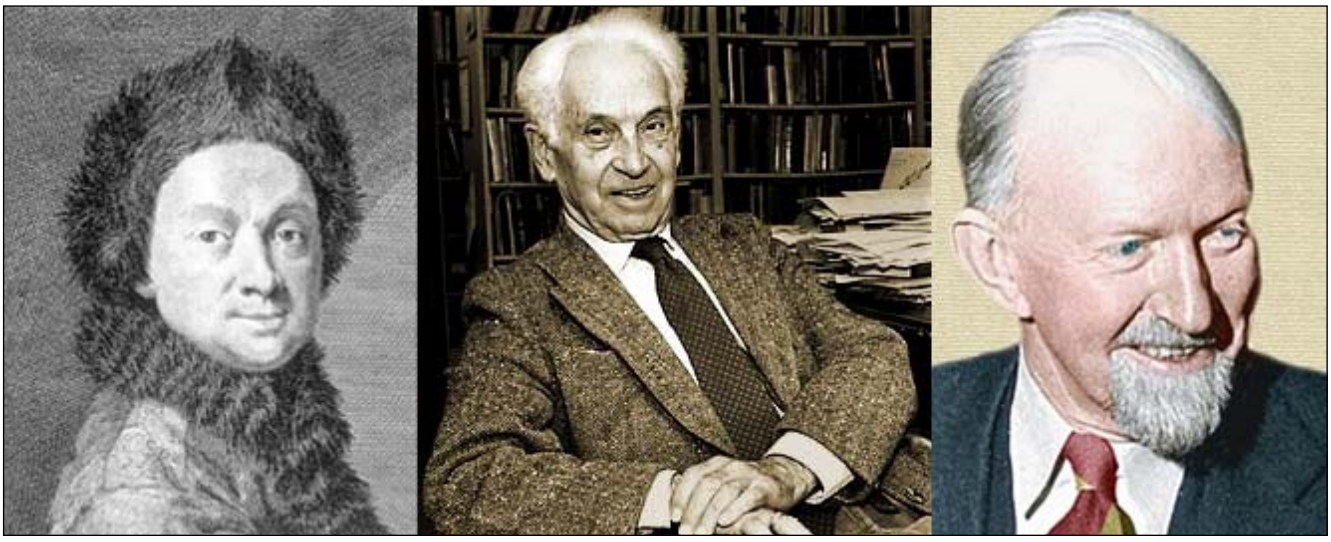
An enthusiast sways humanity by...dinning it into our ears that this or that question has only one possible solution; but when once he is gone, an army of quiet and influential people set to work to remind us of the other side and demolish the generous imposture.
--R. L. Stevenson

This essay seeks to analyze cladistics with regard to its assumptions, strengths and weaknesses, and to compare it with its competition.

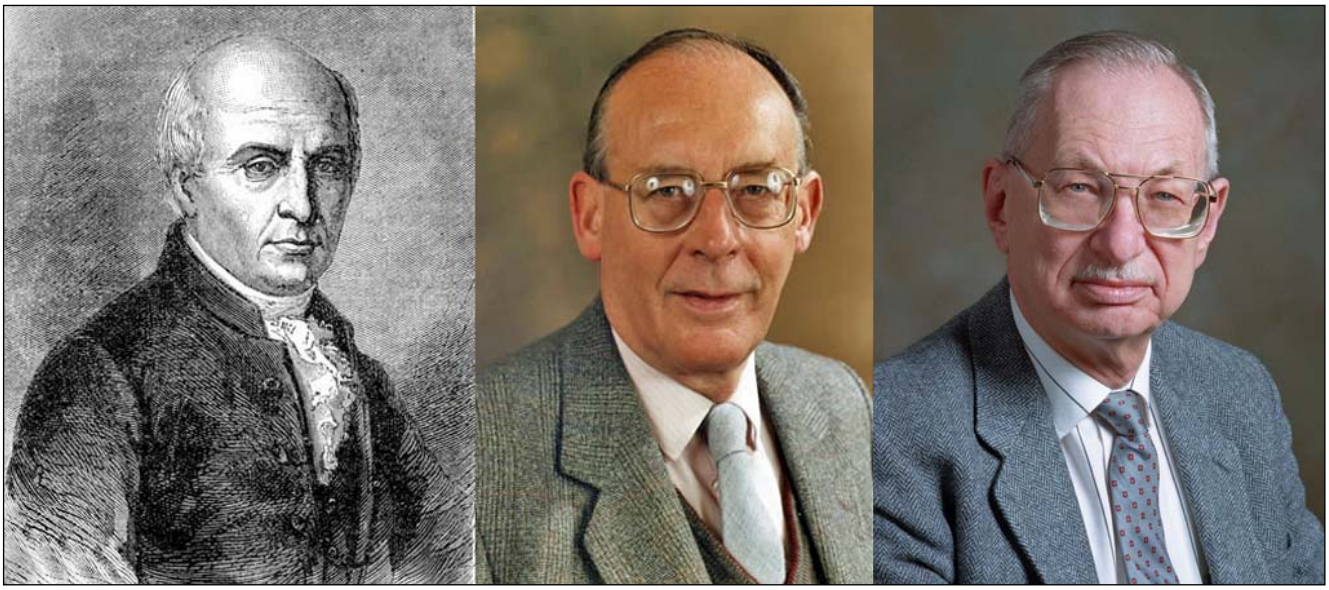
EVOLUTIONARY SYSTEMATICS

Evolutionary systematics arose as a result of the influence of the theory of evolution on Linnaean taxonomy. The idea of translating Linnaean taxonomy into a sort of dendrogram of the Animal and Plant Kingdoms was formulated toward the end of the 18th century, well before Charles Darwin's book *On the Origin of Species* was published. The first to suggest that organisms had common descent was Pierre-Louis Moreau de Maupertuis in his 1751 *Essai de Cosmologie*, Transmutation of species entered wider scientific circles with Erasmus Darwin's 1796 Zoönomia and Jean-Baptiste Lamarck's 1809 *Philosophie Zoologique*. The idea was popularized in the English-speaking world by the speculative but widely read *Vestiges of the Natural History of Creation*, published anonymously by Robert Chambers in 1844.

Following the appearance of *On the Origin of Species*, Tree of Life representations became popular in scientific works. In *On the Origin of Species*, the ancestor remained largely a hypothetical species; Darwin was primarily occupied with showing the principle, carefully refraining from speculating on



Proponents of Evolutionary Systematics . From left to Right: Pierre-Louis Moreau de Maupertuis (1696-1759), Ernst Mayr (1904-2005) and Gaylord Simpson (1902-1984.



Proponents of Phenetics. From left to Right: Michel Adanson (1727-1806), Peter H. A. Sneath (1923-2011) and Robert R. Sokal (1926-2012)

relationships between living or fossil organisms and using theoretical examples only. In contrast, Chambers had proposed specific hypotheses, the evolution of placental mammals from marsupials, for example. Following Darwin's publication, Thomas Henry Huxley used the fossils of *Archaeopteryx* and *Hesperornis* to argue that the birds are descendants of the dinosaurs. Thus, a group of extant animals could be tied to a fossil group. The resulting description, that of dinosaurs "giving rise to" or being "the ancestors of" birds, exhibits the essential hallmark of evolutionary taxonomic thinking.

PHENETICS

A French botanist, Michel Adanson (1727-1806), worked in Africa and used 65 different characters to classify plant families. It formed the philosophical (if not actual) basis for the phenetic or numerical taxonomic (the names are often used interchangeably) methods that followed. In the 1950s, Peter H. A. Sneath of England was working on bacterial classfication systems using computers. Sneath and Robert R. Sokal (Austrian-American biostatistician and entomologist) teamed up in 1963 to produce *Principles of Numerical Taxonomy*. Later, Sneath and Sokal (1973) wrote *Numerical Taxonomy: The Principles and Practice of Numerical Classification*. This became a standard work and started a bandwagon rush by taxonomists to employ these methods in classification. In practice, measurements were made of a large number of characters of a taxon, e.g., at least 60 per plant and often 100 or more. No special importance was attributed to any one of the characters. After the measurements were complete on hundreds of individuals, the data were analyzed statistically with computer programs and cluster analysis or other methods to show purported natural groupings of plants with overall similarities. Systematists' interpretations were thought to be minimized in this fashion.

CLADISTICS

Cladistics (from klados = "branch") is an approach to biological classification in which organisms are grouped together based on whether or not they have one or more shared unique characteristics that come from the group's last common ancestor and are not present in more distant ancestors. Therefore, members of the same group are thought to share a common history and are considered to be more closely related. Cladistics was first proposed by Willi Hennig in 1950 as an alternative to then current systematic methods. It wasn't until 1966, when Hennig's original work was revised and translated into English, that cladistics began to have a substantial impact on English-speaking evolutionists.

Hennig argued that methods current in his day had two fundamental flaws: they were hopelessly subjective, and they failed to properly identify evolutionary relationships. Traditional evolutionary systematics was generally driven by the intuition of the individual biologist, which of course creates problems when disagreements arise because there are no evidential reasons to choose between the two. Phenetics sought to get around this by subjecting characters of organisms to pairwise comparisons, and thus evaluating the overall similarity between taxa (a taxon, plural = taxa - a back-formation from taxonomy - is a group of one or more populations of an organism or organisms seen by taxonomists to form a unit; common taxa among fishes are species and genera). However, such a method would seem ill-equipped to deal with taxa that have similar forms, but are clearly not closely related, e.g. sharks, ichthyosaurs and dolphins. Character weighting then became inherent in the analysis, and it thus became as subjective as traditional Darwinian taxonomy.

The basic idea behind cladistics is that members of a group share a common evolutionary history, and are closely related, more so to members of the same group than to other organisms. These groups are recognized by sharing unique features which were not present in distant ancestors. These shared derived characteristics are called **synapomorphies** (from syn meaning 'together' + apo meaning 'separate' + morph meaning 'form').

Note that it is not enough for organisms to share characteristics; in fact two organisms may share a great many characteristics and not be considered members of the same group. For example, consider a jellyfish, starfish and a human; which two are most closely related? The jellyfish and starfish live in the water, have radial symmetry and are invertebrates, so you might suppose that they belong together in a group. This would not reflect evolutionary relationships, however, since the starfish and human are actually more closely related. It is not just the presence of shared characteristics which is important, but the presence of shared ***derived*** characteristics. In the example above, all three characteristics are believed to have been present in the common ancestor of all animals, i.e., primitive, and so are trivial for determining relationships, since all three organisms in question belong to the group "animals." While humans are different from the other two organisms, they differ only in characteristics that arose newly in an ancestor which is not shared with the other two. Choosing the right characters, therefore, is one of the most important steps in a cladistic analysis.

JARGON YOUR MEMORY

Jargon is the technical terminology or characteristic idiom of a special activity or group. It is commonplace for each science to create their own jargon, and taxonomists are no exception. The philosopher, Étienne Bonnot de Condillac, observed in 1782 that "every science requires a special language because

Proponents of Cladistics. From left to Right: Willi Hennig (1913-1976), Joel J. Cracraft and Gareth Nelson.

every science has its own ideas." Within each field, terms have one or more specific meanings that are not necessarily the same as those in common use and, in many cases, this causes a barrier to communication with those not familiar with the language of the science. Two examples we have just seen are taxa and synapomorphy, and we are about to add another two.

The terms "primitive" and "derived" are often avoided by cladists since those terms have been much abused in the past. Thus the convention is to call the "original" state of the characteristic "**plesiomorphic**" (from plesio meaning 'near' or 'close to' + morph meaning 'form') and the "changed" state "**apomorphic**" (from apo meaning 'separate'). Figure 1 shows examples of apomorphy, plesiomorphy and synapomorphy. Note that in the apomorphy the trait is shared but it is not derived

FIGURE I

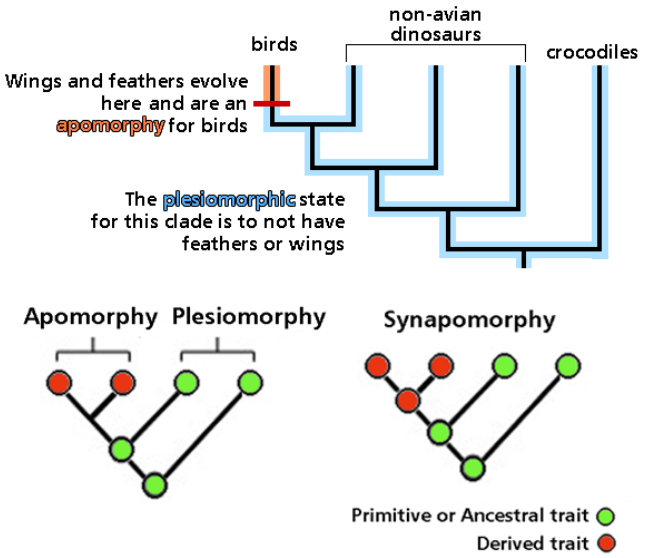


TABLE I

	EVOLUTIONARY SYSTEMATICS	NUMERICAL TAXONOMY	CLADISTICS
Principal proponent(s)	Mayr, Simpson, and Ashlock	Sneath and Sokal	Hennig, Wiley, Cracraft, Eldredge, Nelson, Platnick, Schuh
Operational basis of relationship; what determines relatedness?	All shared characters	All shared characters	Synapomorphies
Weighting of items above; how are the characters evaluated one to another?	unequal, some weighted to be more important than others; derived usually weighted more than primitive	equal or unequal	equal or unequal, depending upon the type of data.
Is it numerical? Can the operational principles be formulated in terms of mathematical algorithms?	No*	Yes	Yes
Is the degree of difference between taxa used to determine relatedness (and resultant taxonomy)?	Yes	Yes	No*
Does its taxonomic applications reflect phylogeny?	Not necessarily*	Not necessarily*	Yes
Underlying principles	Overall similarity, degree of difference, and sister-group relationships must be used to infer relationship and generate classification.	Overall similarity infers relationship; characters evolve at equal rates.	Shared-derived characters infer sister group relationships; classifications should exactly reflect sister group relationships.

*A perceived "weakness" of the approach.

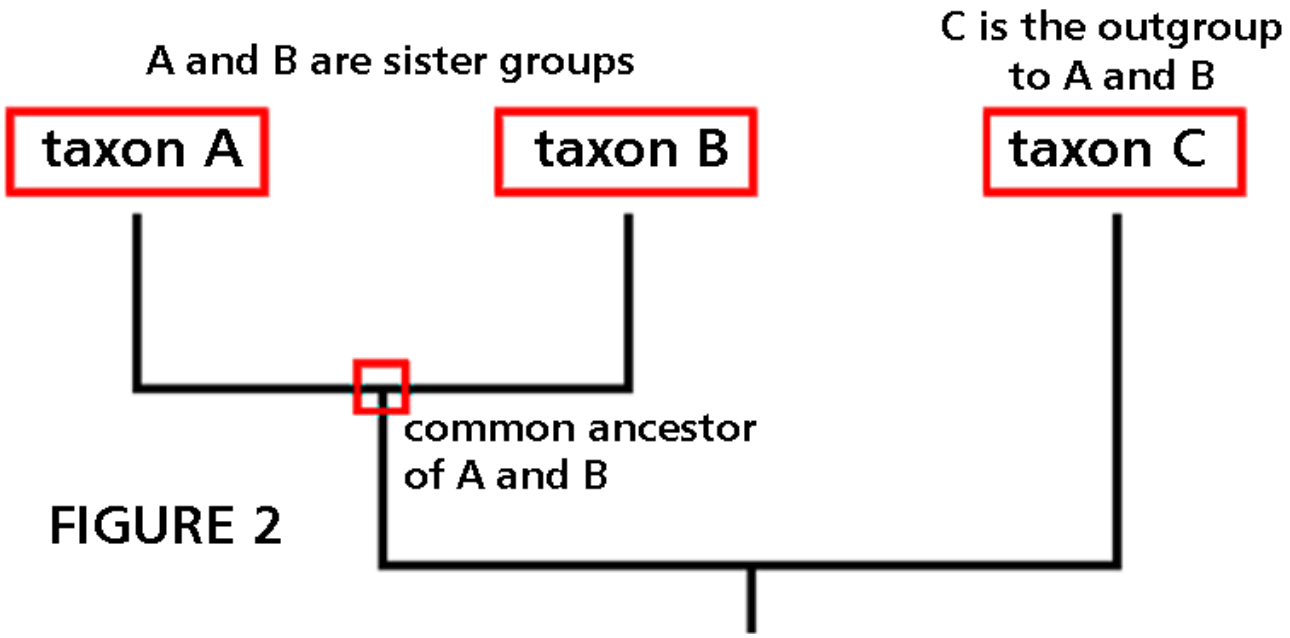


FIGURE 2

from a common ancestor. In the synapomorphy it is.

The three schools are compared in Table I and measure up, roughly, in the following way:
(1) Phenetics is practical (at least in principle) but not objective.
(2) Cladistics is objective and natural but (often) not practical.
(3) Evolutionary classification is a somewhat muddled combination, traditionally useful but not rigorous by any strict criterion.

CHARACTERISTICS OF PHILOGENETIC TREES

A phylogeny, or evolutionary tree, represents the evolutionary relationships among taxa. The tips of the tree represent groups of descendent taxa (often species) and the nodes on the tree represent the common ancestors of those descendants. Two descendants that split from the same node are called sister groups. In the tree shown in Figure 2, species A & B are sister groups — they are each other's closest relatives. Adjacent taxa are called "sister groups" or

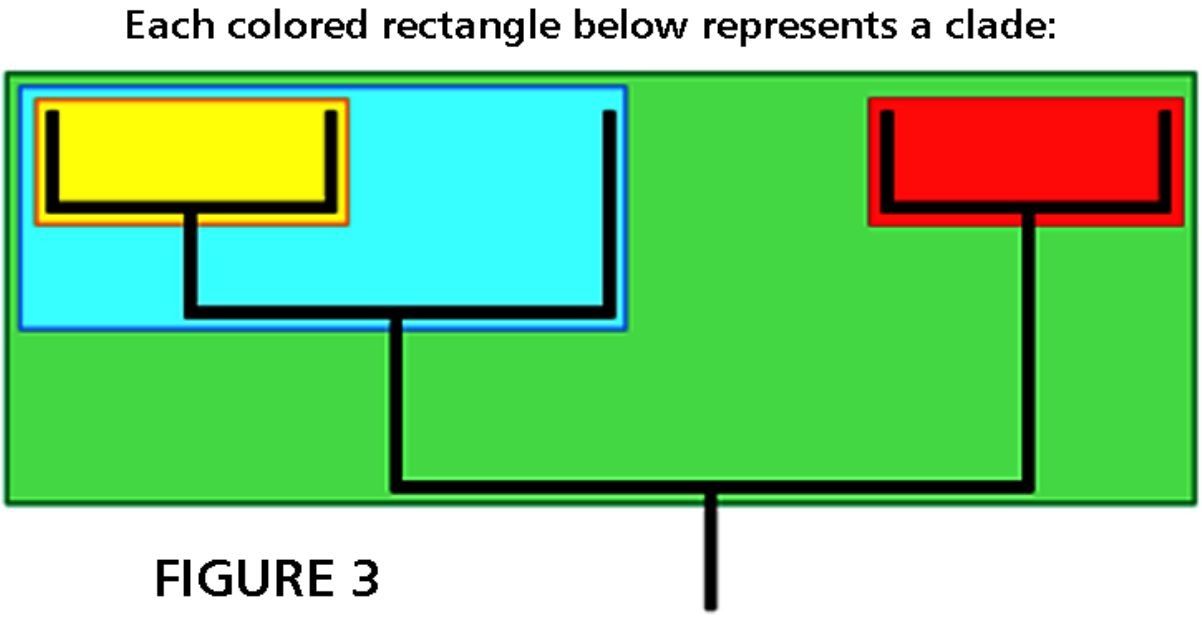


FIGURE 3

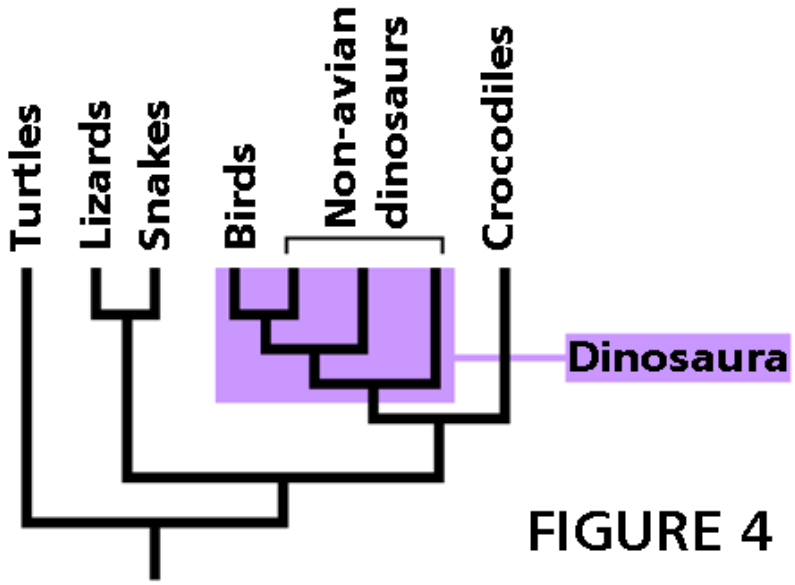


FIGURE 4

"clades." They are usually presumed to be descendants of a common ancestor. My brother and I form a sister group (pardon the confusion of gender) because he is my only sib and neither of my parents had any other children.

Many phylogenies also include an outgroup — a taxon outside the group of interest. All the members of the group of interest are more closely related to each other than they are to the outgroup. Hence, the outgroup stems from the base of the tree. An outgroup can give you a sense of where on the bigger tree of life the main group of organisms falls. It is also useful when constructing evolutionary trees.

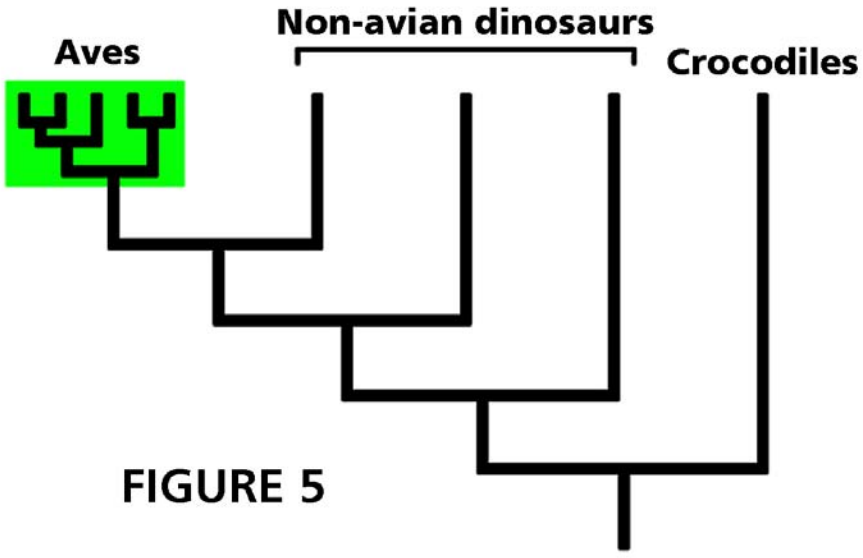


FIGURE 5

Evolutionary trees depict clades. A clade is a group of organisms that includes an ancestor and all descendants of that ancestor. You can think of a clade as a branch on the tree of life. Some examples of clades are shown on the tree in Figure 3 where each colored rectangular represents a clade.

LINNAEAN VERSUS PHYLOGENTIC CLASSIFICATION

In contrast to the traditional Linnaean system of classification, phylogenetic classification names only clades. For example, a strictly Linnaean system of classification might place the birds and the non-Avian dinosaurs into two separate groups. However, the phylogeny of these organisms reveals that the bird lineage actually branches off of the dinosaur lineage, and so, in phylogenetic classification, the birds should be considered a part of the group Dinosauria (Figure 4).

Phylogenetic classification has two main advantages over the Linnaean system. First, phylogenetic classification tells you something important about the organism, i.e., its evolutionary history. Second, phylogenetic classification does not attempt to rank organisms. Linnaean classification ranks groups of organisms artificially into kingdoms, phyla, orders, etc. This can be misleading as it seems to suggest that different groupings with the same rank are equivalent. For example, the cats (Felidae) and the orchids (Orchidaceae) are both family level groups in Linnaean classification. However, the two groups are not comparable:

(1) One has a longer history than the other. The first representatives of the cat family Felidae probably lived about 30 million years ago, while the first orchids may have lived more than 100 million years ago.

(2) They have different levels of diversity. There are about 35 cat species and 20,000 orchid species.

(3) They have different degrees of biological differentiation. Many orchids belonging to different genera are able to hybridize. But the same is not true of cats — house cats (belonging to the genus *Felis*) and lions (belonging to the genus *Panthera*) cannot form hybrids.

WHAT'S IN A NAME?

Biologists deal with phylogenetic classification by de-emphasizing ranks and by reassigning names so that they are only applied to clades. This means that one's use of biological names doesn't have to change very much. In many cases the Linnaean names are perfectly good in the phylogenetic system. For example, Aves, which is the class of birds in the Linnaean system, is also used as a phylogenetic name since birds form a clade (Figure 5). Most of the specific names that one is accustomed to using (e.g., *Homo sapiens* and *Drosophila melanogaster*) have not changed at all with the rise of phylogenetic classification. However, there are some names from Linnaean classification that do not work in a phylogenetic classification. For example, as we shall see, the fishes do not form a clade and thus cannot be a named group in the phylogenetic system.

TYPES OF PHILOGENIC TREES

Just as a genealogist might construct a family tree to illustrate ancestors and descendants within a human family, systematic biologists (taxonomists) construct phylogenetic trees to depict relationships among groups of living organisms. There are several ways to create such trees. The method chosen often depends on the distinctiveness of each taxon, the type and quality of categorical data available, and the scientist's overall philosophy toward classification.

(1) Evolutionary Systematics is a synthesis of phenetics and cladistic principles and so there is no single underlying method of analysis. In the "old days" (before the twentieth century), classification was largely carried out by "gentlemen" scientists who based their identifications of organisms upon a few "important" characteristics and a "gut feeling" developed during many years experience. Proponents of evolutionary systematics today attempt to produce a phylogenetic tree (dendrogram) that faithfully reproduces a taxon's lineage: each junction point represents a common ancestry and the length of each branch reflects the amount (or duration) of evolutionary divergence from the presumed ancestor. Even under the best of circumstances, developing such a dendrogram requires a great deal of speculation because the data is often fragmentary (or entirely absent).

(2) Phenetics is advanced by some systematic biologists who argue that it is pointless to create an evolutionary tree because there is no way to prove whether it is right or wrong. Instead, they advocate the phenetic approach to classification, i.e., grouping organisms entirely on the basis of physical similarities. In a phenogram, each branch point represents a step of increasing similarity - taxa which share the most characters (both primitive and advanced) perch next to one another in the family tree even though they do not necessarily share a common ancestor.

(3) Cladistics, strives to reflect evolutionary lineage without "creating" hypothetical ancestors. This is accomplished by first using an "outgroup" to determine which characteristics are primitive" (ancestral) and which are "advanced" (derived). This outgroup is considered to be distantly related to the taxa whose phylogeny we want to know and let it be our standard. We assume that the character states that it shows are ancestral, and score the other taxa (the ingroup) by comparison with it. A cladogram is constructed by grouping taxa that share the greatest number of derived characters.

CLADISTICS VERSUS PHENETICS

We can illustrate the distinction between cladistic and phenetic analyses by imagining the evolution of metal fasteners that include the rivet, the nail, the screw and the bolt (Figure 6). Since the rivet has the simplest structure we will presume it to be the common ancestor of all fasteners. Among the other fasteners, there are at least seven derived character states (physical characteristics not found in rivets: 1.) notched heads, 2.) rounded heads, 3.) hex

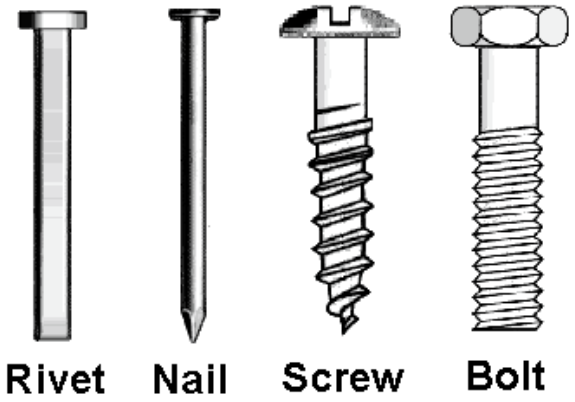


FIGURE 6

heads, 4.) threaded shafts, 5.) tapered shafts, 6.) pointed tips, and 7.) thick diameter.

The character states of all four fasteners are compared in Table II where the symbol "0" represents the pleisiomorphic (primitive or "rivet-like") state and "1" represents the apomorphic (derived or evolved) state.

If the phenetic approach is used to classify these fasteners, they are compared with one another by counting the total number of shared character states (both primitive and derived). If the cladistic approach is used, the comparison is based only upon the number of derived character states shared (see Table III).

Finally, a phenogram or cladogram is constructed by placing "closely related" species next to one another within the family tree. As this "fastener example" in Figure 7 illustrates, phenetic and cladistic analyses do not always give similar results.

Regardless of how they are constructed, phylogenetic trees are usually governed by the Rule of Parsimony, a "simplest is best" precept which dictates that a family tree should contain no more than the minimum number of branch points necessary to accommodate all of the observed character states. Such a constraint is consistent with scientific method, but it may not necessarily reflect the true path of evolutionary change. We shall examine the objections to parsimony later.

TABLE II

Character	Rivet	Nail	Screw	Bolt
Head notch	0	0	1	0
Rounded head	0	0	1	0
Hex head	0	0	0	1
Threaded shaft	0	0	1	1
Tapered shaft	0	0	1	0
Pointed tip	0	1	1	0
Thick diameter	0	0	1	1

TABLE III

Phenetic Comparison
(Total of all shared states)

	Rivet	Nail	Screw	Bolt
Rivet	-	6	1	4
Nail		-	2	3
Screw			-	2
Bolt				-

Cladistic Comparison
(Total of derived states only)

	Rivet	Nail	Screw	Bolt
Rivet	-	0	0	0
Nail		-	1	0
Screw			-	2
Bolt				-

THE ASSUMPTIONS OF CLADISTICS

There are three basic assumptions:

(1) Any group of organisms is related by descent from a common ancestor.

(2) At each node (divergence of a population), there are two branching lines of descendants.

(3) Change in characteristics occurs in lineages over time.

The first assumption is a general assumption made for all evolutionary biology. It essentially means that life arose on earth only once, and therefore all organisms are related in some way or other. Because of this, we can take any collection of organisms and

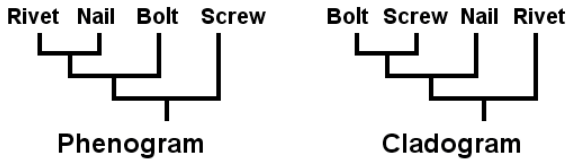


FIGURE 7

determine a meaningful pattern of relationships, provided we have the right kind of information. Again, the assumption states that all the diversity of life on earth has been produced through the reproduction of existing organisms.

The second assumption is perhaps the most controversial; that is, that new kinds of organisms may arise when existing species or populations divide into exactly two groups. There are many biologists who hold that multiple new lineages can arise from a single originating population at the same time, or near enough in time to be indistinguishable from such an event. While this model could conceivably occur, it is not currently known how often this has actually happened. The other objection raised against this assumption is the possibility of interbreeding between distinct groups. This, however, is a general problem of reconstructing evolutionary history, and although it cannot currently be handled well by cladistic methods, no other system has yet been devised which accounts for it.

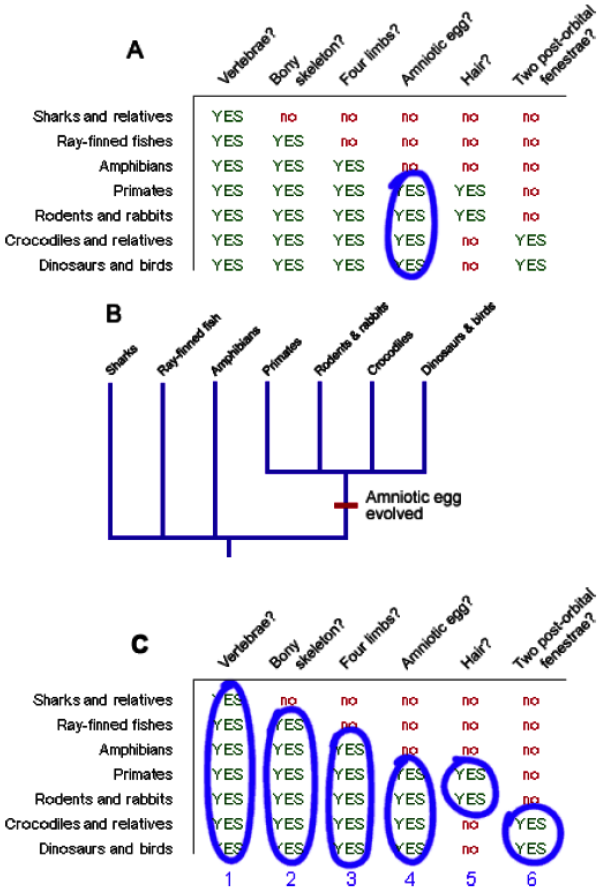
The final assumption, that the characteristics of organisms change over time, is the most important assumption in cladistics. It is only when characteristics change that we are able to recognize different lineages or groups.

CONSTRUCTING TREES 101

A cladistic analysis typically requires the following steps. Though they may seem simple, each step actually requires a great deal of background knowledge and work.

1. Choose the taxa. Let's decide to study the major clades of the vertebrates shown in the leftmost column of the Table shown in Figure 8A. We have selected seven (Note that, for simplicity, many vertebrate lineages are excluded from this example).
2. Determine the characters. After studying the vertebrates, one needs to select a set of traits that seem to be homologies, and build the data table to record your observations. Homologies (homology is from the Greek meaning to agree) are characters that are similar because they were inherited from a common ancestor. Analogies, i.e., characters that evolved through convergent evolution in two separate lineages (like the dorsal fins of sharks and dolphins), are not useful for reconstructing phylogenies. We have selected traits in this example (Note that many relevant vertebrate characters are excluded from this example for the sake of simplicity).
3. Determine the polarity of characters, i.e., figure out the order of evolution for each character. From studying fossils and outgroups closely related to the vertebrate clade, we have hypothesized that the ancestor of vertebrates had none of these features. (Note: This step is not absolutely necessary in some computer algorithms.)
4. Group taxa by synapomorphies Since we have a good idea of what the ancestral characters are (see above), this is not so hard. We might start out by examining the egg character. We focus in on the group of lineages that share the synapomorphic form of this character, i.e., an amniotic egg (A, in Figure 8), and hypothesize that they form a clade (B). We go

FIGURE 8



through the whole table like this, grouping clades (C, in Figure 8) according to synapomorphies.

5. Work out conflicts that arise by some clearly stated method, usually parsimony (minimizing the number of conflicts; see the parsimony section). There are no conflicts here. Every group is a subset of another group.

6. Build the tree following these rules:

(a) All taxa go on the endpoints of the cladogram, never at nodes.

(b) All cladogram nodes must have a list of synapomorphies which are common to all taxa above the node (unless the character is later modified).

(c) All synapomorphies appear on the cladogram only once unless the character state was derived separately by evolutionary parallelism.

Based on the groupings above, the tree shown in Figure 9 is produced.

Note: Parallelism and convergence are not always clearly distinguishable. Features that become more rather than less similar through independent evolution are said to be convergent. Convergence is often associated with similarity of function, as in the evolution of wings in birds, bats and flies. The shark (a fish) and the dolphin (a mammal) are much alike in external morphology; their similarities are due to convergence, since they have evolved independently as adaptations to aquatic life.

Parallel evolution on the other hand implies that two or more lineages have changed in similar ways, so that the evolved descendants are as similar to each other as their ancestors were. For example, the cichlids in Lake Malawi and in Lake Tanganyika all originated from similar ancestral populations. What's more, the cichlids in each of the three lakes have evolved to fill nearly the exact same niches. In Figure 10, the fish on the left come from Lake Tanganyika and the ones on the right are from Lake Malawi. The correspondence in ecology and morphology between the fish of these lakes is a clear example of parallel evolution.

FIGURE 9

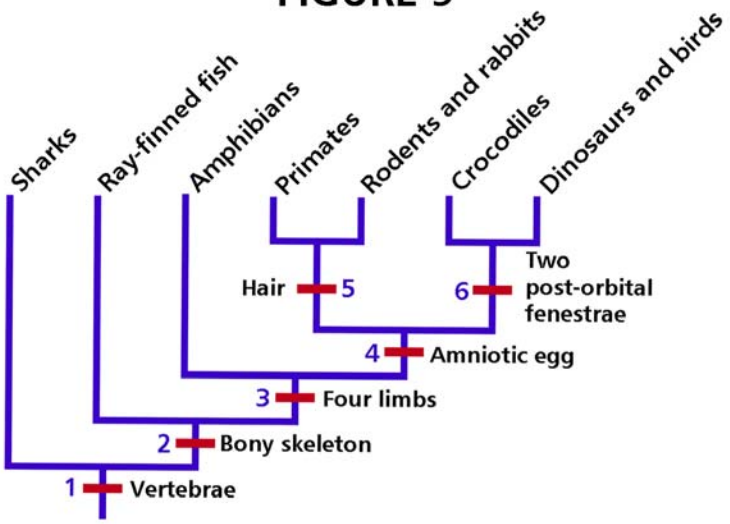
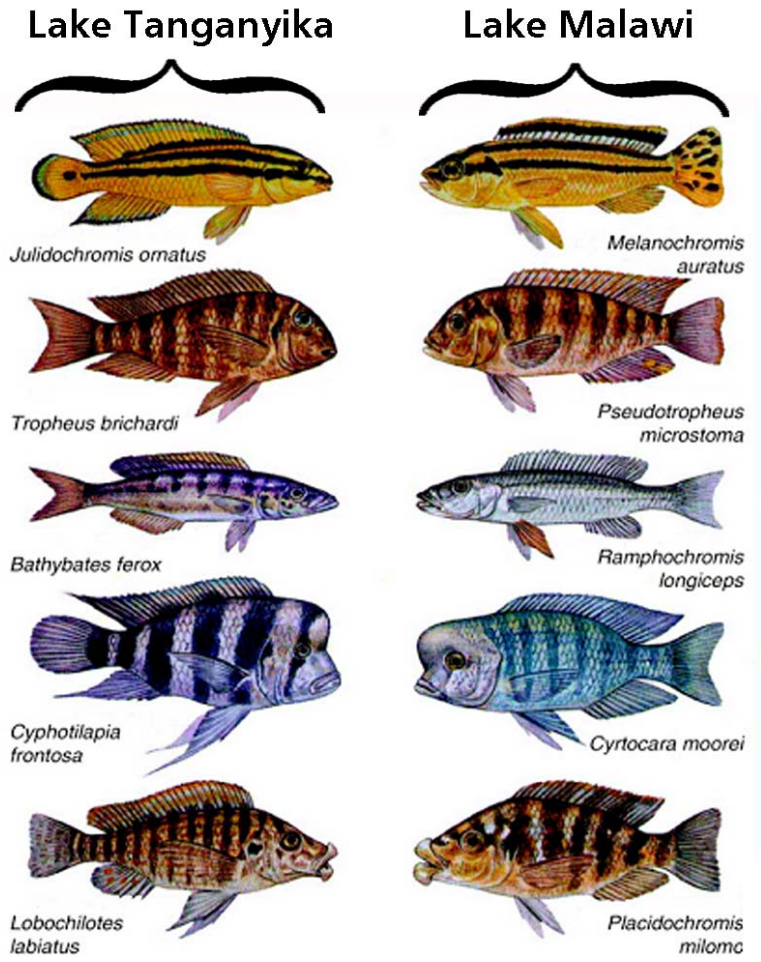


FIGURE 10

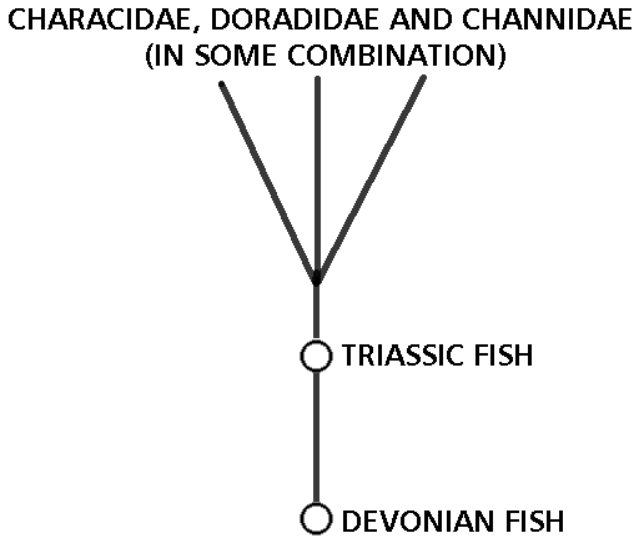


PROBLEMS WITH CLADISTICS

Like any computerized method, cladistics suffers from the problem that the quality of the output it produces is entirely dependent on the quality of the input it is given - or, to put it another way, "garbage in, garbage out." There are several choices that the worker must make before the computer, in all its objectivity, can be put to work, and some further issues may also cast doubt over the results of a cladistic analysis.

For example, poorly chosen characters can yield incorrect results. To take an extreme example, if we applied the cladistic method to three taxa - lions, tigers and convict cichlids - using only the single character "has stripes," we would obviously get the nonsensical result that tigers and convict cichlids are more closely related to one another than either is to lions.

Another way in which a worker's preconceived ideas can affect the result of a cladistic analysis is in the assumptions about the primitive states of the characters. Since we can't know what taxon is actually the most recent common ancestor of those being analyzed, we use a well-understood outgroup as a proxy for that ancestor - that is, a taxon outside of, but as close as possible to, the clade containing the taxa to be analyzed. For example, if we think that the phylogeny looks like this:



Then we might perform the analysis on the assumption that A, B and C's common ancestor had the same character states as the Triassic fish; or, if we decided that its remains are too fragmentary to be used in this way, we might use the less closely related but better represented Devonian fish. In practice, several different outgroups are typically analyzed to help determine the most likely ancestral state of characters. Therefore, the choice of taxa to use as outgroups is clearly a subjective one since it is chosen on the basis of how the phylogeny is likely to look.

The problem, therefore, lies in determining just what is or is not a shared derived character. We have some rough guidelines, and some seat-of-the-pants feelings, but no unerring formulas. If derived characters are sufficiently "complex," for example, we begin to feel confident that they could not have evolved independently in separate lineages and that their mutual presence therefore indicates common descent. Unfortunately, most derived characters are more ambiguous. They tend to be either easy to construct or else so advantageous that several lineages might evolve them independently by natural selection.

In August of 1961 I became interested in the use of electrophoresis techniques in the identification of fishes (this came about as a result of an article which appeared in *Science* magazine **(** Lillevik, H.A. and C. L. Schloemer, "Species differentiation in fish by electrophoretic analyses of skeletal muscle protein**,"** *Science*, Vol. 134, August 16, 1961). Electrophoresis is the movement of charged molecules under the influence of an electric field. Since many biological molecules carry a charge, they can be separated by this technique. Electrophoresis can separate fragments of DNA that were cut with restriction enzymes, creating a visual map of fragment size that is easy to interpret. One of the advantages of electrophoresis is that scientists can separate several samples side by side so they can compare them. The comparison of separated DNA molecules is the basic method behind the DNA fingerprints that forensic scientists use to compare samples from crime scenes with those of suspects. In my case, the method was used to determine the relationship between closely-related *Aphyosemion* species, and was the first ever published on this subject in the aquarium hobby.

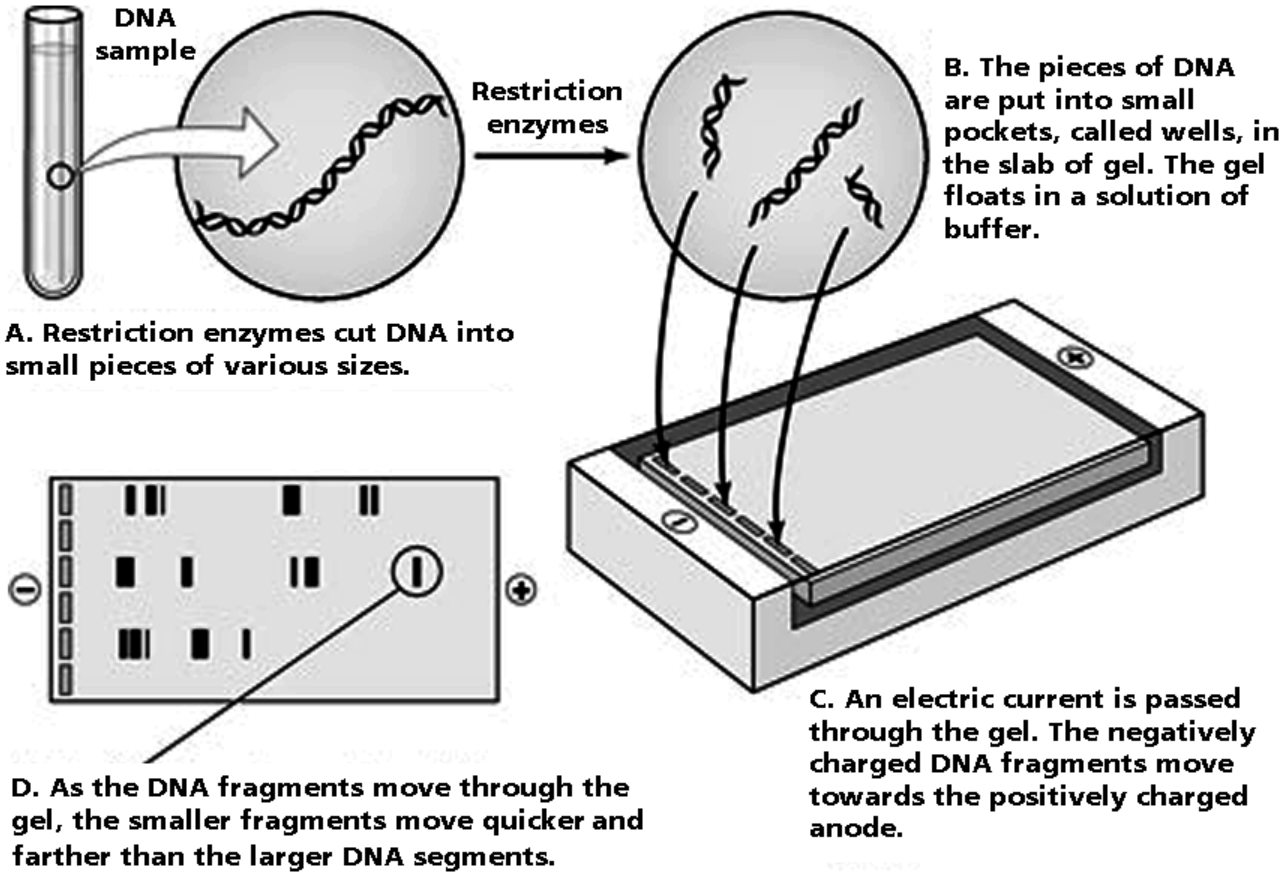
The basic idea is shown in Figure 11. Note that in this diagram, moistened paper can also be used in place of a gel. A DNA sample (part of the ground-up and filtered portion of the fish specimen in this case) is cut into small pieces of various sizes by a restriction enzyme. These pieces are put into small pockets in the slab of gel. An electric current is passed through the gel and the DNA fragments move towards the anode. As they move through the gel, the smaller fragments move quicker and farther than the larger DNA segments. These bands are then brought out strikingly when stained with a dye specific only to protein. Such bands from groups of muscle proteins may "fingerprint" the species in question.

At the time electrophoresis was expensive but, through the courtesy of some good friends and an authority at the Carnegie Institution, I was able to study various forms of *Aphyosemion cognatum* and *A. christyi* (Klee, Albert J., "The Christyi-Cognatum Problem revisited," AKA Killie Notes, Vol. II, No. 1, pp. 8-12 1963). In 1965 I repeated these experiments (Klee, Albert J., "The Bivittatum Group – Part II," Aquarium Journal, March, 1965) with males and females of *Aphyosemion australe*, *Aphyosemion multicolor*, various *Aphyosemion bivittatum* strains and an outgroup, *Aplocheilus lineatus* (Note: These names were the ones used in the hobby when the articles were written; for example, *Aphyosemion multicolor* is now *A. bitaeniatum*).

Figure 12 shows the electrophoretic traces obtained in the last paper; both protein and esterase stains were used, but the figure only shows the esterase stain results. Some of the observations were as follows:

1. *Aplocheilus lineatus* differs markedly from the others (as was expected) in both stains.
2. *A. multicolor* is very nicely separated from *A. bivit-*

FIGURE 11



tatum in aromatic esterase stain. They are also separable in protein stain but to a less dramatic extent.
3. *A. australe* is distinguished easily from *bivittatum* and *multicolor* in both stains, via distance from one band to the next, band intensities and number of bands.

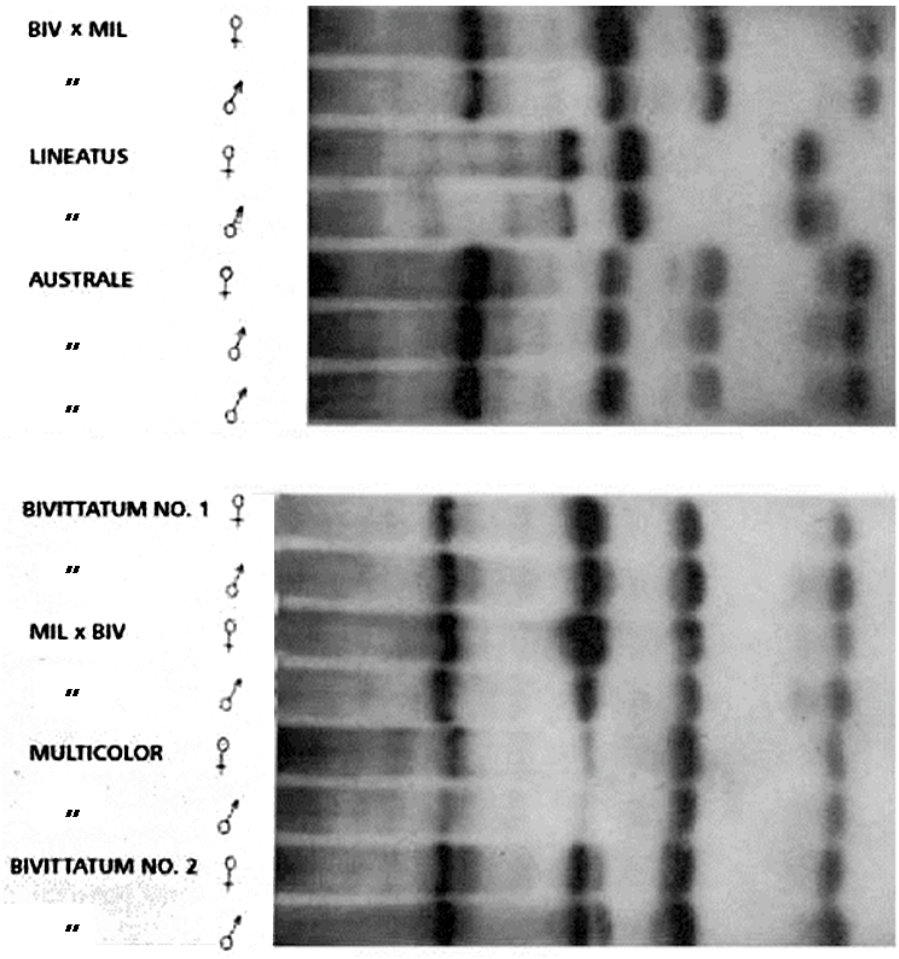
One would hypothesize, therefore, that electrophoretic traces - which are complex - are shared primitive characters in Aphyosemion since the more complex characters that a group shares, the more likely that the group is genealogical – unless there is good reason to regard the characters as primitive, which I did not in this case.

PARSIMONY PROBLEMS AND OTHER METHODS

Consider the problem of inferring how cichlids, killifish and mice are related to each other. Two hypotheses that might be considered are depicted in Figure 13 where f signifies fins and –f signifies no fins. The (CK)M hypothesis says that cichlids and killifish have a common ancestor that is not an ancestor of mice; the C(KM) hypothesis says that it is killifish and mice are more closely related to each other than either is to cichlids. Now consider an observation: cichlids and killifish have fins, while mice do not. Which phylogenetic hypothesis is better supported by this observation?

If finlessness is the ancestral condition, then the (CK)M hypothesis has one character change - no fins to fins - represented by the slash on the cichlid/killifish branch. On the other hands the C(KM) hypothesis has two character changes - no fins to fins on the cichlid branch and no fins to fins on the killifish branch - represented by the two slashes shown. Thus the C(KM) hypothesis is more parsimonious. (Notice that the parsimoniousness of a hypothesis is assessed not by seeing how many changes it says actually occurred, but by seeing what the minimum number of changes is that the hypothesis requires. (CK)M is more parsimonious because it entails a lower minimum.)

FIGURE 12



In choosing the most likely candidate tree, cladistics programs frequently rely on the principle of parsimony, but nature is not always parsimonious since lineages of animals have a way of evolving a feature, then removing it, and then re-evolving it again (this is called a "reversal"). For example, sufficiently basic ancestors of birds were flightless, and birds evolved the feature of flight; but flightless birds such as ostriches and penguins have lost that feature. An analysis using the character "can fly" would be fooled into misreading this as evidence

that penguins are more closely related to the ancestors of birds than to contemporary birds.

Parsimony may be a standard approach but it is not the only basis used in computer programs to determine the cladogram. The methods for calculating phylogenetic trees fall into two general categories:

(1) Distance-matrix methods (also known as clustering or algorithmic methods; much faster than the discrete data methods). Includes UPGMA, Least Squares, Minimum Evolution and Neighbour-Joining methods. **These are phenetic methods**.

(2) Discrete data methods (also known as tree searching methods; more information rich-than distance-matrix methods). Includes Parsimony, Maximum likelihood and Bayesian methods. **These are cladistic methods**.

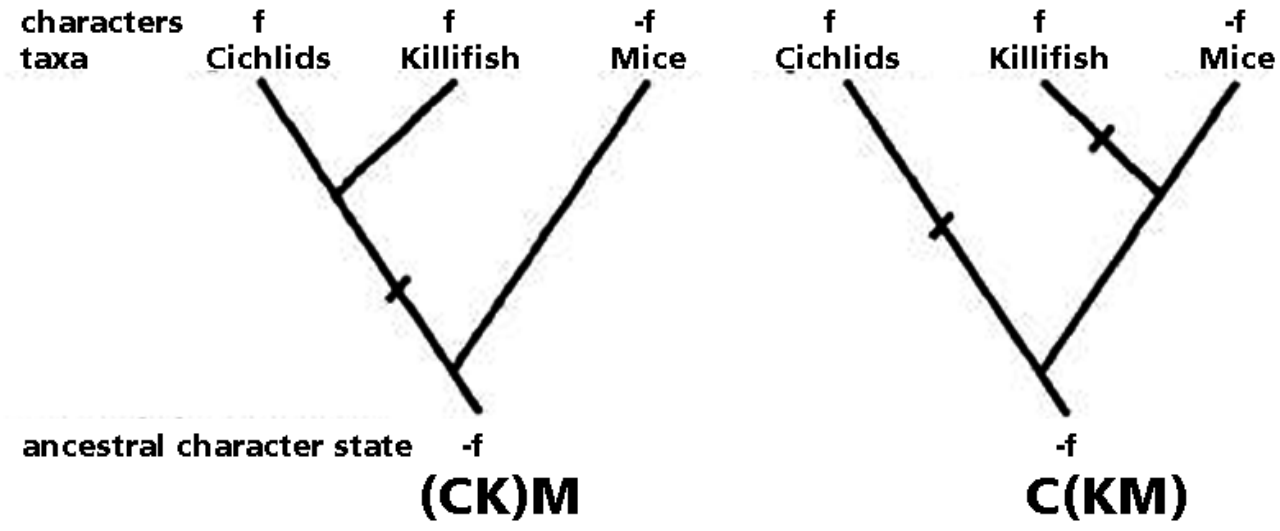
With regard to these three discrete data methods, I have presented an example of parsimony here and one of maximum likelihood in my essay**, "**How Cladists Work" (Aquarium Hobby Historical Society, Files, October 21, 2007). Bayesian inference is similar to maximum likelihood except that it includes prior information regarding relationships into the process of phylogeny estimation.

Quite a few years ago when I was working for the United States Health Service in Cincinnati, Ohio, I was asked by the City Manager of Covington, Kentucky (located right across the Ohio River) if I could solve a problem involving the assignment of crews to their solid waste collection vehicles. At the time, Covington was using a 5-man crew system that required that each crewman get along with the other four, but there was too much strife within the crews and they just didn't get along. As a result, collection efficiency suffered.

About this time I had read Sneath and Sokal's books on mathematical taxonomy and thought I might try one of the clustering algorithms they described. The basic principle behind cluster analysis is fairly simple; it finds groups of objects such that the objects in a group are sim**il**ar to one another and different from the objects in other groups (Figure 14). Since Sneath and Sokal's objects were fish species, I saw no reason why mine couldn't be *Homo sapiens*.

After doing a little research in the social psychology literature, I put together a survey form that essentially asked questions about likes and dislikes and asked the City Manager to have the survey filled out by each of his men. I then took the results and entered into a cluster analysis computer program that enabled me to specify the size of the groups to be identified, which was five in this case. The City Manager used these crew assignments generated by the com-

FIGURE 13



puter and Voila! He had very few problems with internal discord afterwards. Sneath and Sokal were vindicated!

Using different algorithms on a single data set can sometimes yield different "best" cladograms, because each algorithm may have a unique definition of what is "best." Algorithms that perform optimization tasks (such as building cladograms) can be sensitive to the order in which the input data (the list of species and their characteristics) is presented. Inputting the data in various orders can cause the same algorithm to produce different "best" cladograms.

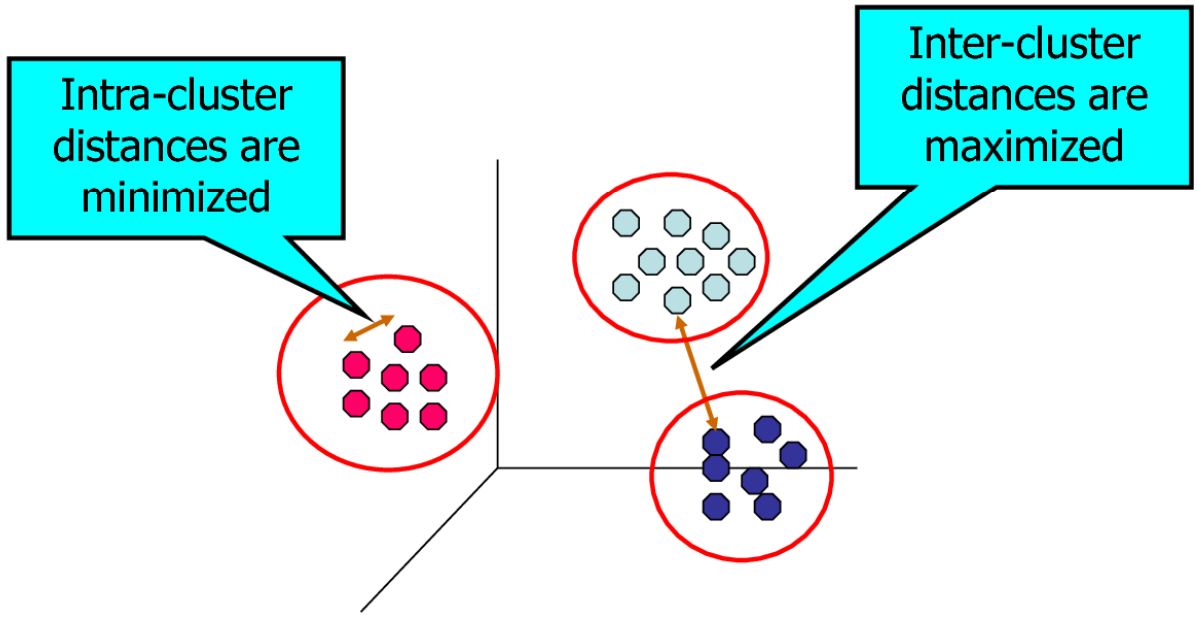
THERE IS NO SUCH THING AS A FISH

With apologies to the members of the Aquarium Hobby Historical Society, I regret to report that there is no such thing as a fish. Most people are confident that they have a pretty good idea of what a fish is. But recognizing fishiness is not as simple or as straight-forward as many might suppose. This is because many fishes lack what are usually thought of as "fishy" characteristics. Characteristics like fins, scales, cold-bloodedness, water-breathing, and even eyes are not shared by all fishes. Some eels lack fins. Lampreys and some freshwater catfishes are completely scaleless, while paddlefishes, some sticklebacks and sculpins are nearly so. Tunas and some sharks are functionally warm-blooded. Mudskippers actually drown if held underwater. Hagfishes and blind cave fish lack eyes. In general, however, most fishes have fins and scales, are cold-blooded, breathe water via gills and have eyes, but it is surprisingly difficult to list characteristics common to all forms.

All known fishes are multicellular organisms that do not manufacture their own food. Therefore they - along with ourselves and many other creatures - are members of the kingdom Animalia. All fishes have a notochord (stiff cartilaginous rod extending along the back), a tubular nerve chord just above it, gill pouches in the throat region, segmental muscle blocks, and a tail posterior to the anus or cloaca. As such, they - along with less familiar creatures such as tunicates, acorn worms and lancelets - are card-carrying members of the phylum Chordata. All fishes have a backbone divided into segmental vertebrae (even those that lack bones), and are therefore members of the

FIGURE 14

Cluster analysis is finding groups of objects such that the objects in a group will be similiar (or related) to one another and different from (or unrelated to) the objects in other groups.



sub-phylum Vertebrata. Vertebrates include many of the most familiar animals: amphibians, reptiles, birds and mammals (including dogs, cats, horses, elephants, whales, apes, and us). Such non-fishy vertebrates are termed “tetrapods” - which means “four-footed,” in reference to the fact that all have two sets of paired limbs.

Living fishes are currently divided into a number of different classes, the two most importamnt being Sarcopterygii (lobe-finned fishes) and Actinopterygii (ray-finned fishes.) Figure 15 shows how these classes of living fishes are believed to be interrelated. Most familiar bony fishes - including sturgeons, gars, eels, herrings, carps, catfishes, salmons, mullets, perches, pipefishes, scorpionfishes, butterflyfishes, gobies, tunas, billfishes, flatfishes, pufferfishes, and many, many others - are placed in the class Actinopterygii. However, it is the class Sarcopterygii to which I would like to draw your attention.

The Sarcopterygii includes “primitive” fishes such as the lungfishes (represented in each of the southern continents by a separate family) and the coelacanth (Latimeria chalumnae), a long-lost survivor from the Age of Dinosaurs living in deep waters off southeastern Africa and Indonesia. They are most notably characterized by having jaws with fixed teeth, a bony skeleton, a skull with sutures, a type of scale known as “cosmoid,” and heavy, lobe-like paired fins (pectoral and pelvic) supported by stout bones. For this reason, they are informally known as the lobe-finned fishes. As their name suggests, lungfishes actually have primitive lungs and breathe not water, but air.

Consider that the tetrapods, too, have jaws with fixed teeth, a bony skeleton, a skull with sutures, and heavy, paired appendages. As we have seen, scales are not at all a defining character of fishiness, nor is breathing by way of gills. Therefore, based on many structural and physiological synapomorphies, the tetrapods not only share a common ancestor with the lobe-finned fishes, but are derived from them (Figure 16). The tetrapods are now generally believed to represent a subclass within the Sarcopterygii. And therein lies a major reason for the difficulties in defining fishes as a group. In a cladistic analysis the lungfish must form a sister group with the sparrow or elephant, leaving the trout in its stream. Fish - as the term is usually applied - is not a monophyletic taxon since if we are to include the common ancestor of the fish-like vertebrates and all of its descendants, then we must include the tetrapods. Thus, frogs, snakes, ducks, kangaroos, elephants, rats, bats, whales, and other mammals, are all sarcopterygian “fishes.” To put this another, more cogent way: cladistically speaking, we are fish.

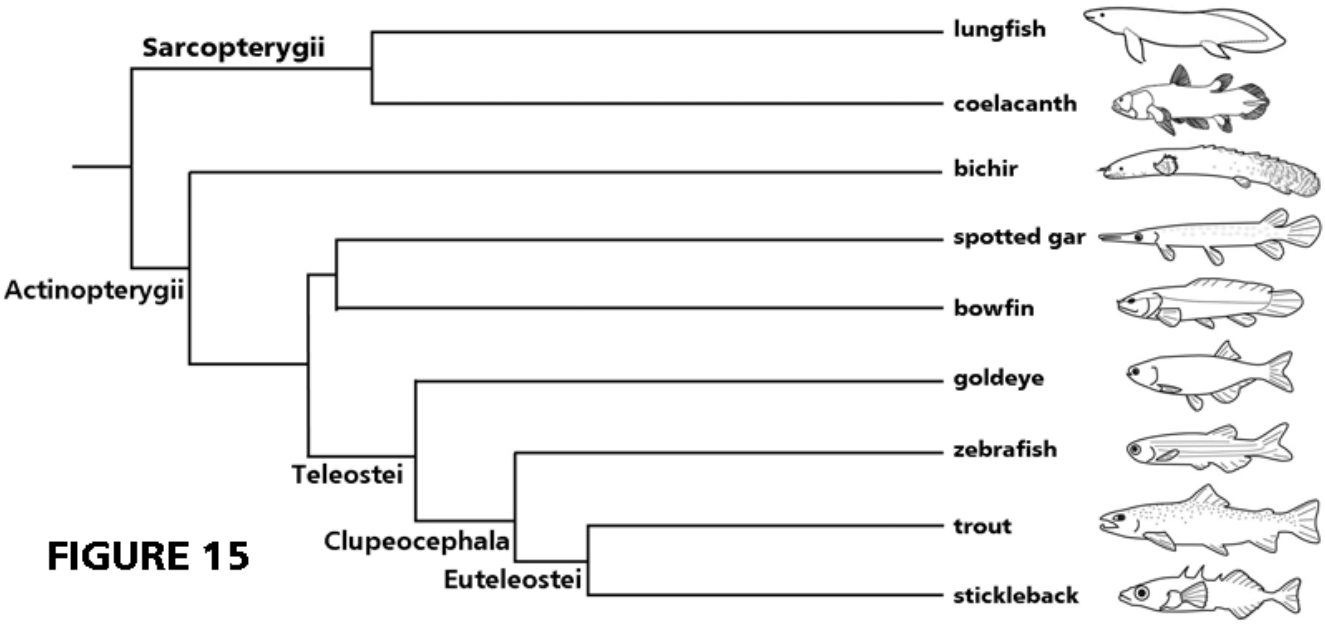


FIGURE 15

No debate in evolutionary biology has been more intense during the past decade than the challenge raised by cladistics against traditional schemes of classification. The cladogram of trout, lungfish and elephant is undoubtedly true as an expression of branching order in time, but must classifications be based only on cladistic information? A coelacanth looks like a fish, tastes like a fish, acts like a fish, and therefore - in some legitimate sense beyond hidebound tradition—*is* a fish.

The problem arises from the two rather different conceptions of "similarity" between organisms. On one hand, cladistics works with branching order alone, rigorously excluding any other notion of similarity. On the other, phenetics focuses on overall similarity alone and tries to escape the charge of subjectivity by insisting that phenetic classifications be based upon large suites of characters, all expressed numerically and processed by computer.

Unfortunately, as we have seen from the nail example, these two types of information - branching order and overall similarity -do not always yield congruent results. Thus the cladist rejects overall similarity as a snare and delusion and works with branching order alone. The pheneticist attempts to work with overall similarity alone and tries to measure it in the vain pursuit of objectivity. The traditional systematist tries to balance both kinds of information but often falls into hopeless confusion because they really do conflict. Coelacanths are like mammals by branching order and like trout by biological role. Thus, cladists

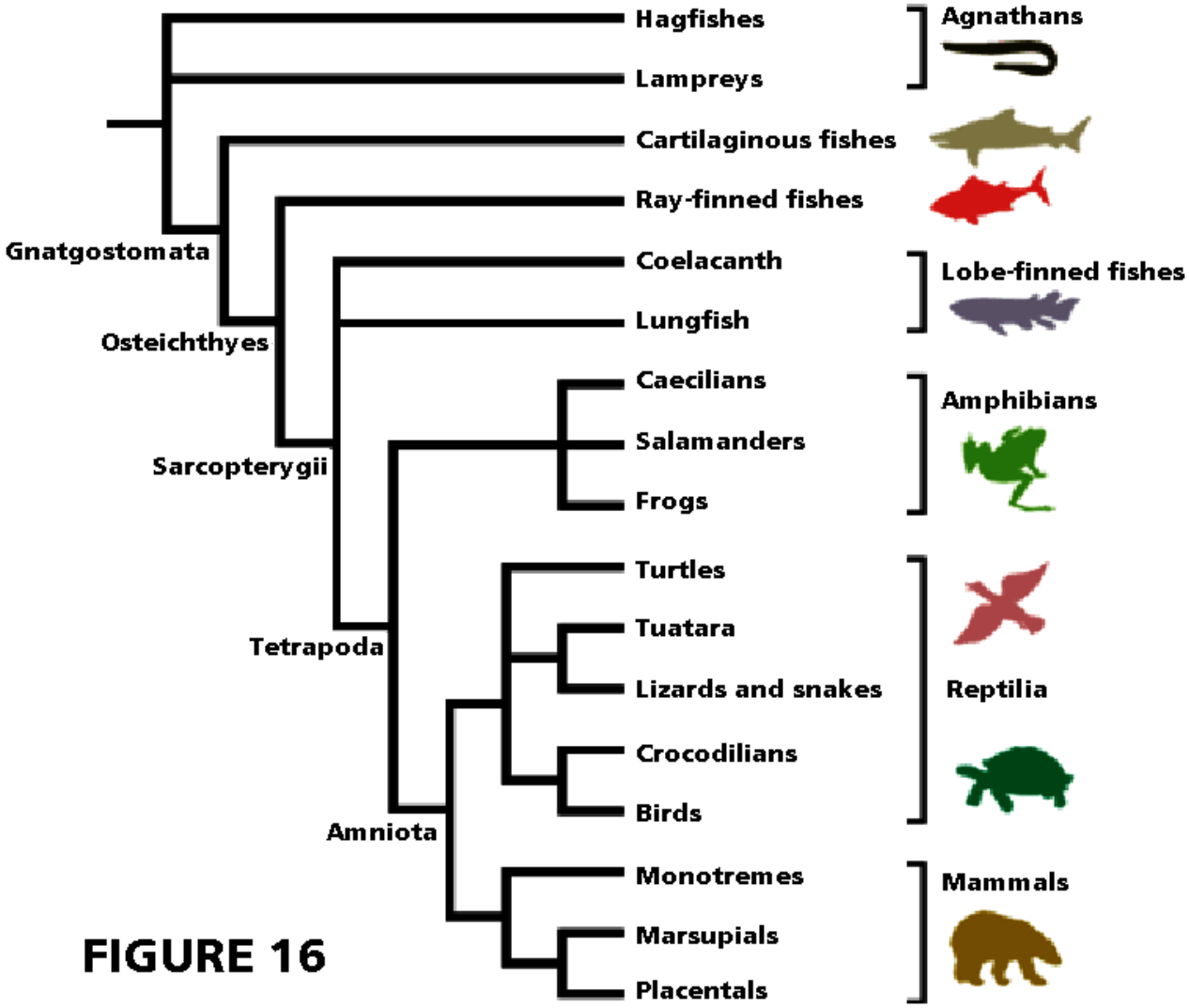


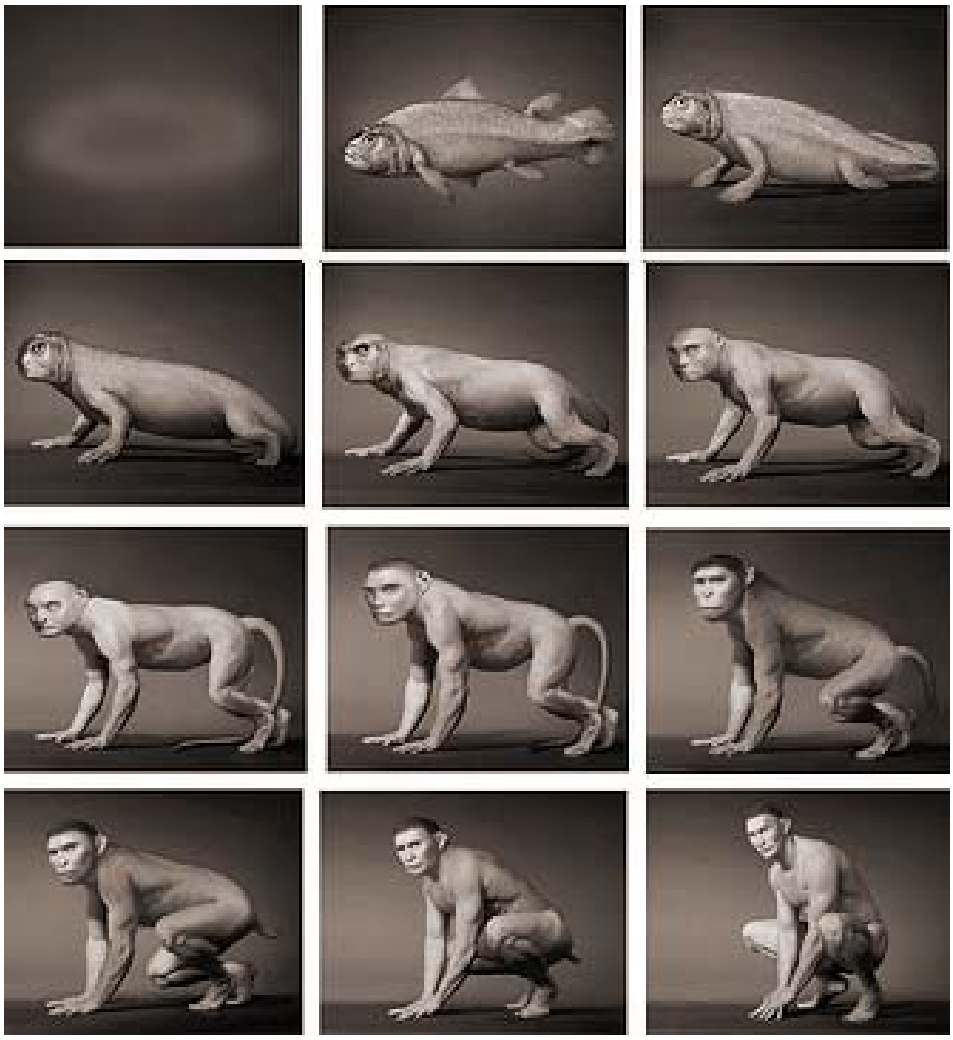
FIGURE 16

buy potential objectivity at the price of ignoring biologically important information. And traditionalists curry confusion and subjectivity by trying to balance two legitimate, but often disparate, sources of information. To quote Stephen Jay Gould from his essay on zebras,*

The world is much more interesting than ideal. Phenetic similarity often correlates very poorly with recency of common ancestry. Our ideal world requires a constancy of evolutionary rate in all lineages. But rates are enormously variable. Some lineages change not at all for tens of millions of years; others undergo marked alterations in a mere thousand. When the forebears of terrestrial vertebrates first split off from a common ancestry with coelacanths, they were still unambiguously fish in appearance. But they have evolved, along numerous lines during some 250 million years, into frogs, dinosaurs, flamingos and rhinoceroses. Coelacanths, on the other hand, are still coelacanths. By branching order, the modem coelacanth may be closer to a rhino than a tuna. But while rhinos, on a rapidly evolving line, are now markedly different from that distant common ancestor, coelacanths still look and act like fish - and we might as well say so. Cladists will put them with rhinos, pheneticists with tunas; traditionalists will hone their rhetoric to defend a necessarily subjective decision.

Nature has imposed this conflict upon science by decreeing, through the workings of evolution, such unequal rates of change among lineages and such a poor correlation between phenetic similarity and recency of common ancestry. I do not believe that nature frustrates us by design, but I rejoice in her intransigence nonetheless.

*Gould, Stephen Jay, "Hen's Teeth and Horse's Toes," Chapter 28, "What, if anything, is a Zebra?" W.W. Norton and Company Ltd., pp-355-365, London, 1984.



A HISTORY OF AQUARIUM KILLIFISHES

by Albert J. Klee

(AKA killie notes, Volume 2, Number 3, Summer Issue, 1963)

Data concerning the chronological acquisition of killifishes in this country is almost nonexistent unless we take as our starting point, the post World War II years. Much the same can be said for all other countries with the single exception of Germany. The reasons for this situation in our own country are not hard to find. Prior to World War II there existed but a single American work that merited the appellation, "reference book", i.e., Innes' "Exotic Aquarium Fishes". All others, regardless of isolated merits here and there, were either introductory booklets or rambling discussions of popular topics in the aquarium hobby. Dr. Innes' book has been called, and not without some justification, the fish "bible" for American aquarists. In compiling his catalog of fishes he chose not to imitate the current styles or formats, but rather to devise a new approach, one which still basically has never been improved upon (however, it has been widely copied). Unfortunately, the one weakness of this book was that it failed to include historical information about the fishes it described.

At the same time the first edition appeared, the aquarium hobby in the United States was still in its infancy and few references were available containing such historical data. The situation in Germany was quite different, however. Not only were there numerous books published about aquarium fishes, but the German hobby boasted a number of active periodicals as well. In line with the well- known Teutonic proclivity towards documentation, every new import was duly and quickly written up and reported in print. Thus, the task of the German author was made immeasurably easier. Even to this day, our books fail to list historical information. One must fall back on magazine articles, most of which are deficient in this matter also.

The aquarium hobby was introduced to America mainly via German hobbyists, many of whom migrated to this country. As Germans received new fishes, it wasn't too long before they were sent to friends and hobbyists in America. Thus it would not be far afield for us to discuss the pre World War II chronology of killifish importations into Germany, the data for which is fairly reliable. Such a list is shown in Table I, the nomenclature having been brought up to date. From this listing, a number of things are made clear. Aquarists frequently wonder why our handbooks include species that few, if any, hobbyists have ever seen. Partly this is a matter of copying, one book listing fishes from a previous one. Then too, there is always pressure to be "complete". For example, the first killifish listed in Table I is Valencia hispanica (see figure 1). It is, at 1881, our earliest recorded aquarium killifish. Although it was again imported into Germany during the early 1900's, it has not appeared on the aquarium scene since. However, if one were to avoid all information about this fish, then it would be just our luck to see it re-imported in the near future! In addition, aquarists become interested in fishes only when they know something about them and if information is made available about rare fishes, hobbyists may militate for our importers to obtain them.

Some aquarists may be surprised to learn how "old" in the aquarium sense, some of our killies really are. As a partial listing of "firsts" in the importation of important killifish genera, Table II has been prepared.

Of course, the fishes listed in these tables were not necessarily known by these names at the time. In the early days of our hobby, "*Fundulus*" and "*Haplocheilus*" were common terms. Among those fishes included in the former (besides the fishes we today know under that name) were: *Cubanichthys, Valencia, Nothobranchius, Profundulus* and *Aphyosemion* (especially members of the subgenus *Fundulopanchax*). Among those fishes included in the latter were: *Aplocheilus, Epiplatys, Pachypanchax, Aphyosemion* (especially members of the subgenus *Aphyosemion*), and *Micropanchax*. Forgotten names such as "*Adinops," "Lebias*" and "*Panchax*" were prevalent in those early days. Anyone doing research nowadays using old texts is haunted by these ghosts!

TABLE I: CHRONOLOGY OF KILLIFISH IMPORTATIONS INTO GERMANY PRIOR TO WORLD WAR II

Before 1900
1881 Valencia hispanica
1890 Fundulus majalis
1895 Oryzias latipes
1899 Aplocheilus panchax

1900 to 1909
1903 Rivulus santensis
1904 Pachypanchax playfairii
Aphanius dispar
Fundulus chrysotus
Fundulus notti
Micropanchax schoelleri
1905 Rivulus urophthalmus
Fundulus catenatus
Fundulus diaphanus
Aphyosemion arnoldi
Cyprinodon variegatus
Epiplatys sexfasciatus
Aphyosemion coeruleum
1906 Fundulus heteroclitus
Rivulus ocellatus
Aplocheilichthys spilauchen
Rachovia brevis
Cynolebias bellottii
1907 Aphyosemion gulare
Fundulus grandis
1908 Aphyosemion loennbergii
Aphyosemion liberiensis
Aphyosemion gardneri
Aphyosemion calliurum
Aphyosemion bivittatum
Epiplatys chaperi
Epiplatys longiventralis
Cynolebias nigripinnis
1909 Rivulus isthmensis
Aplocheilus lineatus
Aphyosemion sjoestedti
Rivulus tenuis

1910 to 1919
1910 Fundulus cingulatus
Epiplatys grahami
Rivulus strigatus
Aphanius sophiae
Micropanchax macurus
Cynolebias wolterstorffi
Oryzias javanicus
Oryzias melastigma
Epiplatys senegalensis
1911 Fundulus notatus
Aphanius iberus
Epiplatys fasciolatus
Epiplatys macrostigma
Aphyosemion bitaeniatum
1912 Cynolebias melanotaenia
Oryzias celebensis
Cynolebias elongatus
1913 Aphyosemion australe
Aphyosemion cameronense
Aphanius fasciatus
Nothobranchius guentheri
1914 Jordanella floridae

1920 to 1929
1921 Cynolebias adloffi
1923 Rivulus dorni
1924 Rivulus xanthonotus
Leptolucania ommata
1925 Nothobranchius rachovii
1926 Micropanchax macrophthalmus
1927 Rivulus hartii
Aphyosemion vexillifer
1928 Epiplatys ornatus
Lucania goodei
Aphyosemion multicolor
Aphyosemion oeseri
1929 Aphyosemion splendopleuris
Micropanphax flavipinnis
Rivulus cylindraceus

1930 to 1939
1930 Pterolebias longipinnis
Aphyosemion fallax
Aphyosemion meinkeni
1931 Fundulus sciadicus
Aphyosemion filamentosum*
1932 Profundulus punctatus
Cubanichthys cubensis
Aplocheilus dayi
Aphyosemion rubrostictum
1933 Cynolebias schreitmuelleri
1935 Epiplatys dorsalis
Aphyosemion calabaricum
1936 Aphyosemion roloffi
Nothobranchius orthonotus
1937 Micropanchax katangae
Epiplatys nigromarginatus
1938 Rivulus roloffi
Kosswigichthys asquamatus

*There is evidence to suggest that this fish was imported prior to 1923.

Data for Table I was taken mainly from the following texts:

Anon, "Katalog der Vereinigten Zierfischzuechterein," 1922/1923.
Arnold, J. P., "Alphabetisches Verzeichnis der bisher eingefuehrten fremdlaendischen Suesswasserfische." 1949.
Holly, M; Meinken, H; and Rachow, A., "Die Aquarien- fische in Wort und Bild", 1932 to 1963.

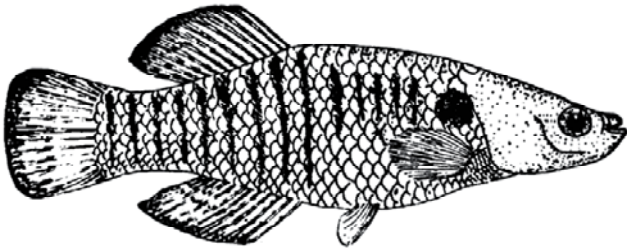
The following is the source of the figure to the right shown below:

Brylińska Maria (Editor), "Ryby słodkowodne Polski" ["Freshwater Fishes of Poland"], Polish Scientific Publishers PWN, Warszawa, Poland, 2000.

TABLE II: DATES OF INITIAL IMPORTATIONS OF IMPORTANT KILLIFISH GENERA INTO GERMANY

1890	**First Fundulus (F. majalis)**
1895	**First Oryzias (O. latipes)**
1899	**First Aplocheilus (A. panchax)**
1903	**First Rivulus (R. santensis)**
1904	**First Micropanchax (M. schoelleri)**
1904	**First Pachypanchax (P. playfairii)**
1905	**First Aphyosemion (A. coeruleum)**
1905	**First Epiplatys (E. sexfasciatus)**
1906	**First Aplocheilichthys (A. spilauchen)**
1906	**First Cynolebias (C. bellottii)**
1913	**First Nothobranchius (N. guentheri)**
1930	**First Peterolebias (P. longipinnis)**

***Valencia hispanica*, the first aquarium killifish.**
The image on the left was the one shown in the original article. However, the shape of the head was Drawn incorrectly. The image on the right shows the shape more accurately.



ENDLER'S GUPPY AND THE DESKTOP COMPUTER

by Albert J. Klee, Ph.D
(Aquarium Hobby Historical Society, Files, March 21, 2015)

Although I have written a good deal about introductory cladistics (all of which can be found in my "Essays on Aquarium Hobby History") Schories et al. 2009 paper in which they stated that "*P. wingei* is now unequivocally defined by the molecular phylogeny as a valid species" contained some techniques in their "Material and Methods" section that I have not heretofore described. To quote from their paper, "Heuristic and branch-and-bound tree searches were performed using both parsimony and distance (minimum evolution). Neighbor-joining (NJ) trees were also constructed. Robustness of the trees was tested by bootstrap analyses using 20000 replicas." In this essay I will endeavor to explain these terms and talk a bit about computation.

NEIGHBOR-JOINING METHODS

Firstly, phylogenetic trees can be drawn with or without a root (see Figure 1). For rooted trees, the root is the common ancestor. For each taxon (usually species or genus in our case), there is a unique path that leads from the root to that taxon, the direction of each path corresponding to evolutionary time. An unrooted tree specifies the relationships among taxa but does not define the evolutionary path. An unrooted tree can be rooted, but for any given unrooted tree there are many possible rooted trees that can be derived. Rooting a tree usually requires identification and use of an outgroup, i.e., a taxon that is more distantly related than the taxa contained within the tree. I mention this because when discussing computer calculations, unrooted trees are simpler to deal with and more often than not, phylogenetic software frequently uses them as a matter of course.

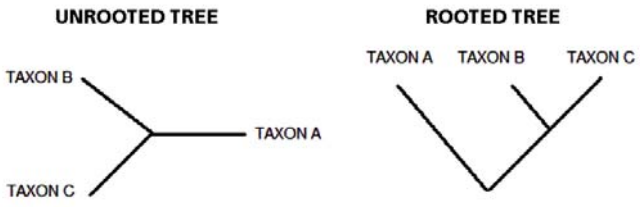


FIGURE 1: ROOTED VERSUS UNROOTED TREES

The Schories paper states: "The molecular data were analyzed with maximum likelihood, parsimony and neighbor-joining methods which yielded almost identical phylogenetic results. The topology of the resulting trees was always the same."

As I have written previously, there are basically two methodologies by which phylogenies can be reconstructed: phenetic and cladistic. Trees made by cladistic methods are referred to as cladograms; phenetic trees are phenograms. However, in colloquial usage, phenogram is barely heard and cladogram has come to dominate, even when phenetic methods are used for tree construction. This annoys cladists no end since the characters entered into the basic data matrix for a calculation are assumed to be synapomorphies, i.e., shared derived characteristics and thus their resulting tree has evolutionary implications. To pheneticists, any characteristic is fair game and thus their tree has similarity implications.

While you might have heard that phenetics is a naughty word, phenetic methods are still widely in use in classification and in molecular systematics. To aquarists, classification is of far more importance than evolution since aquarists usually only want a name for what is being offered as a species or genus and nothing more.

Phenetics has major problems for phylogenetic reconstruction, mostly stemming from differing algorithms, their assumptions and their calculation. That said, there are some undeniable advantages to phenetics, which is why it is still around. It allows us to combine morphological and molecular matrices together, and it is also less skill-intensive – anyone can measure the width of an ant head, but not many can recognize the derived trait that that separates the Formicinae, which is what one would need when working cladistically. Phenetics is thus arguably easier for field guides and identification keys, items of far more importance to aquarists than is evolutionary theory.

Cladistic analyses most often use parsimony as their criterion for determining their tree, whereas phenetic analyses typically use distance-based criteria. What is meant by "distance-based" is that in phenetics, the number of DIFFERENCES between data sets is quantified. To do this, a mathematical formula is used to describe the degree of similarity or distance between each pairwise comparison of taxa. One simple formula is the Simple Matching Coefficient (S) and is defined as follows:

S = [total number of character matches between two taxa] x 100/ total number of characters.

For example, consider the following character matrix where 1 indicates that the character is present and 0 indicates that it is not:

TAXON	DATA									
A	0	1	1	0	0	0	1	1	1	0
B	0	0	0	1	1	1	0	1	1	1
C	0	0	1	0	0	1	0	0	0	1
D	1	1	0	0	0	1	1	1	1	0

Using the above formula, the following distance matrix is constructed:

	A	B	C	D
A	-	0.3	0.4	0.6
B		-	0.5	0.4
C			-	0.3
D				-

After a distance matrix is computed, it is then run through an algorithm, i.e., a procedure or formula for solving a problem. These algorithms fall into two categories: those based on clusters and those based on optimality.

The cluster-based methods are the simplest and since the Schories paper used a cluster-based method, this is what I will describe. What they do is initially combine everything into pairs based on their similarities, forming the tips of the tree. The similarity matrices for the pairings are recalculated, and another round of grouping takes place, forming deeper nodes in the tree. Eventually, when everything is combined into one group, one obtains the final tree.

One of the most often encountered algorithms for doing this is the neighbor-joining method (NJ). NJ is the most popular to use for "quick-and-dirty" analyses – the results are usually astoundingly accurate and the computation is quick. It is commonly used for trees based on DNA or protein sequence data and, as mentioned, the algorithm requires knowledge of the distance between each pair of taxa in the tree.

In Figure 2 we start with a star tree of seven taxa (A). A distance matrix is used to choose a pair of closest nodes for joining, in this case f and g. These are joined to a newly created node, u, as shown in (B). The part of the tree shown as solid lines is now fixed and will not be changed in subsequent joining steps. This process is then repeated, using just the distances between the nodes a, b, c, d, e and u. In this case u and e are joined to the newly created v, as shown in (C). Two more iterations lead first to (D), and then to (E), at which point the algorithm is done, as the tree (unrooted in the example) is fully resolved.

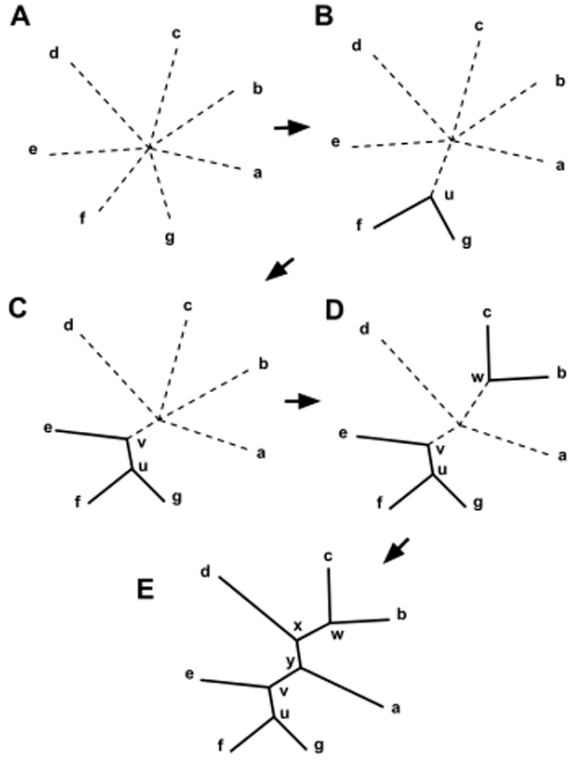


FIGURE 2: NEIGHBOR-JOINING

EXACT METHODS

The Schories paper stated that "Heuristic and branch-and-bound tree searches were performed …" Computerized searches to find cladograms can be divided into two groups: exact methods and heuristic methods. The exact method is shown in Figure 3 using five taxa, A, B, C, D and E. First, three taxa are chosen and connected to form the only possible unrooted resolved cladogram for these taxa (Figure 3, top cladogram). A fourth taxon is then selected (which taxon is chosen is immaterial) and joined to each of the three branches of cladogram 1, yielding three possible networks for four taxa (Figure 3, second row) Note that at this point taxon A has been chosen as the root and all cladograms are rooted. (The majority of the computer algorithms used to estimate most parsimonious cladograms actually generate unrooted networks.) A fifth taxon is then selected and added to each of the five branches of the three cladograms, giving 15 cladograms (Figure 3, rows 3-5) and all taxa have been added. The lengths (i.e., the number of steps or changes in character traits) of all these cladograms are calculated and the shortest, i.e., the one with the smallest number of character changes is the optimal, i.e., most parsimo-nious.

Number of taxa	Number of rooted trees	Number of unrooted trees
1	1	-
2	1	1
3	3	1
4	15	3
5	105	15
20	8,200,794,532,673,891,559,375	221,643,095,476,699,771,875

FIGURE 4: NUMBER OF TREES VERSUS NUMBER OF TAXA

The problem with exact methods is that as the number of taxa considered increases, the number of trees increases much more rapidly, especially with rooted trees (see Figure 4). The taxa in the Schories paper consisted of various specimens taken from different localities of four species of *Poecilia*, plus *Micropoecilia picta* as an outgroup, resulting in a total of 37 taxa. Just for 20 taxa, the number of possibilities that must be evaluated is huge.

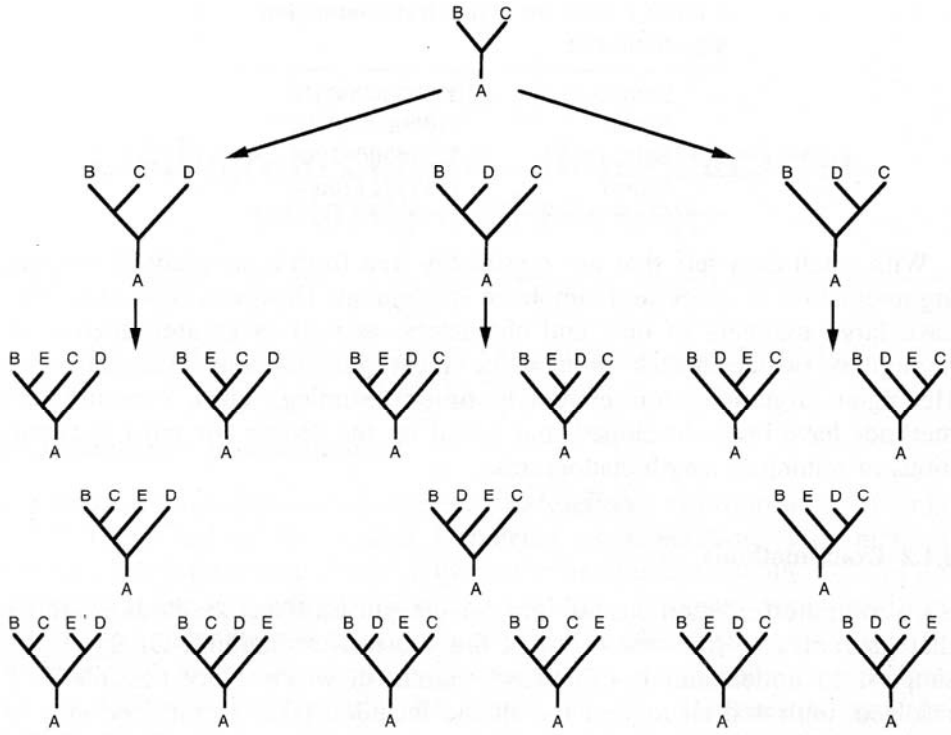


FIGURE 3: EXACT (EXHAUSTIVE) SEARCH

Branch-and-Bound (Figure 5) is an exact technique that does not require every possibility to be examined individually. In this method a cladogram is constructed for all the taxa using one of the heuristic techniques that we will discuss later. The length of this cladogram is stored in the computer memory and called the "upper bound" (100 steps where step = one character change). The Branch-and-Bound method then proceeds as in the exact search routine. As each of the paths is followed, the lengths of the partial cladograms (those in which

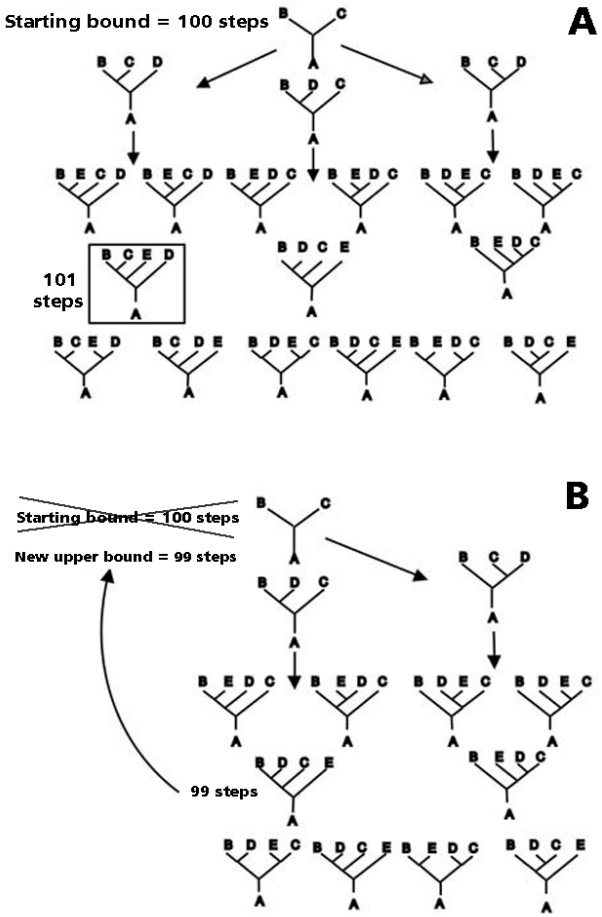


FIGURE 5: BRANCH-AND-BOUND

not all taxa have been yet added) is calculated. As soon as the length of a cladogram in any path is longer than the upper bound, that entire path is abandoned because the addition of more taxa can only increase the length of the cladogram further. If one of the paths is completed and a shorter cladogram is found, this then becomes the new upper bound.

In Figure 5 we started the analysis by assuming that the starting bound was 100 steps. In row 4, however, the cladogram has 101 steps so the whole portion of that part of the tree in part A is discarded (part B of the figure). Note that one of the cladigrams has only 99 steps. This now becomes the new upper bound and the process continues. By this method the number of cladograms that have to be evaluated is drastically reduced. Even so, Branch-and-Bound usually begins to stress most computers at about 15 to 20 taxa.

HEURISTIC METHODS

For larger data sets, approximate or heuristic methods that generally use "hill climbing" techniques must be used. These approaches are essentially trial-and-error and do not guarantee to find all - or even any – of the minimum length cladograms. Thus, certainty of finding the optimal results is sacrificed in favor of reducing computational time.

The heuristic method example here starts with the same first three taxa (Figure 6a). It then adds the fourth taxon, calculates the lengths, and discards all but the shortest (Figure 6b). This means that even if the addition of the next taxon to one of the cladograms now discarded should turn out to yield trees shorter than those retained it will not be considered again; it has already been discarded because of the inferiority of its antecedent cladograms. If there is a tie in the lengths of the cladogram one will arbitrarily be discarded (Figure 6c). It is possible, therefore, that by discarding paths of cladogram building so early we are forced onto a path that may lead to a less than optimal cladogram length.

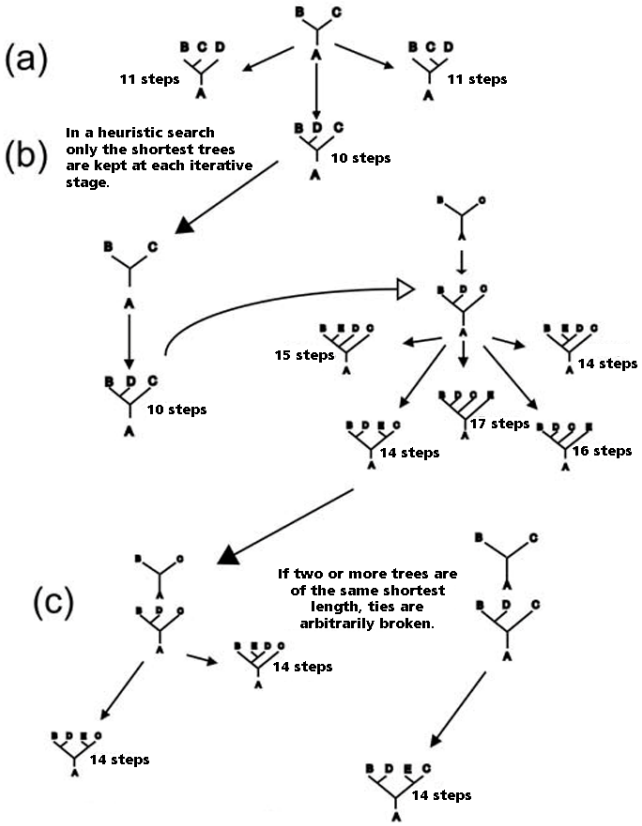


FIGURE 6: HEURISTIC SEARCH

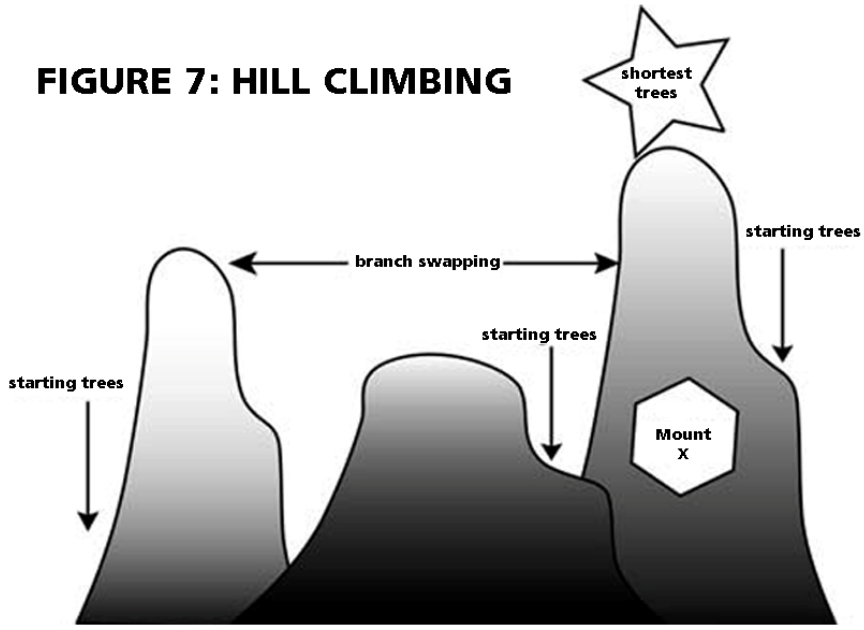


FIGURE 7: HILL CLIMBING

This can be illustrated by using the analogy of a hill climber wishing to reach the highest peak using the shortest route which, in our case, is the shortest cladogram. Figure 7 is meant to illustrate the problem. Each of the mountains represents a path of cladogram construction. If we happened to start on any mountain but Mount X we would never reach the optimal solution and, having started to climb a particular mountain (i.e., started a path of tree building), we cannot go back. We could (1) choose to start somewhere else (on another hill); in other words we could change the order in which we add the taxa; or (2) having started to climb and if we were wearing a rocket backpack, we could jump horizontally from one hill to another in the hope of landing on a more promising hill. Both tactics are invoked in heuristic algorithms.

The order in which taxa are to be added to the heuristic search is called "stepwise addition" and is an attempt to start on different mountains. Figure 8A shows how a single search can maroon the hill climber on a local minimum. In Figure 8B, multiple searches on different starting points increases the likelihood of finding the global maximum.

Another approach, the equivalent of jumping from one mountain to another, performs a series of predefined rearrangements of the cladogram in the hope that a shorter cladogram will be found. This rearrangement, commonly referred to as "branch-swapping," is very hit-and-miss but if a shorter cladogram does exist and sufficient rearrangements are performed, then one of these rearrangements is likely to find it. By using a combination of stepwise addition and branch swapping the heuristic algorithm more than likely will find the shortest tree(s).

In stepwise addition we start with three taxa and then add taxa one at a time at each of the branches of the tree from the previous step. The best tree is retained according to the parsimony (shortest path) criterion. There a number of ways the addition can be carried out and two are shown in Figure 9. In the ASIS sequence we start with taxa A, B and C then add D, E and F at the fourth, fifth and sixth steps. In the Random sequence we start with taxa A, B and C then

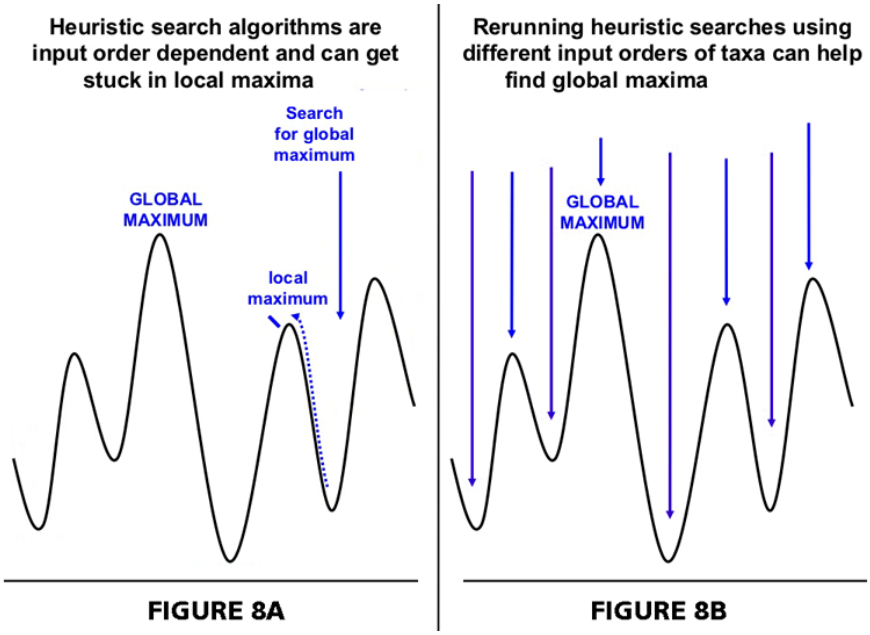


FIGURE 8A **FIGURE 8B**

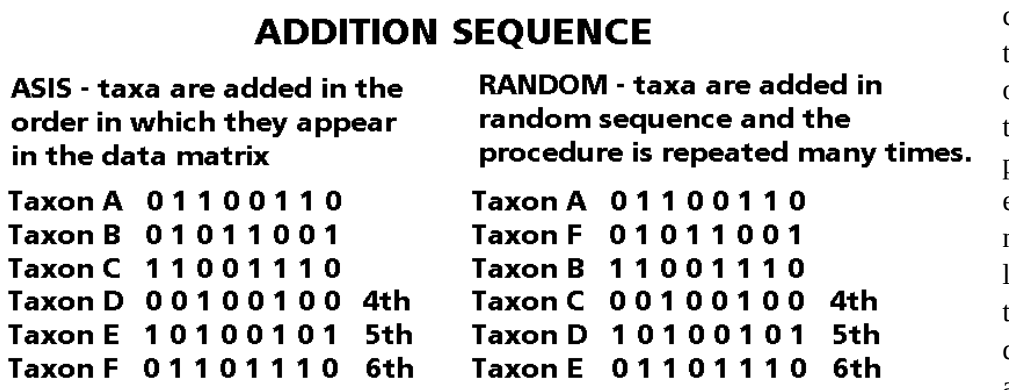


FIGURE 9: STEPWISE ADDITION

add C, D and E (these were selected randomly) at the fourth, fifth and sixth steps. The random addition sequence is most often used. It is also useful in that it can provide a number of different starting points and thereby improve the chances that at least one will lead to the global, rather than a local, optimum.

Branch-swapping algorithms are implemented by all cladistic computer packages. The simplest rearrangement is nearest-neighbor interchange, sometimes referred to as local branch-swapping. For any internal branch, there are just two such nearest-neighbor interchange rearrangements. In Figure 10, the chosen branch (indicated by the short arrow) has a pair of nearest-neighbor groups at either end, A + B, C and D, E + F. One of these from the left end (C) is interchanged with each of those on the right end (D or E + F) in turn to give two new topologies. The procedure is then repeated for all possible internal branches and the lengths of the resulting topologies calculated to determine whether they are shorter.

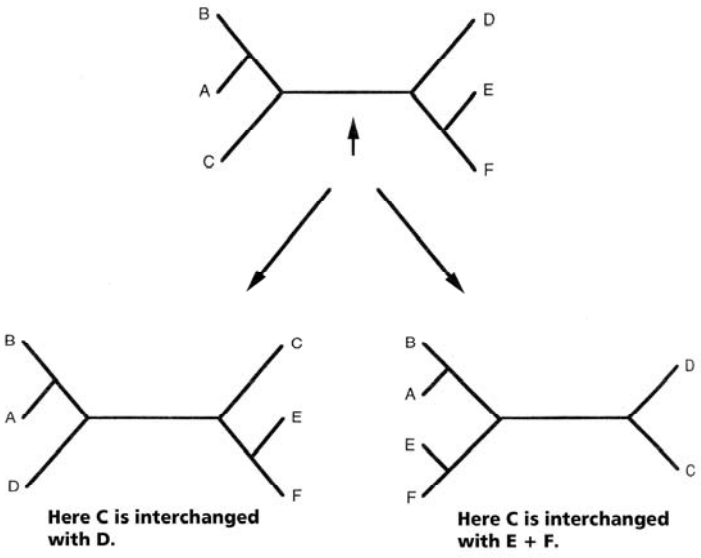


FIGURE 10: BRANCH SWAPPING

Note that the Branch and Bound technique discussed in the exact methods section uses any one of these heuristically-derived minimum lengths as a starting point.

CONSENSUS TREES

Often a tree building routine will report more than one parsimonious tree. In other words, the data used is compatible with more than one cladogram or tree. In such circumstances there are two things that one can do. We can choose one of the trees as the one we favor (the criteria by which we do this are varied and usually based on biological or geological arguments) or we can establish the common elements between the trees, i.e., the lowest common denominator. For the second route, consensus trees are constructed. There are several kinds of consensus trees but I will discuss only two here: Strict and Majority Rule.

Let us assume that as a result of an analysis we ended up with three equally parsimonious cladograms shown in the top row in Figure 11. These are called the starting or fundamental trees because they are the three alternatives derived from the analysis of the data. The simplest way to combine the elements of all three cladograms into one is to show only those components that appear in all three cladograms. By scanning across the three trees we see that relationships differ between A, B and C, and again between D, E and F. However, the two groups, ABC and DEF, are the same in all trees. Therefore if we combine this infor-

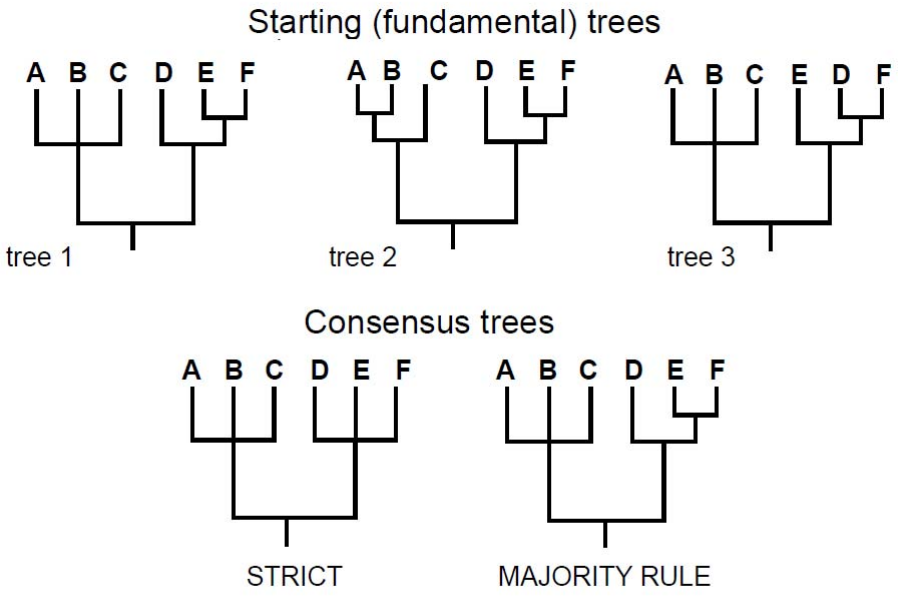


FIGURE 11: CONSENSUS TREE CONSTRUCTION

mation we end up with the tree to the left in the second row. This is known as the Strict Consensus method. Many purists believe that this is the only consensus method that should be considered, all others being tainted by concessions that cannot be justified. Other practitioners think otherwise.

The Majority Rule simply takes those solutions within the starting trees that are found in the majority of the trees. Thus the grouping (A,B,C) is found in two out of three trees and the grouping (D (E,F)) is also found in two out of three.

BOOTSTRAPPING

With the increasing emphasis by systematic biologists on tree construction, questions arose as to how confident one should be in a given phylogenetic tree and how support for phylogenetic trees should be measured. The bootstrap was introduced in 1979 by statisticians to obtain estimates of error in non-standard situations by resampling the data set many times to provide a distribution against which hypotheses could be tested. Very soon after the introduction of the bootstrap, it was applied to questions in phylogeny reconstruction and formally proposed as a method for obtaining confidence limits on cladograms.

Bootstrapping reanalyzes the data of the original character-taxon matrix by selecting (resampling) CHARACTERS at random. In this way any given character can be selected more than once. The start of the method is shown in Figure 12 and, for a change, I will use molecular data - nucleotide characters - rather than morphological data in this example: G is guanine, A is adenine, T is thymine and C is cytosine. The original data set of 4 taxa (A–D) each with 10 nucleotide characters is resampled across characters (with replacement) to produce bootstrap pseudoreplicates. Each pseudoreplicate contains each of the 4 original taxa, but

Original Data Set

Taxa	Characters
	1 2 3 4 5 6 7 8 9 10
A	C G A A C C A C T T
B	C G A A C C G G T T
C	G G T A C C G G A T
D	G C T A G C G C A T

Bootstrap Data Sets

Bootstrap Pseudoreplicate 1:

Taxa	Characters
	8 10 7 4 1 10 2 8 5 3
A	C T A A C T G C C A
B	G T G A C T G G C A
C	G T G A G T G G C T
D	C T G A G T C C G T

Bootstrap Pseudoreplicate 2:

Taxa	Characters
	1 8 10 4 2 9 2 8 5 6
A	C C T A G T G C C C
B	C G T A G T G G C C
C	G G T A G A G G C C
D	G C T A C A C C G C

Bootstrap Pseudoreplicate 3:

Taxa	Characters
	3 2 5 7 1 6 9 4 4 10
A	A G C A C C T A A T
B	A G C G C C T A A T
C	T G C G G C A A A T
D	T C G G G C A A A T

Bootstrap Pseudoreplicate 4:

Taxa	Characters
	7 8 5 8 9 6 4 10 1 5
A	A C C C T C A T C C
B	G G C G T C A T C C
C	G C G A C C A T G C
D	G C G C A C A T G C

FIGURE 12: BOOTSTRAPPING DATA GENERATION

some original characters for those taxa are represented more than once and some not at all.

Each bootstrap data set is analyzed and the cladograms resulting from parsimony analysis of each bootstrap data set are shown in Figure 13. The seven trees from all four of these pseudoreplicate data sets are then summarized in a consensus tree, typically a 50% majority rule consensus tree that shows all clades recovered in more than 50% of all trees (four out of the seven or 57% had the CD clade and four out of the seven or 57% had the BCD clade.

There is, however, a serious and fundamental problem with the bootstrap. This is the requirement that the characters in the original data matrix should represent a random sample of all possible characters. However, in systematic studies, characters are not randomly sampled from independent, identically distributed populations. Rather, they are carefully selected and filtered with the aim of best resolving the relationships of the taxa under study. However, most systematists view bootstrap values as relative assessments of clade support rather than strict statistical values. In this sense, consensus has been reached among practitioners, if not among statisticians and theoreticians. Despite concerns, controversy and confusion over interpretation of bootstrap values, bootstrap analyses have played a prominent role in many phylogenetic studies and likely will remain a key method for assessing nodal support in phylogenetic trees. Given that most systematists are most interested in identifying well-supported groups, the ease of bootstrap analysis using readily-available computer packages ensures that the bootstrap will continue to be widely used in systematic circles for the foreseeable future.

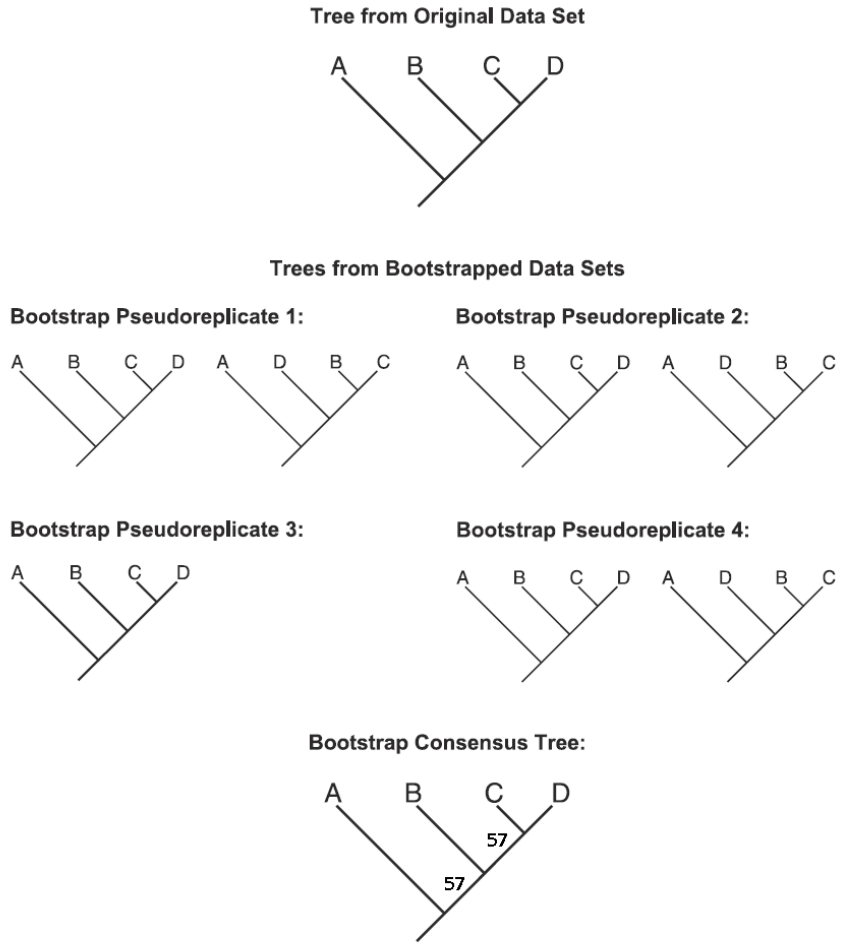


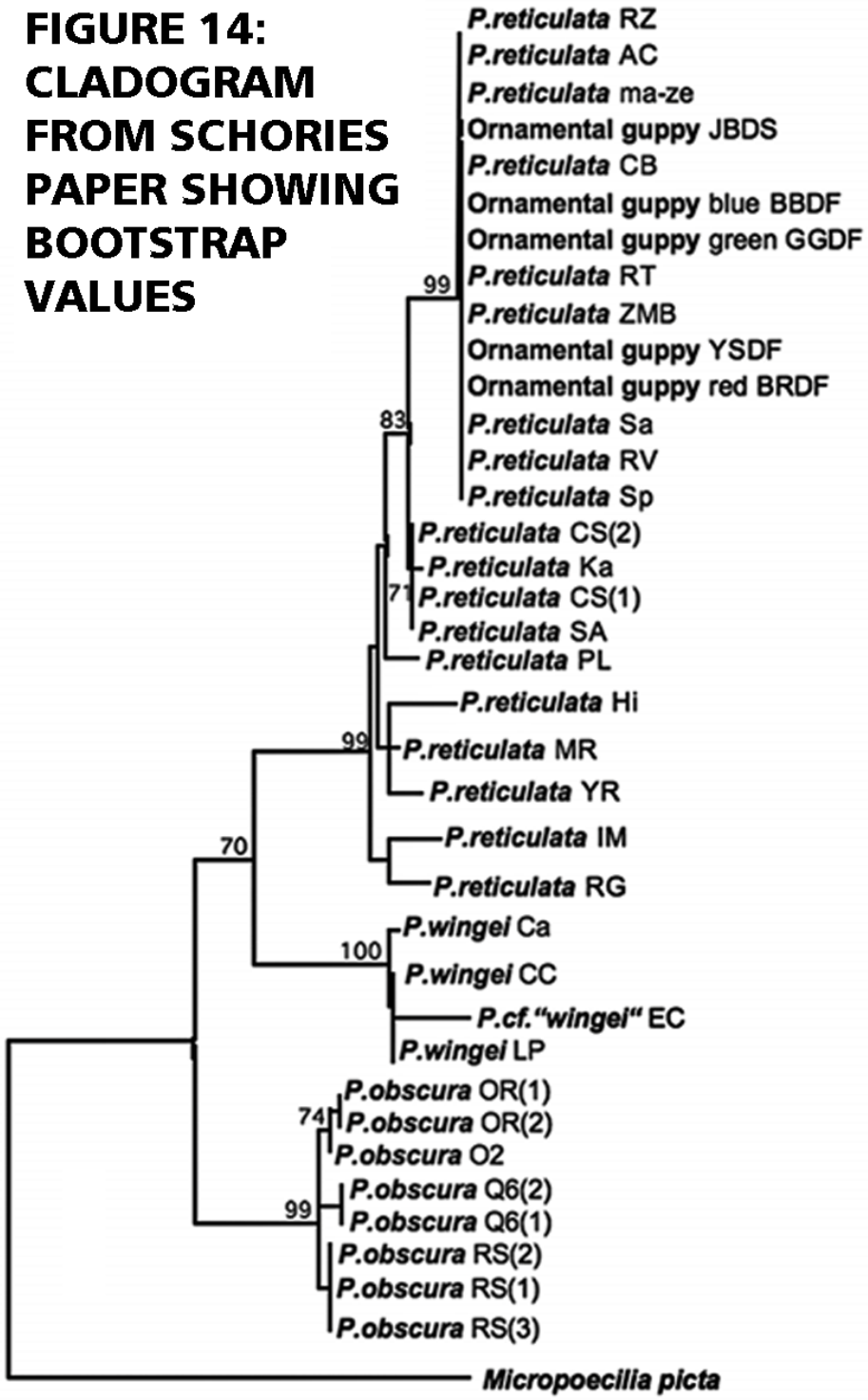
FIGURE 13:
CONSTRUCTION OF BOOTSTRAP CONSENSUS TREE

Cladograms (and phylogenetic trees in general) are typically presented with bootstrap values associated with the nodes. Figure 14 shows a cladogram from the Schories paper showing the relationships among various specimens taken from different localities of four species of *Poecilia*, plus *Micropoecilia picta* as an outgroup, based upon strict consensus of the most parsimonious trees. The bootstrap values for 20000 replicates are shown. Note that some nodes receive bootstrap values of 100%, indicating strong support for these nodes, whereas other nodes receive weaker support.

COMPUTER PROGRAMS

There are many phylogenetic software programs to choose from but my own preferences are PAUP and PHYLIP. PAUP (Phylogenetic Analysis Using Parsimony), written by David L. Swofford of the School of Computational Science and Information Technology, Florida State University,

FIGURE 14: CLADOGRAM FROM SCHORIES PAPER SHOWING BOOTSTRAP VALUES



Tallahassee, Florida, as the name implies originally, only implemented parsimony, but from version 4.0 (when the program became known as PAUP*) it also supports distance matrix, invariants, and maximum likelihood methods and many indices and statistical tests. PHYLIP (PHYLogeny Inference Package), written by Joseph Felsenstein, Professor in the Department of Genome Sciences and the Department of Biology at the University of Washington, Seattle, supports parsimony, distance matrix, and likelihood methods, including bootstrapping and consensus trees. Data types that can be handled include molecular sequences, gene frequencies, restriction sites and fragments, distance matrices, and discrete characters. Both run on Windows and Mac OS X; PHYLIP is free (I have the Windows version on my computer) and the Windows version of PAUP costs $85 (I have used the Windows version on my university's computer). The program used in the Schories paper was MEGA 3.1 and, like PHYLIP, it also is free.

Using phylogenetic software is not for the faint of heart since one has to know the relevant biology and also be comfortable with computers, the latter especially with the free programs since most run from the command line and do not have a mouse interface with the computer.

Two of the PAUP menus are shown in Figure 15 (the PAUP interface is much easier to use than the PHYLIP interface). A glance at the Analysis menu shows that all of the computations I have discussed in this essay are implemented here (the first two menus have to do with data input and intermediate output). The Trees menu is concerned with output and I have shown an example produced by an exhaustive search in Figure 16

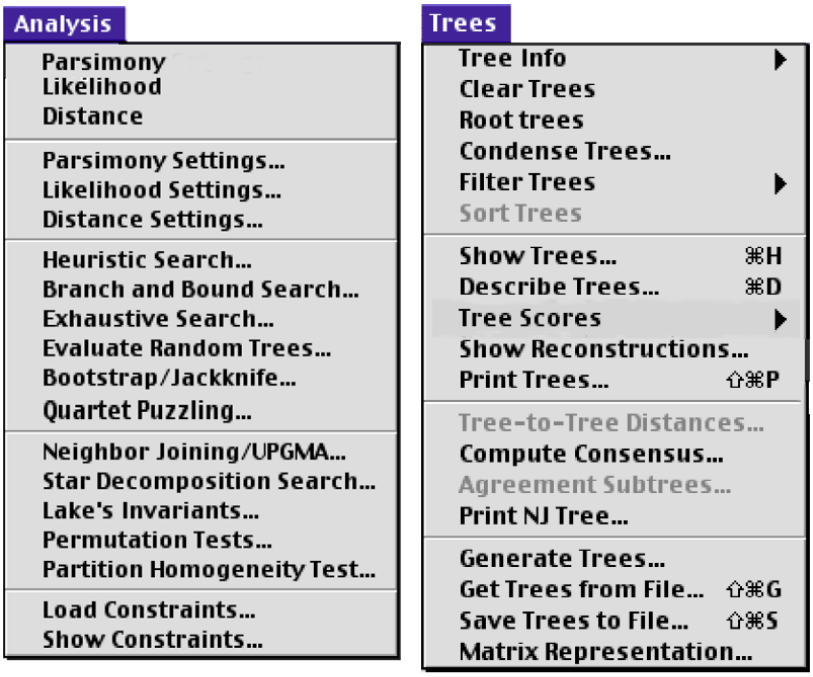


FIGURE 15: PAUP MENUS

where the tree is presented in the form of a distribution. The top of the diagram indicates that four most parsimonious trees were found, one that was just one step longer and seven that were two steps longer. The program can then be used, after selecting any or all of these cladograms, to produce a consensus tree.

Schories, S., M.K. Meyer and M. Schartl, "Description of *Poecilia* (Acanthophacelus) *obscura* n. sp., (Teleostei: Poeciliidae), a new guppy species from eastern Trinidad, with remarks on *P. wingei* and the status of the (Endler's guppy)," *Zootaxa* 2266, pp. 35-50, 2009.

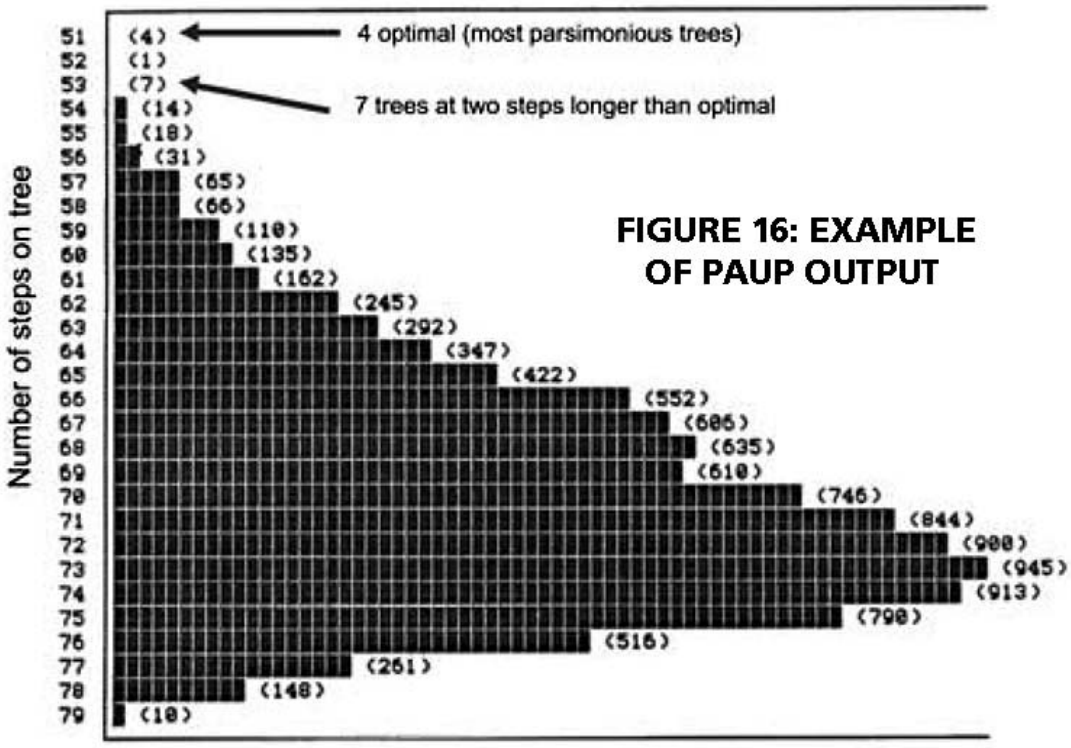


FIGURE 16: EXAMPLE OF PAUP OUTPUT

BAYESIAN INFERENCE IN PHYLOGENY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, April 11, 2015)

There is no doubt that phylogeny reconstruction has had a major effect on systematic ichthyology, resulting in many name changes of aquarium fishes. There is also no doubt that fish systematics is currently in a period of reevaluation as to the methodology employed to estimate phylogeny. This is not to say that issues such as the use of morphological data versus molecular data or whether or not to combine data for phylogenetic analyses have not been debated in the past. Clearly, these and many other issues have received a considerable amount of debate in the phylogenetic literature. Possibly one of the most rigorously debated topics is the choice of an optimality criterion. In general, there are three basic methods that have been used to estimate phylogeny, including distance, maximum parsimony (MP), and maximum likelihood (ML). The relative merits and shortcomings of these methods have been debated for a number of years.

Numerous comparative studies employing both known phylogenies and simulated data have been very useful in determining under what set of conditions each of the methods "out performs" the others. For example, it is now generally accepted that when rates of change along branches vary greatly, employing a parsimony optimality criterion may be misleading due to "long branch attraction" (LBR). LBA is a phenomenon in phylogenetic analyses (most commonly those employing maximum parsimony) when rapidly evolving lineages are inferred to be closely related, regardless of their true evolutionary relationships.

The problem arises when the DNA of two or more lineages evolves rapidly. There are only four possible nucleotides (the DNA used by living organisms is synthesized using only four DNA bases: cytosine, guanine, adenine and thymine, C, G, A and T, respectively) and when DNA substitution rates are high (a substitution is a mutation that exchanges one base for another such as switching an A to a G), the probability that two lineages will independently evolve the same nucleotide at the same site increases. When this happens, parsimony erroneously interprets this similarity as a synapomorphy (a shared derived character trait).

A simulated example of the LBA is shown in Figure 1. The real tree shows the relationships of five taxa with two taxa (2 and 3) having long evolutionary branches. The tree derived from using the parsimony criterion results in artificially grouping 2 and 3 together because of LBA.

As in Maximum Parsimony (MP), Maximum Likelihood (ML) evaluates alternative trees. However it considers the probability of each tree explaining the given data based on a model of evolution. In this case, the tree with the highest probability of explaining the data is chosen over the other ones. In other words, it compares how different

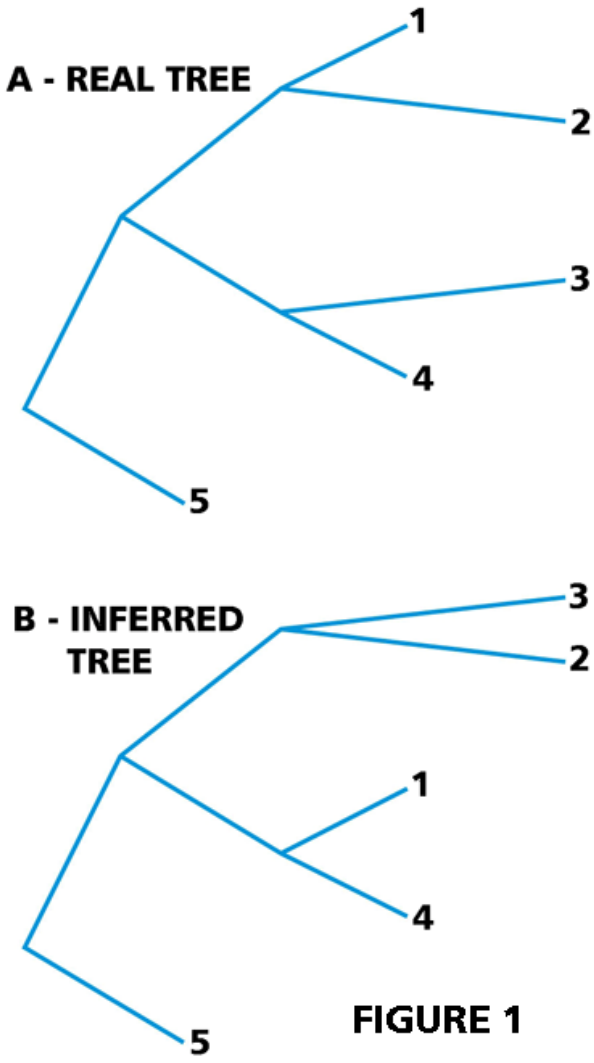


FIGURE 1

trees predict the observed data. The introduction of a model of evolution in ML analyses presents an advantage over MP as the probability of nucleotide substitutions and rates of these substitutions are taken into account, explaining the phylogenetic relationships of taxa in a more realistic way. An important consideration of this method is the branch length, which parsimony ignores, where changes are more likely to happen in long branches than in short ones. This approach eliminates the LBA problem and explains the greater consistency of ML over MP. Although considered by many the best approach to infer phylogenies from a theoretical point of view, ML is computationally intense and it is almost impossible to explore all trees as there are just too many.

Recently, another round of comparative studies has begun to address a new approach for phylogeny reconstruction - Bayesian analysis. Bayesian statistics dates back to the 18th century and is named after the Rev. Thomas Bayes (1701–1761), who first showed how to use new evidence to update beliefs. Its utility for reconstructing phylogeny was suggested initially in 1968 but it is only recently that these methods have become more widely known and relevant computer programs have become available. Like ML, Bayesian inference also incorporates a model of evolution, the main advantages over both MP and ML being that is computationally more efficient than traditional methods, it quantifies and addresses the source of uncertainty and is able to incorporate complex models of evolution.

MONTE CARLO METHODS

Monte Carlo methods are computational algorithms (simply sets of instructions) which randomly sample from some process under study. They are a way of estimating something which is too difficult or time consuming to find mathematically. You could, for example, determine the probably of obtaining 3 heads and 7 tails on a flip of a biased coin that comes up heads 65% of the time mathematically, but hand-held computations would keep you at it for quite a while. On the other hand, you could program a computer to randomly sample from a binomial distribution (the relevant distribution for this example) 50,000 times and to record the number of times 3 heads and 7 tails came. Divide this 50,000 and you have your answer within a few seconds.

MARKOV CHAINS

A simple description of Markov chain is a frog jumping on a set of lily pads. The frog jumps from a lily pad to a lily pad and where it lands depends only on where it was at the time when it jumped and not on where it was in the past. In other words, a Markov Chain is a random process that has the property that the future depends only on the current state of the process and not the past i.e. it is memoryless.

A SIMPLE EXAMPLE OF A MARKOV CHAIN

Suppose that the weather on any given day can be classified into two states only: sunny and rainy. Based on past experience, we know the following:

P(Next day is sunny | Given today is rainy) = 0.50
Since the next day's weather is either sunny or rainy it follows that:
P(Next day is Rainy | Given today is rainy) = 0.50

Similarly, let:
P(Next day is rainy | Given today is sunny) = 0.10

Therefore, it follows that:
P(Next day is sunny | Given today is sunny) = 0.90

The above four numbers can be compactly represented by what is known as a “transition matrix” which represents the probabilities of the weather moving from one state to another.

transition matrix

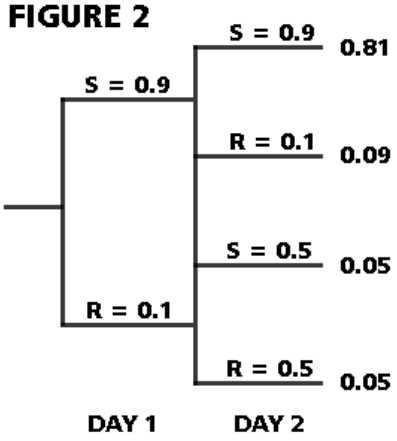
State	Sunny	Rain
Sunny	0.900 000	0.100 000
Rain	0.500 000	0.500 000

Let’s examine the following two questions and answers:

Q1: If the weather is sunny today then what is the weather likely to be tomorrow?
A1: Since, we do not know what is going to happen for sure, the best we can say is that there is a 90% chance that it is likely to be sunny and 10% that it will be rainy.

Q2: What about two days from today?
A2: This might be easier to visualize as we go along by using the tree shown in Figure 2.

FIGURE 2



The next day prediction is as before, 90% sunny, 10% rainy. Two days from now it can also be sunny. The chances of this happening are: 0.9*0.9.

However, on the first day it can be rainy and second day it can be sunny. The chances of this happening are: 0.1 * 0.5. Therefore, the probability that the weather will be sunny in two days is

P(Sunny two days from now) = 0.9*0.9 + 0.1*0.5 = 0.81 + 0.05 = 0.86.
Similarly, the probability that it will be rainy is
P(Rainy two days from now) = 0.9* 0.1 + 0.1 * 0.5 = 0.09 + 0.05 = 0.14

Table I shows that if you keep forecasting weather like this you will notice that eventually the 20th day and after forecast settles down to the following "equilibrium" probabilities," 0.883 and 0.167.

The numbers form what is known as a "probability distribution vector," in this case the equilibrium probability vector. In other words, your forecast for the nth day and the n+1th day remain the same. In addition, Table I shows that the equilibrium probabilities do not depend on the weather today. You would have gotten the same forecast for the weather if you had started off by assuming that the weather today was rainy.

BAYES THEOREM

We are all familiar with the use of classical statistics to examine a current set of data to test specific hypotheses; Bayesian statistics differs in that in addition to the current data, prior knowledge is included in the testing of the hypothesis.

Let A_1, $A2$, ... , A_n be a set of mutually exclusive events that together form the sample space S. Let B be any event from the same sample space, such that P(B) > 0. Then, by Bayes Theorem,

$P(A_k|B) = P(A_k \text{ and } B)/[P(A_1 \text{ and } B) + P(A_2 \text{ and } B) + \ldots + P(A_n \text{ and } B)]$

Note: Invoking the fact that $P(A_k \text{ and } B) = P(A_k)P(B|A_k)$, Baye's theorem can also be expressed as

$P(A_k|B) = P(A_k)\, P(B|A_k)/[P(A_1)\, P(B|A_1) + P(A_2)\, P(B|A_2) + \ldots + P(A_n)\, P(B|A_n)]$ or

$P(A_k|B) = P(A_k)\, P(B|A_k)/[\sum P(A_j)\, P(B|A_j)]$
where the sum ($\sum$) goes from j = 1 to n.

As an example, Marie is getting married tomorrow, at an outdoor ceremony in the desert. In recent years, it has rained only 5 days each year. Unfortunately, the weatherman has predicted rain for tomorrow.

TABLE I

probability distribution vectors

Start = Sunny			Start = Rain		
Day	Prob Vector		Day	Prob Vector	
0	1	0	0	0	1
1	0.900 000	0.100 000	1	0.500 000	0.500 000
2	0.860 000	0.140 000	2	0.700 000	0.300 000
3	0.844 000	0.156 000	3	0.780 000	0.220 000
4	0.837 600	0.162 400	4	0.812 000	0.188 000
5	0.835 040	0.164 960	5	0.824 800	0.175 200
6	0.834 016	0.165 984	6	0.829 920	0.170 080
7	0.833 606	0.166 393	7	0.831 968	0.168 032
8	0.833 442	0.166 557	8	0.832 787	0.167 212
9	0.833 377	0.166 622	9	0.833 114	0.166 885
10	0.833 350	0.166 649	10	0.833 245	0.166 754
11	0.833 340	0.166 659	11	0.833 298	0.166 701
12	0.833 336	0.166 663	12	0.833 319	0.166 680
13	0.833 334	0.166 665	13	0.833 327	0.166 672
14	0.833 333	0.166 666	14	0.833 331	0.166 668
15	0.833 333	0.166 666	15	0.833 332	0.166 667
16	0.833 333	0.166 666	16	0.833 332	0.166 667
17	0.833 333	0.166 666	17	0.833 333	0.166 666
18	0.833 333	0.166 666	18	0.833 333	0.166 666
19	0.833 333	0.166 666	19	0.833 333	0.166 666
20	0.833 333	0.166 666	20	0.833 333	0.166 666

When it actually rains, the weatherman correctly forecasts rain 90% of the time. When it doesn't rain, he incorrectly forecasts rain 10% of the time. What is the probability that it will rain on the day of Marie's wedding?

Solution: The sample space is defined by two mutually-exclusive events: it rains or it does not rain. Additionally, a third event occurs when the weatherman predicts rain. Notation for these events appears below.

Event A_1. It rains on Marie's wedding.
Event A_2. It does not rain on Marie's wedding.
Event B. The weatherman predicts rain.

In terms of probabilities, we know the following:

$P(A_1) = 5/365 = 0.014$ [It rains 5 days out of the year.]
$P(A_2) = 360/365 = 0.986$ [It does not rain 360 days out of the year.]
$P(B|A_1) = 0.9$ [When it rains, the weatherman predicts rain 90% of the time.]
$P(B|A_2) = 0.1$ [When it does not rain, the weatherman predicts rain 10% of the time.]

We want to know $P(A_1|B)$, the probability it will rain on the day of Marie's wedding, given a forecast for rain by the weatherman. The answer can be determined from Bayes' theorem, as shown below.
$P(A_1|B) = P(A_1)\, P(B|A_1) / \sum [\, P(A_i) + P(A_2)\, P(B|A_2)]$
Where the sum ($\sum$) in this case goes from 1 to 2.

Thus,

$P(A_1|B) = (0.014)(0.9) / [(0.014)(0.9) + (0.986)(0.1)] = 0.111$

Note the somewhat unintuitive result. Even when the weatherman predicts rain, it rains only about 11% of the time. Despite the weatherman's gloomy prediction, there is a good chance that Marie will not get rained on at her wedding.

SUBSTITUTION MODELS

The Bayesian approach combines the prior probability of a tree with the likelihood of the data observed to produce a posterior probability distribution on trees. The tree with the highest posterior probability is chosen to best represent a phylogeny. Although Bayesian inference is similar to maximum likelihood (ML) in that it employs a likelihood function and an explicitly stated model of nucleotide substitution, the difference is in the use of a prior probability (see Figure 3). The likelihood is the vehicle that carries the phylogenetic information contained in the data in both maximum likelihood and Bayesian estimation, and the same models of DNA, amino acid, or morphological evolution can be used in both methods.

In biology, a substitution model describes the process from which a sequence of characters changes into another set of traits. In phylogenetics, sequences are often obtained by firstly obtaining a nucleotide

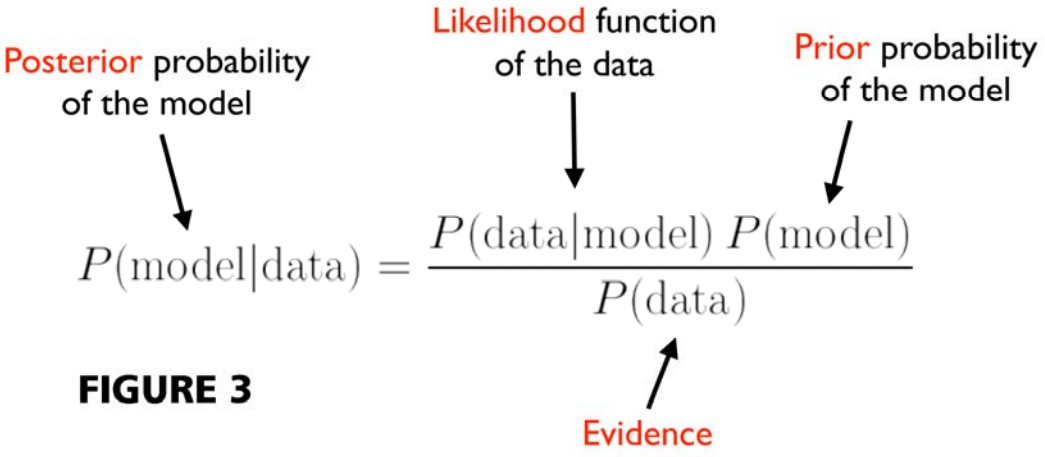


FIGURE 3

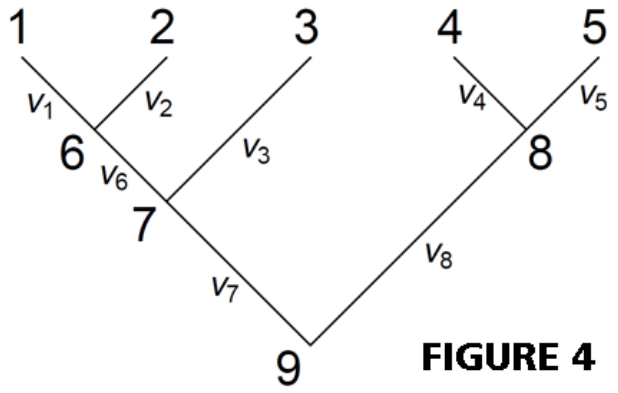


FIGURE 4

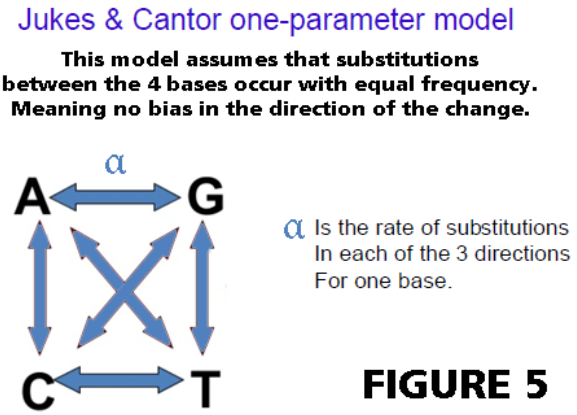


FIGURE 5

and then taking the bases or amino acids at corresponding positions in the alignment as the characters. Sequences achieved by this might look like AGCGGAGCTTA and GCCGTAGACGC.

A Bayesian model consists of a tree (τ_i) with branch lengths specified on the tree (v_i) and a stochastic model of DNA substitution. Figure 4 shows an example of a phylogenetic tree of five species. The tips of the tree are labeled 1, 2, 3, 4 and 5 for the species, and the internal nodes are labeled 6, 7, 8 and 9. The nodes are where the substitution model comes into play. They describe how characters evolve on the tree, and information on the value of the parameters in the model and on the lengths of the branches on the tree.

The parameters of the substitution model vary with the details of the analysis but typically include variables related to the frequency of the character states, biases in rates of change among character states, and rate variation across sites. The simplest model of this type is the one-parameter model of Jukes and Cantor (Figure 5).

The following table shows DNA data for four species.

Species 1	A	A	G	C	**C**	**C**	C	A
Species 2	A	T	A	A	**C**	**C**	G	C
Species 3	C	A	A	T	**A**	**G**	T	C
Species 4	G	G	T	T	**T**	**T**	C	T

Suppose we wished to calculate the probability of going from the character CCAT to character CCGT shown in boldface. Substitution models produce transition matrices like the following one for a CCAT sequence.

	A	C	G	T
A	0.976	0.010	0.007	0.007
C	0.002	0.983	0.005	0.010
G	0.003	0.010	0.979	0.007
T	0.002	0.013	0.005	0.979

The matrix satisfies all the requirements for it to be a Markov chain and after many changes the equilibrium distribution, which is the expected CCAT frequency, is [0.1, 0.4, 0.2, 0.3]. Since

the probability of going from C to C is 0.983,
the probability of going from A to G is 0.007,
the probability of going from T to T is 0.979,

the probability of going from CCAT to CCGT, therefore, is 0.1 * 0.983 * 0.4*0.983 * 0.2*0.007 * 0.3 * 0.979 = 0.0000454.

DETERMINING THE PROBABIILITY DISTRIBUTION OF TREES

Let's say we want to find the posterior probability of the ith tree. We need, however, to know the set of

branch lengths (v_i) and substitution parameters - we'll assume two here (α and θ) – to compute the likelihood. Bayesian inference of phylogeny is based upon the posterior probability of a phylogenetic tree, τ. The posterior probability of the ith phylogenetic tree, τ_i, based on the observed data matrix of DNA sequences (X) is obtained using Bayes formula:

$$P(\tau_i|X) = P(X|\tau_i)P(\tau_i) / [\sum P(X|\tau_j P(\tau_j)]$$

where the summation ($\sum$) goes from j = 1 to s, the number of species. Here, $P(\tau_i|X)$ is the posterior probability of the ith phylogeny and can be interpreted as the probability that τ_i is the correct tree given the DNA sequence data. The likelihood of the ith tree is $P(X|\tau_i)$ and the prior probability of the ith tree is $P(\tau_i)$. The summation in the denominator is over all trees that are possible for *s* species. Typically, an uninformative prior is used for trees, such a uniform distribution, $P(\tau_i) = 1/s$.

The likelihood function, $P(X|\tau_i)$, is integrated over all possible values for the branch length and substitution parameters:

$$P(X|\tau_i) = \int\int\int P(X|\tau_i, v_i, \alpha, \theta)P(v_i)(P(\alpha)P(\theta)dv_i d\alpha d$$

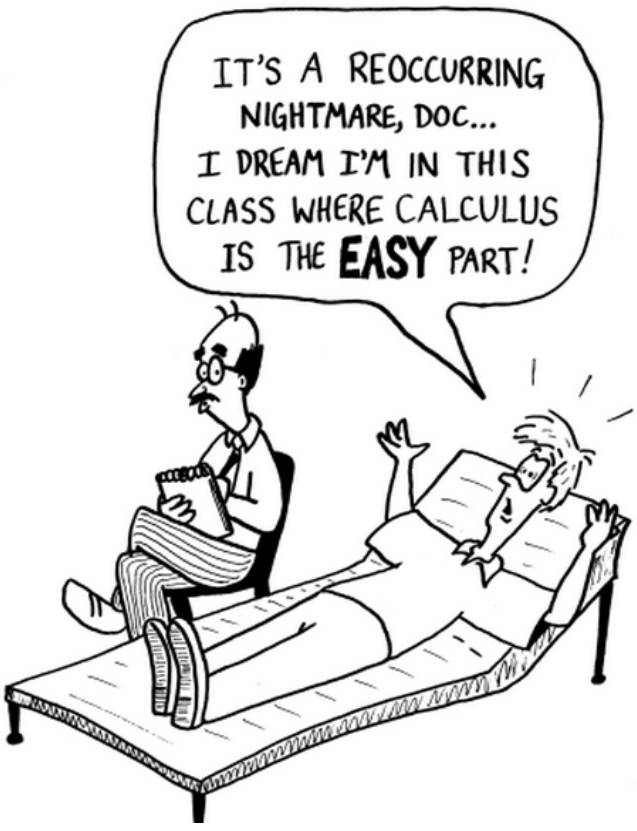
where the integrals sum over all values of the parameters, v_i, α and θ. (For those who are not familiar with calculus, just ignore the dv_i, $d\alpha$ and $d\theta$ terms.)

However, the denominator $\sum P(X|\tau_j P(\tau_j)$ and the integral in the numerator are generally not computable, except perhaps in a few of the very simplest cases. By necessity, then, the posterior probabilities of trees, branch lengths and substitution parameters must be approximated.

There are a number of methods available for approximating such sums, some of which involve sampling procedures. Ideally, one would like to approximate the posterior probability distribution of trees by randomly drawing from the posterior probability distribution of trees. The fraction of the time any tree was drawn would be a valid approximation of its posterior probability. This method is called Monte Carlo integration. Unfortunately, this ideal cannot yet be realized since the method requires that the samples must be independent. However, one can obtain information equivalent to that from independent samples by instead taking much larger dependent samples using the Markov Chain – Monte Carlo (MCMC) method to be described later.

EVOLUTION IS MARKOVIAN

In any phylogenetic tree, the predicted pattern of organisms at any given point in time can be described as "groups within groups," otherwise known as a nested hierarchy. The only known processes that specifically generate unique, nested, hierarchical patterns are branching evolutionary processes. Common descent is a genetic process in which the state of the present generation/individual is dependent only upon genetic changes that have occurred since the most recent ancestral population/ individual. Therefore, gradual evolution from common ancestors must conform to the mathematics



of Markov processes and Markov chains. Using Markovian mathematics, it can be rigorously proven that branching Markovian replicating systems produces nested hierarchies. For these reasons, biologists routinely use branching Markov chains to effectively model evolutionary processes, including complex genetic processes.

Let's examine a genetic example. The simplest type of inheritance of traits in animals occurs when a trait is governed by a pair of genes, each of which may be of two types, say G and g. An individual may have a GG combination or Gg (which is genetically the same as gG) or gg. Very often the GG and Gg types are indistinguishable in appearance, and then we say that the G gene dominates the g gene. An individual is called *dominant* if it has GG genes, *recessive* if it has gg genes and *hybrid* if it has a Gg (or gG) genes. In the mating of two animals, the offspring inherits one gene of the pair from each parent, and the basic assumption of genetics is that these genes are selected at random, independently of each other. This assumption determines the probability of occurrence of each type of offspring. The offspring of two purely dominant parents must be dominant, of two recessive parents must be recessive, and of one dominant and one recessive parent must be hybrid.

In the mating of a dominant and a hybrid animal, each offspring must get a G gene from the former and has an equal chance of getting G or g from the latter. Hence there is an equal probability for getting a dominant or a hybrid offspring (and 0 for a recessive). Again, in the mating of a recessive and a hybrid, there is an even chance for getting either a recessive or a hybrid (and 0 for a dominant). In the mating of two hybrids, the offspring has an equal chance of getting G or g from each parent. Hence the probabilities are 1/4 for GG, 1/2 for Gg, and 1/4 for gg.

Consider a process of continued matings. We start with an individual of known genetic character and mate it with a hybrid. We assume that there is at least one offspring. An offspring is chosen at random and is mated with a hybrid and this process repeated through a number of generations. The genetic type of the chosen offspring in successive generations can be represented by a Markov chain. The states are dominant, hybrid and recessive, indicated by GG, Gg, and gg respectively. The transition probabilities are as follows:

State	GG	Gg	gg
GG	0.500 000	0.500 000	0
Gg	0.250 000	0.500 000	0.250 000
gg	0	0.500 000	0.500 000

Table II shows that at 20 matings they are 0.250, 0.500 and 0.250, after which they remain at these probabilities to within three decimal points. Table II also shows that it makes no difference in which state we started.

HOW MCMC WORKS

Markov Chain Monte Carlo (MCMC) is not the most intuitive concept in statistics. That an iterative algorithm can asymptotically generate dependent samples from a certain target distribution (and what exactly this gobbledygook means) takes a bit of getting used to. One analogy I've found very helpful is to think of MCMC as shuffling a deck of cards.

Suppose we have a deck of n cards. Because we don't want to bother with suits and colors, we'll label the cards 1,2,..,n. For the cards to be shuffled it means that there is no way to tell in which order they will come; every arrangement of the deck is equally likely.

We start out from a sorted deck, i.e. the cards are ordered 1,2,...,n. The goal will be to randomly rearrange the cards such that no order is more likely than any other. One way to proceed is to take out the first card and insert it at a random position in the deck. If we do this many times with the first card this should be sufficient to produce the desired effect; the deck might be in just about any order with equal probability.

The first thing to note is that this shuffling technique can be described as a Markov process. The state space is the space of all arrangements of 1,2,...,n. (If we had just three cards, for example, the state space would include all arrangements of three cards such as (1,2,3), (3,2,1), (2,3,1), etc. The "move" (using MCMC jargon) consists in taking out the first card and reinserting it at random. Since the move depends

TABLE II

probability distribution vectors

Start = GG			
Mating	Prob Vector		
0	1	0	0
1	0.500 000	0.500 000	0
2	0.375 000	0.500 000	0.125 000
3	0.312 500	0.500 000	0.187 500
4	0.281 250	0.500 000	0.218 750
5	0.265 625	0.500 000	0.234 375
6	0.257 812	0.500 000	0.242 187
7	0.253 906	0.500 000	0.246 093
8	0.251 953	0.500 000	0.248 046
9	0.250 976	0.500 000	0.249 023
10	0.250 488	0.500 000	0.249 511
11	0.250 244	0.500 000	0.249 755
12	0.250 122	0.500 000	0.249 877
13	0.250 061	0.500 000	0.249 938
14	0.250 030	0.500 000	0.249 969
15	0.250 015	0.500 000	0.249 984
16	0.250 007	0.500 000	0.249 992
17	0.250 003	0.500 000	0.249 996
18	0.250 001	0.500 000	0.249 998
19	0.250 000	0.500 000	0.249 999
20	0.250 000	0.500 000	0.249 999

Start = Gg			
Mating	Prob Vector		
0	0	1	0
1	0.250 000	0.500 000	0.250 000
2	0.250 000	0.500 000	0.250 000
3	0.250 000	0.500 000	0.250 000
4	0.250 000	0.500 000	0.250 000
5	0.250 000	0.500 000	0.250 000
6	0.250 000	0.500 000	0.250 000
7	0.250 000	0.500 000	0.250 000
8	0.250 000	0.500 000	0.250 000
9	0.250 000	0.500 000	0.250 000
10	0.250 000	0.500 000	0.250 000
11	0.250 000	0.500 000	0.250 000
12	0.250 000	0.500 000	0.250 000
13	0.250 000	0.500 000	0.250 000
14	0.250 000	0.500 000	0.250 000
15	0.250 000	0.500 000	0.250 000
16	0.250 000	0.500 000	0.250 000
17	0.250 000	0.500 000	0.250 000
18	0.250 000	0.500 000	0.250 000
19	0.250 000	0.500 000	0.250 000
20	0.250 000	0.500 000	0.250 000

Start = gg			
Mating	Prob Vector		
0	0	0	1
1	0	0.500 000	0.500 000
2	0.125 000	0.500 000	0.375 000
3	0.187 500	0.500 000	0.312 500
4	0.218 750	0.500 000	0.281 250
5	0.234 375	0.500 000	0.265 625
6	0.242 187	0.500 000	0.257 812
7	0.246 093	0.500 000	0.253 906
8	0.248 046	0.500 000	0.251 953
9	0.249 023	0.500 000	0.250 976
10	0.249 511	0.500 000	0.250 488
11	0.249 755	0.500 000	0.250 244
12	0.249 877	0.500 000	0.250 122
13	0.249 938	0.500 000	0.250 061
14	0.249 969	0.500 000	0.250 030
15	0.249 984	0.500 000	0.250 015
16	0.249 992	0.500 000	0.250 007
17	0.249 996	0.500 000	0.250 003
18	0.249 998	0.500 000	0.250 001
19	0.249 999	0.500 000	0.250 000
20	0.249 999	0.500 000	0.250 000

only on the current state, we can compute the probability distribution over the next state given only the current state; this makes it a Markov chain.

This description makes several key MCMC concepts a bit more intuitively evident:

(1) *Convergence of the probability distribution*: If we start from a fully sorted set and you ask me to guess what the first card is, I will know it's a 1. If you apply the shuffling move once and ask me to guess again, there will be some uncertainty; it's likely to be a 2, but it could also be a 1 in case you reinserted 1 in the first slot. At the third step there is again a little bit more randomness and I won't be able to guess as precisely. If you shuffle enough times I really won't have a clue; the first card might be any of 1,2,…,n cards with about equal probability. In MCMC parlance, the probability distribution of the Markov process after a large number of moves is, for all intents, the uniform distribution over the state space. Each successive move takes us closer to our target distribution. In other words, it converges.

(2) *Invariant distribution*. MCMC moves leave the target distribution invariant. That's the case here. If you have a deck of cards in your hands and I don't know what order the cards are in, it doesn't matter if you shuffle the cards once more; I still won't know any better. The uniform distribution over all the possible orderings is invariant to a shuffling move.

(3) *Dependent samples*. In MCMC the state of the chain is measured at successive iterations. Each measured state is called a "sample" but it is clear from the example that the samples are not independent since it is relatively easy to guess what the state is at time t+1 if one knows what the state at time t is. Suppose again that we start from an ordered set, which will have the card with value i in spot i. It is quite likely that making one "move" will either not affect the position of the ith card, or that it will be replaced by one of its neighbors. Another way of viewing this is that the chain moves "locally" in the state space; it does not allow for radical changes.

(4) *Speed of convergence*. Some MCMC moves are better than others. To shuffle the card, a more radical strategy consists in throwing them down the stairs and picking them up again in the order you find them. We may start from a fully ordered set as before but after just one of these shuffling moves it is

clear that I won't do a very good job of predicting which card is on top of the stack. If the cards are sticky, there will still be some dependence on the previous step but is clear that convergence to the uniform distribution will happen a lot faster. Viewed another way, our first method (using three cards) couldn't go from state (1,2,3) to state (3,2,1) in one step. Our second method – throwing them down the stairs - can and so will produce states that are less dependent on one another.

(5)*Estimating parameters of the distribution from samples*. In MCMC we estimate some aspects of the target distribution from the samples. For example, the mean of the target distribution is estimated from the mean of the samples. In our case let's say that we want to estimate the average label of the ith card, which should be (1 + 2 + ... + n)/n). We could do this by noting the value of the ith card at each iteration of the process and averaging afterwards. However, over many iterations no particular card will have more of a chance to be in the ith spot than the other, so that the sample average will be approximately correct.

The next step is to make a chain that converges to any possible distribution—exactly what generic MCMC methods achieve.

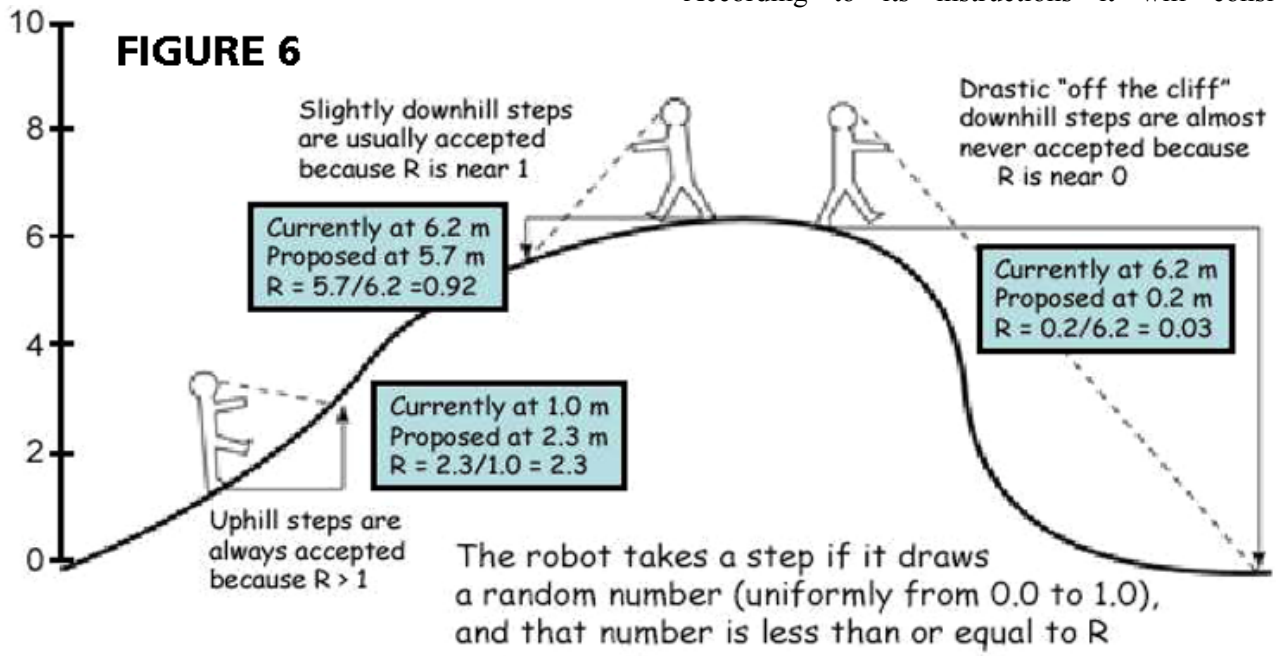
THE METROPOLIS-HASTINGS ALGORITHM

We start by constructing a Markov chain such that its equilibrium probability distribution is our target distribution. Then we arbitrarily start from some point and iterate the Markov chain many times (like how we forecasted the weather n times). Eventually, the draws we generate after discarding a few initial draws would seem as if they were coming from our target distribution.

To design the Markov chain properly, it is sufficient to manipulate the transition matrix. This is done using the Metropolis-Hastings algorithm:

(1) Start with a random tree and parameters.
(2) In each generation, randomly propose either
    a new tree topology or
    a new value for a model parameter.
(3) If the proposed tree has a higher posterior probability, $P_{proposed}$, than the current tree, $P_{current,}$ the transition is accepted.
(4) If the proposed tree has lower posterior probability than the current tree, the transition is accepted with probability $P_{proposed}$ /$P_{current}$.
(5) Every k generations, save the current tree.
(6) After n generations, end the Markov chain and use the saved trees to draw conclusions, using histograms, credibility intervals, etc.

This algorithm can be visualized as a robot walking around in a multidimensional landscape (Figure 6). According to its instructions it will consider



randomly chosen steps, always accepting up-hill steps and sometimes accepting down-hill steps, In Figure 6, R is the ratio, $P_{proposed}$ /$P_{current}$. (Note: m, the probabilities in this diagram, are logs since sums of logs are easier to use in algorithms than products.)

Note that, unlike in the Maximum likelihood method, in Bayesian Inference we are not just interested in the elevation of the very tip of the absolute peak of the posterior probability surface, but rather are interested in topographical map of the entire posterior probability, not the elevation of the tip of the very highest peak in parameter space.

DRAWING CONCLUSIONS

How do we derive phylogenetic conclusions from the posterior probability distribution of trees? One possibility is to use the most probable tree as a point estimate of phylogeny. This is called the maximum a posteriori probability (MAP) estimate of phylogeny.

A standard Bayesian approach to summarize results is to form a 95% credibility interval for the parameter of interest based on the posterior distribution. The Bayesian use of the term "credibility interval" for an entity is similar, at least in some ways, to the "confidence interval of" classical statistics. In phylogeny construction, a 95% credible set of trees can be constructed by starting with the MAP tree and adding trees in order of decreasing probability until the cumulative probability is 0.95.

The most powerful approach is to summarize the results of a Bayesian analysis on a majority rule consensus tree or on the MAP tree, as is typically done when summarizing the results of a bootstrap analysis. However, the numbers on the branches of the tree now represent the posterior probability that the clade is true. Although the MAP, credible set and majority rule consensus tree are the usual ways to summarize the results of a Bayesian analysis of phylogeny, other methods, equally valid, also are used.

BAYESIAN INFERENCE COMPUTER METHODS

There are a host of Bayesian inference computer programs but the one I am familiar with (and have on my computer) is MrBayes, written by John Huelsenbeck of the Department of Integrative Biology of the University of California, Berkeley, and Fredrik Ronquist of the Naturhistoriska Riksmuseet, Stockholm, Sweden.

An example of an input to this program is shown in Figure 7 where a phylogenetic tree of *Homo sapiens*, *Pan* (chimpanzee), *Gorilla*, *Pongo* (orangutan), *Hylobates* (gibbon), *Macaca fuscata* (macaque, a New

```
#NEXUS

[ Data from: Hayasaka, K., T. Gojobori, and S. Horai. 1988. Molecular phylogeny and evolution

begin data;
    dimensions ntax=12 nchar=898;
    format datatype=dna interleave=no gap=-;
    matrix
Tarsius_syrichta    AAGTTTCATTGGAGCCACCACTCTTATAATTGCCCATGGCCTCACCTCCTCCCTATTATTTTGCCTAGCAAATA
Lemur_catta         AAGCTTCATAGGAGCAACCATTCTAATAATCGCACATGGCCTTACATCATCCATATTATTCTGTCTAGCCAACT
Homo_sapiens        AAGCTTCACCGGCGCAGTCATTCTCATAATCGCCCACGGGCTTACATCCTCATTACTATTCTGCCTAGCAAACT
Pan                 AAGCTTCACCGGCGCAATTATCCTCATAATCGCCCACGGACTTACATCCTCATTATTATTCTGCCTAGCAAACT
Gorilla             AAGCTTCACCGGCGCAGTTGTTCTTATAATTGCCCACGGACTTACATCATCATTATTATTCTGCCTAGCAAACT
Pongo               AAGCTTCACCGGCGCAACCACCCTCATGATTGCCCATGGACTCACATCCTCCCTACTGTTCTGCCTAGCAAACT
Hylobates           AAGCTTTACAGGTGCAACCGTCCTCATAATCGCCCACGGACTAACCTCTTCCCTGCTATTCTGCCTTGCAAACT
Macaca_fuscata      AAGCTTTTCCGGCGCAACCATCCTTATGATCGCTCACGGACTCACCTCTTCCATATATTTCTGCCTAGCCAATT
M_mulatta           AAGCTTTTCTGGCGCAACCATCCTCATGATTGCTCACGGACTCACCTCTTCCATATATTTCTGCCTAGCCAATT
M_fascicularis      AAGCTTCTCCGGCGCAACCACCCTTATAATCGCCCACGGGCTCACCTCTTCCATGTATTTCTGCTTGGCCAATT
M_sylvanus          AAGCTTCTCCGGTGCAACTATCCTTATAGTTGCCCATGGACTCACCTCTTCCATATACTTCTGCTTGGCCAACT
Saimiri_sciureus    AAGCTTCACCGGCGCAATGATCCTAATAATCGCTCACGGGTTTACTTCGTCTATGCTATTCTGCCTAGCAAACT
    ;
end;
```

FIGURE 7

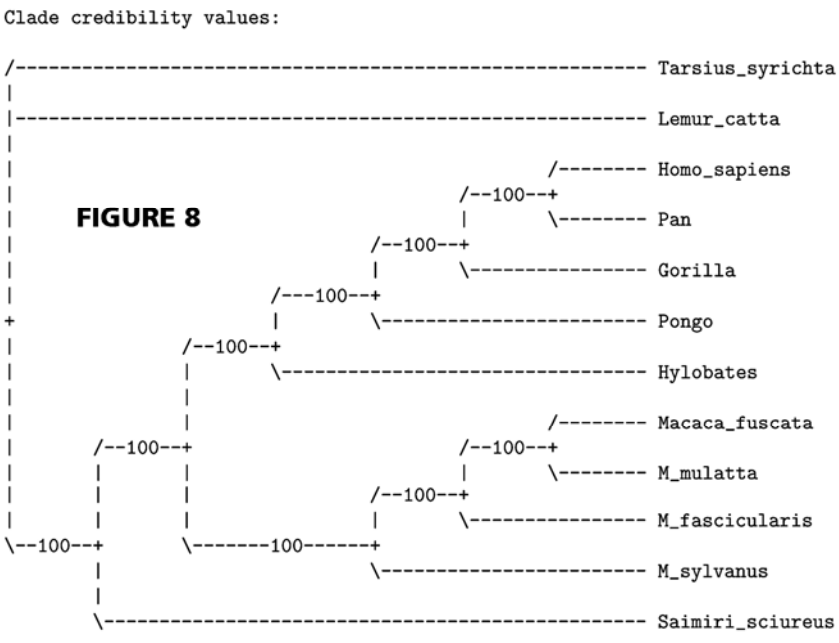


FIGURE 8

World monkey), *Macaca mulatta, Macaca fascicularis, Macaca Sylvanus* and *Saimiri sciureus* (squirrel monkey, a New World monkey) is to be constructed, with *Tarsius syrichta* (tarsier) and *Lemur* (lemur) used as outgroups. The data consists of 898 characters of DNA base information for 12 taxa. (I have truncated the input on the right at 74 characters in order to save space.)

After the data is inputted to the program, the first order of business is to specify a substitution model. There are dozens of models available, including the Jukes & Cantor and Kimura models shown in Figure 5. The one used in this analysis used the General Time Reversal (GTR) model which allows the four nucleotides to occur at different frequencies (the Jukes & Cantor and Kimura models assume that all four nucleotides occur at the same frequencies).

Next, one sets the prior probabilities for the model. There are six types of parameters in the model: the tree topology, the branch lengths, the four stationary frequencies of the nucleotides, the six different nucleotide substitution rates, the proportion of invariable sites, and the shape parameter of the gamma distribution of rate variation but the default priors work well for most analyses.

Before starting the analysis, certain settings must be entered, such as the number of sampling generations, sampling frequency and other constants in the simulation.

Recall, that the idea in MCMC sampling is to move around in parameter space in such a way that the points will be visited according to their posterior probability (i.e., a region with very high posterior probability will be visited frequently). It takes a while after starting such a process before the sampling gets "out of the foot-hills and into the mountains" of the distribution, and only after this "burnin" period can the sample points be trusted.

After the analysis is started the program will print the state of the chains every 100th generation and predict the time to completion. A majority rule consensus tree is calculated and is the first tree plotted to the screen. Below the consensus cladogram (Figure 8), a consensus phylogram (Figure 9) is plotted. The branch

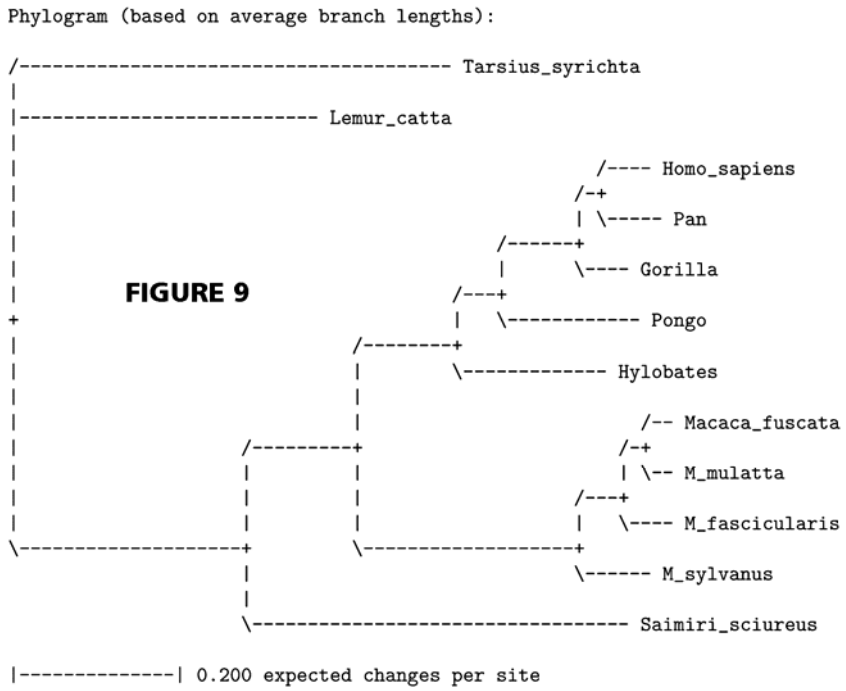


FIGURE 9

FIGURE 10

Parameter	Mean	Variance	95% Cred. Interval Lower	Upper	Median
TL	2.954334	0.069985	2.513000	3.558000	2.941000
r(A<->C)	0.044996	0.000060	0.030878	0.059621	0.044567
r(A<->G)	0.470234	0.002062	0.386927	0.557040	0.468758
r(A<->T)	0.038107	0.000073	0.023568	0.056342	0.037172
r(C<->G)	0.030216	0.000189	0.007858	0.058238	0.028350
r(C<->T)	0.396938	0.001675	0.317253	0.476998	0.394980
r(G<->T)	0.019509	0.000158	0.001717	0.047406	0.018132
pi(A)	0.355551	0.000150	0.332409	0.382524	0.357231
pi(C)	0.320464	0.000131	0.298068	0.343881	0.320658
pi(G)	0.081290	0.000043	0.067120	0.095940	0.080521
pi(T)	0.242695	0.000101	0.220020	0.261507	0.243742
alpha	0.608305	0.042592	0.370790	1.142317	0.546609
pinvar	0.135134	0.007374	0.008146	0.303390	0.126146

lengths in this have been averaged over the trees in which that branch was present (a particular branch corresponds to a partition of the data, and will typically not be present in every sampled tree). The cladogram also has “clade credibility" values” are in fact the posterior probability that the clade is real (based on the present data set). These numbers are different from bootstrap values: unlike bootstrap support (which have no clear statistical meaning) these are actual probabilities.

A list of trees is printed after the phylogram. These trees are sorted according to their posterior probability and highlights how Bayesian phylogenetic analysis is different from maximum likelihood: Instead of finding the best tree(s), we now get a full list of how probable any possible tree is. Estimates of all the parameters, including their credibility intervals, is also printed out (Figure 10).

In this analysis there is overwhelming support for a single tree, so all forks have a posterior probability of 100%. The phylogram is as expected. The Old World macaque species and the New World squirrel monkey clades are clearly separated from each other and they in turn are clearly separated from the great apes - man, chimpanzee (*Pan*), gorilla and orangutan (*Pongo*) - and from the lesser ape, the gibbon (*Hylobates*).

SUMMARY

Bayesian phylogenetics using Markov chain Monte Carlo technology has unquestionably revolutionized the field of phylogenetic systematics, and represents the first treatment of tree topology as a random variable. Bayesian inference has allowed successful analysis of some of the largest and most complex empirical data sets ever compiled. These data sets could not have been analyzed a scant five years ago, and, though computer processor speeds have advanced considerably since then, it is due chiefly to Bayesian methodologies that they can be analyzed today. True, such data sets could be analyzed using maximum likelihood methods, but it would require enormous computer facilities that the average researcher does not have access to. Part of the appeal of Bayesian phylogenetics, then, is that reconstructions can be performed on conventional desktop computers in a reasonable amount of time.

The simultaneous estimation of parameter values and support gives not only a speed benefit to Bayesian Inference, but also provides the investigator with more information than in a maximum likelihood search (i.e. the shape of the posterior probability distribution, rather than just a point estimate). Systematists should be more concerned with identifying the total set of trees that can be reasonably supported by the data, rather than focusing on point estimates of topology.

Bayesian inference is the first methodology in phylogenetics that generates probabilistic calculations of such sets, and the probabilistic properties involved allow for direct interpretation that has until now been sorely missing from phylogenetic systematics. A major benefit of using Bayesian inference is that it explicitly accounts for uncertainty in phylogeny when estimating parameters of interest, rather than assuming the phylogeny is known without error.

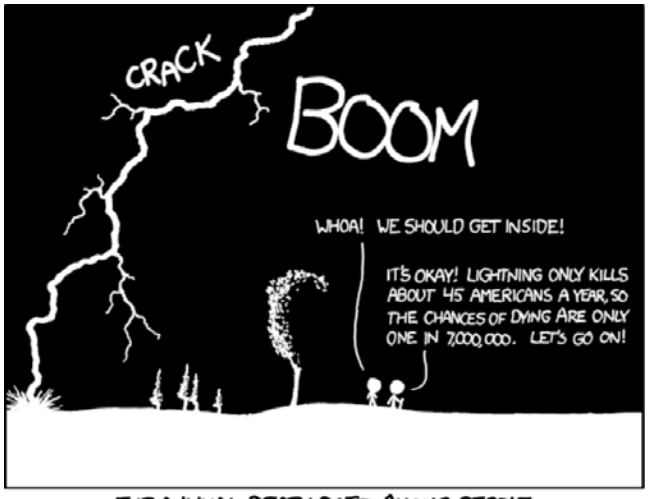
There are, however, some controversies over the method. It has been observed that bootstrap values, calculated under parsimony or maximum likelihood, tend to be lower than the posterior probabilities obtained by Bayesian inference. This fact leads to a number of questions such as: Do posterior probabilities lead to overconfidence in the results? Are bootstrap values more robust than posterior probabilities?

However, a bootstrap proportion is an index of repeatability, *not* of the accuracy of the results. A Bayesian posterior probability, conversely, is a direct probability statement that the results reached are true, given the data. On the matter of interpretation of results, then, a Bayesian approach is undoubtedly ideal.

Using prior probabilities for Bayesian analysis has been seen by many as an advantage as it will provide a hypothesis a more realistic view of the real world. However, some biologists argue about the subjectivity of Bayesian posterior probabilities after the incorporation of these priors. Also, the results of the Bayesian analysis of a phylogeny are directly correlated to the model of evolution chosen, so it is important to choose a model that fits the observed data, otherwise inferences in the phylogeny will be erroneous. However, there are programs that are specifically designed for the purpose of finding models of evolution that best fit the data and those that evaluate the adequacy of different models.

ENTER HAMLET

The last thing that I'd like to mention is that although in the card example I used to explain MCMC it can take us from a probability distribution that's fully concentrated (we know the cards are sorted) to one that's maximally uncertain (the uniform distribution over possible permutations), it's just as easy to do the reverse by having sorting moves instead of shuffling moves. A good example is the following that was devised by Marc Corum, a student at



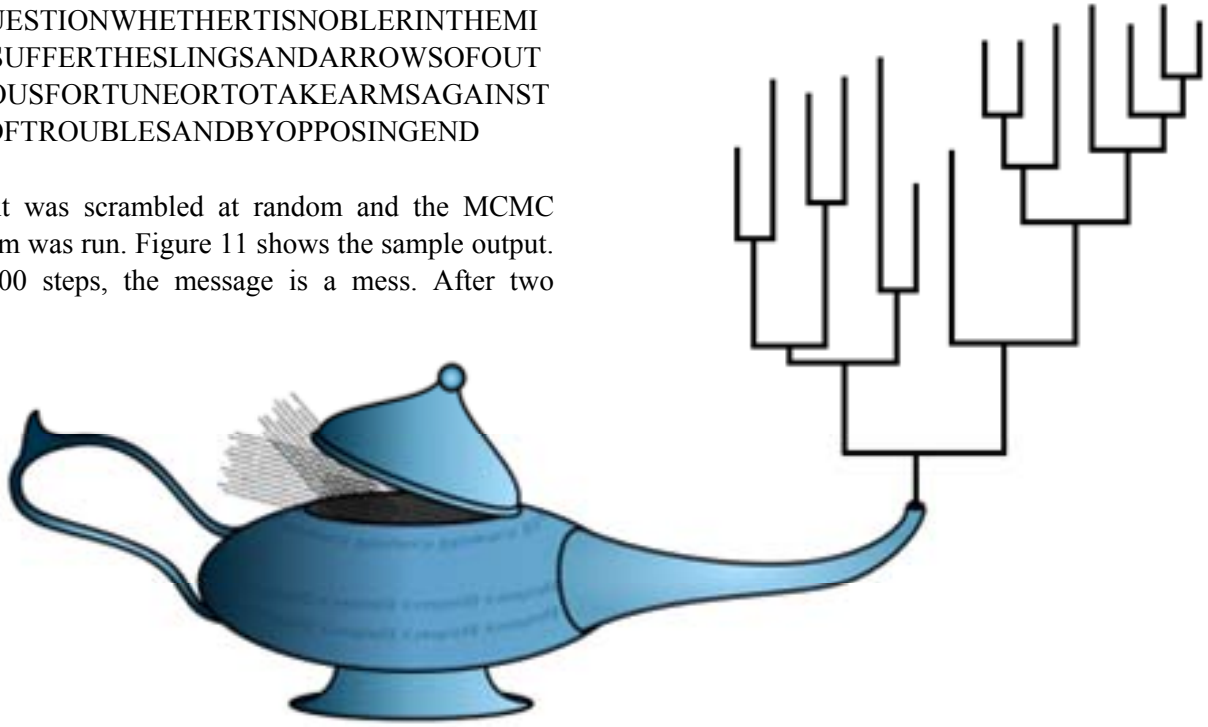
THE ANNUAL DEATH RATE AMONG PEOPLE WHO KNOW THAT STATISTIC IS ONE IN SIX.

Stanford University. To investigate this he tried the algorithm out on a problem for which he knew the answer.

The following is a well-known section of Shakespeare's Hamlet:

ENTERHAMLETHAMTOBEORNOTTOBETHATIS
THEQUESTIONWHETHERTISNOBLERINTHEMI
NDTOSUFFERTHESLINGSANDARROWSOFOUT
RAGEOUSFORTUNEORTOTAKEARMSAGAINST
ASEAOFTROUBLESANDBYOPPOSINGEND

The text was scrambled at random and the MCMC algorithm was run. Figure 11 shows the sample output. After 100 steps, the message is a mess. After two thousand steps, the decrypted message makes sense. It stays essentially the same as further steps are tried. I find it remarkable that a few thousand steps worked so well. It also shows that the method has a wide application in other areas, including cryptology and forensics.



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 100 ER ENOHDLAE OHDLO UOZEOUNORU O UOZEO HD OITO HEOQSET IUROFHE HENO ITORUZAEN
 200 ES ELOHRNDE OHRNO UOVEOULOSU O UOVEO HR OITO HEOQAET IUSOPHE HELO ITOSUVDEL
 300 ES ELOHANDE OHANO UOVEOULOSU O UOVEO HA OITO HEOQRET IUSOFHE HELO ITOSUVDEL
 400 ES ELOHINME OHINO UOVEOULOSU O UOVEO HI OATO HEOQRET AUSOWHE HELO ATOSUVMEL
 500 ES ELOHINME OHINO UODEOULOSU O UODEO HI OATO HEOQRET AUSOWHE HELO ATOSUDMEL
 600 ES ELOHINME OHINO UODEOULOSU O UODEO HI OATO HEOQRET AUSOWHE HELO ATOSUDMEL
 900 ES ELOHANME OHANO UODEOULOSU O UODEO HA OITO HEOQRET IUSOWHE HELO ITOSUDMEL
1000 IS ILOHANMI OHANO RODIORLOSR O RODIO HA OETO HIOQUIT ERSOWHI HILO ETOSRDMIL
1100 ISTILOHANMITOHANOT ODIO LOS TOT ODIOTHATOEROTHIOQUIRTE SOWHITHILOTEROS DMIL
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1800 ESTER HAMLET HAM TO BE OR SOT TO BE THAT IN THE QUENTIOS WHETHER TIN SOBLER
1900 ENTER HAMLET HAM TO BE OR NOT TO BE THAT IS THE QUESTION WHETHER TIS NOBLER
2000 ENTER HAMLET HAM TO BE OR NOT TO BE THAT IS THE QUESTION WHETHER TIS NOBLER
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FIGURE 11

A FEW WORDS ON THE ORIGIN OF THE WORD "AQUARIUM"

by Albert J. Klee, PhD

(Aquarium Hobby Historical Society, Yahoo Post # 13052, April 3, 2015)

János Reisinger (born in Győr, Hungary in 1784 and died in Pest, 1852) received his medical degree in 1806 and a year later his degree in surgery. He practiced medicine in Szeged (the fourth largest city in Hungary) for a short time and in 1807 returned to Pest where he was a senior lecturer at the Department of Natural History of the university. From 1810 until his retirement in 1848 he was a professor of zoology and mineralogy at the Faculty of Medicine in Pest.

In 1830 he wrote a book titled *Specimen ichthyologiæ-sistens pisces aquarium dulcium Hungariæ*. As this was the earliest reference in which I saw the word "aquarium" and "fish" (i.e., "pisces") together, it got me wondering what exactly the word "aquarium" had meant in those days and also who came up with the word in the first place.

I had come across the term "dulcium aquarium" in many texts published later in the Nineteenth Century and there also, as it did in Reisinger's text, it always meant "fresh water." For example, Mercator drew a marine chart in 1569 that portrayed the Great Lakes as accurately as could be drawn at the time. It was noted that river running into the St. Lawrence Gulf had two large branches and at the head of the northern branch was grouped three small lakes just west of which is a very large lake. Beside this lake is written (the boldfacing in this essay is mine): "hic mare est **dulcium aquarium**, cujus terminum ignorari Canadenses ex relatu Saguenaiensium aiunt" ("this sea is of **fresh water**; the Canadians do not know its bounds, according to the report of the people of Saguenay"). The "sea" that Mercator was talking about, by the way, is what is now known as Lake Huron.

The earliest reference I found to "**dulcium aquarium**" was in Pliny the Elder's *Naturalis Historia*, published circa AD 77–79. In Book 59, Volume 19, he talks about directions for watering certain plants:

Peculiaris medicina raphano, betae, rutae, cunilae in **salsis aquis**, quae et alioqui plurimum suavitati et fertilitati conferunt. Ceteris **dulcium aquarum** rigua prosunt. Utilissimae ex his quae frigidissimae et quae potu suavissimae.

"There is a curative property especially effective for radish, beet, rue and savory in **salt waters**, which moreover also contributes a great deal to their sweetness and to their fertility. All other plants are benefited by being watered with **fresh water**, the most useful for the purpose being water from streams, which is extremely cool and very sweet to drink."

Note: In Latin, adjectives and nouns agree in case, number, and gender. Aquis is the plural of water. To make things more difficult, aquarium can be an adjective meaning "pertaining to water" or a noun, 2nd declension, neuter meaning "a source of water," "a watering place" or "a water hole (for cattle)."

Marcus Porcius Cato, byname Cato the Censor, or Cato the Elder (born 234 BC in Tusculum, Latium [Italy] and died in 149 BC), was a Roman statesman, orator and the first Latin prose writer of importance. The earliest mention of the word "aquarium" is found in Cato's *De agricultura* ("On Farming" sometimes referred to as *De re rustica*), written about 160 BC. It is his only surviving work and the oldest remaining complete prose work in Latin. It is a practical handbook dealing with the cultivation of grape vines and olives and the grazing of livestock, but it also contains many details of old customs and superstitions.

As mentioned, Cato was the first author of record to use the word aquarium. Examples from his book include the following: **situlum aquarium** ("water bucket"), **urceum aquarium** ("water vessel") and **bonumque aquarium** ("well-watered"). Note, however, that aquarium here did NOT mean a container of water.

With regard to the term, "watering place," in Cicero's *Three Books of Offices and Other moral Works*, written in 44 BC, we find the following:

Tum Canius inquit, quæ, Pythi, quid est hoc? Hic, ne, tantum piscium, ne tantum cymbarum? Et ille inquit, quid mirum? Quidquid piscium est Syacusis est hoc poco, **hic aquatio**…

"Then Canius says, 'What is this, pray, Pythias – so many fish – so many boats?' And he answers, 'What's the wonder? Whatever fish there are at Syracuse are taken at this place; **here is their water-place**…'"

"Aquationis" is the genitive (possessive) form of a Latin word that was used by Julius Caesar, Palladius, Columella, Pliny and Cicero with regard to water that had several different meanings but Cicero uses the nominative form "aquatio" here to mean "watering-place; it was not used in the sense of a container to hold fish (or anything else for that matter).

Thus at no time did the Romans use aquarium or its cousins in the sense of a container; rather, it was either meant as water or a place (but not a vessel) that held water.

The one who DID use the word aquarium as a vessel to hold water was Linnaeus. In his 1742 prologue to his *Hortus Upsaliensis*, he defined the following terms under the heading of "Aquaria:" Aquarium fluviatile, Aquarium lacustre and Aquarium palustre, denoting respectively a river pond aquarium, a lake pond aquarium and a marsh pond aquarium. Here is how Linnaeus described the last-named:

Aquarium palustre ad latera truncos horizontales seu parietes habet, aquam a solo separantes, inter illos vero & ipsam humum repletum est spatium humo limosa e paludibus desumta, cui insertae plantae palustres.

"The marsh aquarium has horizontal sides of tree trunks or walls that separate the water from the surrounding soil; the ground between them is filled with soil from muddy swamps, into which is inserted marsh plants."

Clearly Linnaeus was describing the construction of an artificial container and was not using the word aquarium merely as a synonym for water. Linnaeus, of course, was not concerned with fish but with aquatic plants but, as we all know, by the beginning of the 1800s the gardener's aquarium morphed into that of the aquarist's well.

Watering place near Cervara, a municipality in the province of Rome in the Italian region Latium, located about 31 miles east of Rome.

EXPLAINING AWAY THE NON-EXISTENT

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, May 21, 2015)

Much of my career - both as an engineer and as a scientist - has been involved with mathematics and one of these areas includes experimentation. Now in addition to requiring some technical knowledge, bona fide experimentation is both expensive and time-consuming. The last two affected my ability to do much experimentation in the aquarium hobby and thus I can list them here very quickly with regard to their topics: the effects of salt on catfish, beef heart versus snail meat in the feeding of bettas, the effect of various dyes on the prevention of fungus in the development of killifish eggs, and electrophoresis in differentiating strains and species of *Aphyosemion*.

With regard to the last, I had hoped that after it had taken a breather from the hectic days of getting started in earnest, the American Killifish Association would establish a committee that conducted experiments relevant to killifishes. I would have taken on the job myself but my limited time was required in the area of Association publications; unfortunately, no one volunteered for the job and so the committee never saw the light of day.

Now if one is averse to expending the time and expense it would take to conduct experiments that produce reliable conclusions, we are reduced to opinions or beliefs based upon little or no evidence. This not to say that they are worthless; indeed, the opinions and beliefs of those with experience and other qualifications are often highly regarded. Unfortunately, they are also often highly in error.

When Sam Wineberg and I were publishing *The Aquarist's Notebook*, the publication was sent to several thousand pet stores across the country and we got to be on very friendly terms with most of them. I was interested in the incidence of *Ichthyophthirius* in their stores and after agreeing that their store name would not be mentioned in any article that I might write (I mentioned *Pet Shop Management* as one possibility), a good many of them provided me with the information I had requested.

I was mostly interested in whether the incidence of *Ichthyophthirius* was greater or larger in small stores than in larger ones and found that it indeed was greater in the small stores. As I was putting this into an article I was writing, along with a discussion as to why this might be so, I decided to check my calculations by looking at the smallest incidence of *Ichthyophthirius* and found that it also occurred in the small stores! How could this be? The answer was in the Law of Small Numbers, which is based upon the fact that smaller samples have more extreme values than large ones.

The Law of Small Numbers is the judgmental bias which occurs when it is assumed that the characteristics of a sample population can be estimated from a small number of observations or data points. My mistake was in computing simple percentages without also calculating their standard error. When I did do this, the ranges for the incidence of *Ichthyophthirius* overlapped, indicating that there was no difference between the large and small stores.

To show how an increase in sample size diminishes the probability of the occurrence of a rare event, consider a tank full of platys, half of which are red and the other half are blue. Two aquarists, Sam and Betty, are asked to dip into the tank and remove some fish. Sam is instructed to draw out three fish while Betty is allowed six. The tank has opaque sides and is high enough so that neither can see the fish before drawing them out. They both record each time they observe a sample that is either all red or all blue. The sampled fish are returned to the tank and the sampling is renewed for many times. If they go on long enough, Sam will observe such extreme outcomes more often than Betty – by a factor of 8 (the expected percentages are 25% and 3.125%, respectively).

Fortunately for me, I caught my mistake and discarded the article before it ever got to the publisher. My "explanation" for the difference being that large stores were more careful in handling their fish would have been an embarrassment indeed had it been published!

Our minds are drawn to causal explanations and when our attention is called to an event, our associative memory will look for a cause; more precisely, activation will automatically spread to any cause that is already restored in memory. However, random events do not, by definition, have a cause and so such causal explanations will be wrong.

Another area where causal explanations try to explain events that have no explanation is the concept of "Regression to the Mean." The statistician, David Freeman (a professor of statistics at the University of California, Berkeley who transformed the practice of

applied statistics as it is directed toward litigation, Congressional action and public policy), used to say that if the topic of regression comes up in trial, the side that must explain it to the jury will lose the case. I'll give it a try here.

In statistics, regression to the mean is the phenomenon that if a variable is extreme on its first measurement, it will tend to be closer to the average on its second measurement In other words, an extreme event is likely to be followed by a less extreme event.

The concept of regression comes from genetics and was popularized by the polymath Sir Francis Galton (Charles Darwin's cousin) during the late 19th century with the publication in 1886 of his *Regression towards mediocrity in hereditary stature*. For example, the children of tall parents tend to be tall themselves but not as tall as their parents. The fact that the children tend to be taller than average is probably the result of genetics, but the fact that they tend not to be as tall as their parents is the result of regression to the mean. (I should note that the word "mediocrity" was neutral at first – it was based upon the Latin mediocris, meaning halfway up a mountain, and merely designated a middle state. Its disparaging sense began to predominate from the late 1600s but was replaced by the mean by later day statisticians.)

Here is why it happens. In the figure suppose you sample a point (point 1) and it falls where the red region and the yellow region meet. If you sample another point is it more likely to be closer to the mean (yellow region B) or further from the mean (red region A)? Obviously it is more likely to be closer to the mean because there is more probability there. Now suppose you sample another point (point 2) and it falls where the green region D and the white region C meet. If you sample another point, once again it is more likely to be closer to the mean because there is more probability there.

A fallacy occurs when one mistakes regression to the mean, which is a statistical phenomenon, for a causal relationship. For example, if a tall father were to conclude that his tall wife committed adultery because their children were shorter, he would be committing a regression fallacy.

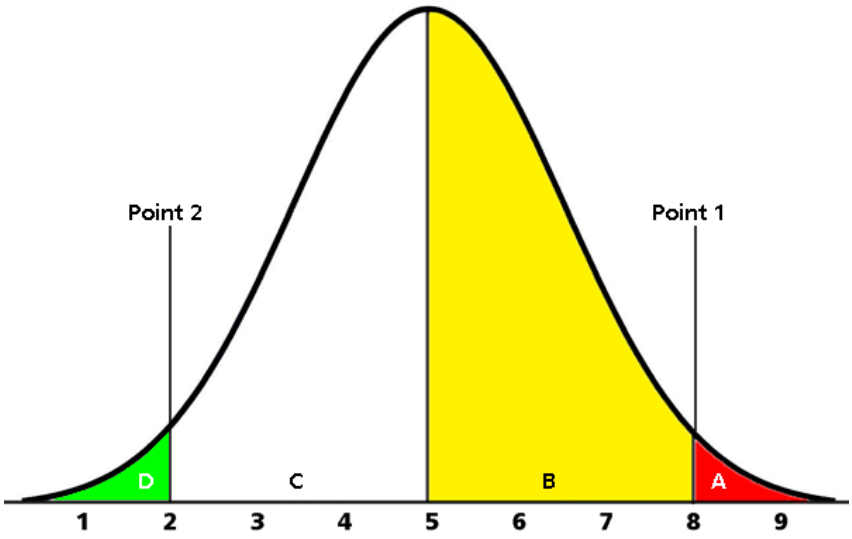
Now consider a guppy breeder who has a tank containing a strain of fish, each with the same genetic background and kept under identical environmental conditions. He wants to increase their size by using the largest of the fish in the tank. However, he finds that the offspring generally are smaller than the parents and he has a causal explanation, i.e., that the strain is deteriorating and so he feels that he must introduce some large fish from some other strain into his breeding program. This is another example of the regression fallacy, i.e., explaining away the non-existent.

You can get a good conversation started at a party by asking for an explanation of the following assertion - which is true, by the way - offered by Daniel Kahneman (he received the Nobel Prize in Economic Science in 2002 for his pioneering work on decision making):

Highly intelligent women tend to marry men who are less intelligent than they are.

Some may think of highly intelligent women wanting to avoid the competition of equally intelligent men, or being forced to compromise in their choice of spouse because intelligent men do not want to compete with intelligent women. More far-fetched explanations will come up at a really good party, especially if alcohol is readily available! The bottom line is that it is a mathematical inevitability that highly intelligent women will be married to husbands who are on average less intelligent than they are (and vice versa, of course).

In any event, those aquarists who take shortcuts to experimentation should beware of these two hidden traps, The Law of Small Numbers and Regression to the mean.



A HISTORY OF ZOOLOGICAL NOMENCLATURE

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, June 28, 2015)

Experienced aquarists generally have more than just a passing acquaintance with the International Code of Zoological Nomenclature (ICZN). The Code's fundamental aim is to provide the maximum universality and continuity in the scientific names of animals compatible with the freedom of scientists to classify animals according to judgments made with regard to the description, identification, naming and classification of animals. It is designed to enable zoologists to arrive at names for taxa - such as genus and species - that are correct under particular taxonomic circumstances. The use of the Code enables a zoologist to determine the valid name for a taxon to which an animal belongs at any rank in the hierarchy of species, genus, and family, and it is these names that are passed down to aquarists as a fish's "scientific name." However, it is not my intention here to discuss the working of the Code - which I have done in some detail (see "The Name Game" in my *Essays on Aquarium Hobby History*) - but rather to examine its development from an historical perspective. It is also neither my intention to discuss all the historical details of the problems faced by its trustees and Secretaries as the Code was developed and changes made over the years, as this would result in a small book rather than an essay, but I will comment on a limited number some of the thornier problems experienced during the Code's development.

PART I: THE PRE-LINNAEAN ERA

To a large extent, the study of the natural sciences up to the Eighteenth Century was not differentiated into separate realms, or at least far less so than at any time since. Every educated person could communicate in Latin more easily than between one modern language and another, and biologists could feel themselves to be, as it were, members of a club. There was a measure of understanding where names were concerned that rendered formal rules of nomenclature superfluous.

However, as more and more undescribed material was sent back from all corners of the world, so the number of biologists increased and the need for a more organized approach to describing and naming plants and animals became clear. The first step in that direction was the recognition of two categories of biological units that we now term "taxa" - the genus and the species. The second step was the reduction of the generic name to one word. Pliny the Elder in his *Naturalis Historia* (begun in 77 AD and comprised of 37 books) had already supplied many familiar words of that sort for the European, Middle Eastern and African animals known to the Romans. Species, however, were still denoted by descriptive phrases. The full name thus indicated its generic placing but employed a sentence instead of a word to designate a species.

This formed a system of polynomial nomenclature with the names having two separate functions. First, to designate or label the species, and second, to be a

Pliny the Elder (AD 23-AD 79), Roman naturalist.

Joseph Pitton de *Tournefort* (1656 – 1708), French botanist.

diagnosis or description; however these two goals were eventually found to be incompatible. Many biologists gave the species they described long, unwieldy Latin names that could be altered at will and a scientist comparing two descriptions of species might not be able to tell which organisms were being referred to. For instance, the common wild briar rose was referred to by different botanists as *Rosa sylvestris inodora seu canina* and as *Rosa sylvestris alba cum rubore, folio glabro*.

The French botanist, Joseph Pitton de Tournefort (1656-1708), is often credited with being the first to make a clear distinction between genus and species. Though he did indeed cluster the 7,000 plant species that he described into around 700 genera, this was not particularly original. Concepts of genus and species had been framed as early as the 16th century; Caspar Bauhin (1560–1624), a Swiss botanist, in particular consistently distinguished genera and species and took some important steps towards the binomial system, by pruning the Latin descriptions, in many cases to two words. Linnaeus honored the Bauhin brothers, Caspar and Jean, in the genus name *Bauhinia*.

Augustus Quirinus Rivinus (1652-1723), a German physician and botanist (he was also known as August Bachmann) had even advocated the use of binary nomenclature shortly before Tournefort's work was published in 1700. Rivinus was the first to apply consistently the rule that the names of all species in a genus should start with the same word (generic name). If a genus contained just one species, the generic name would be its only name. If there were more than one species in the genus, their names should consist of the generic name followed by a brief diagnostic phrase. His nomenclature differed from de Tournefort's in not using a diagnostic phrase with the first plant of a genus, adding differentiae (i.e., characters differentiating the species) only to the second and subsequent plant species.

Caspar Bauhin (1560–1624), Swiss botanist.

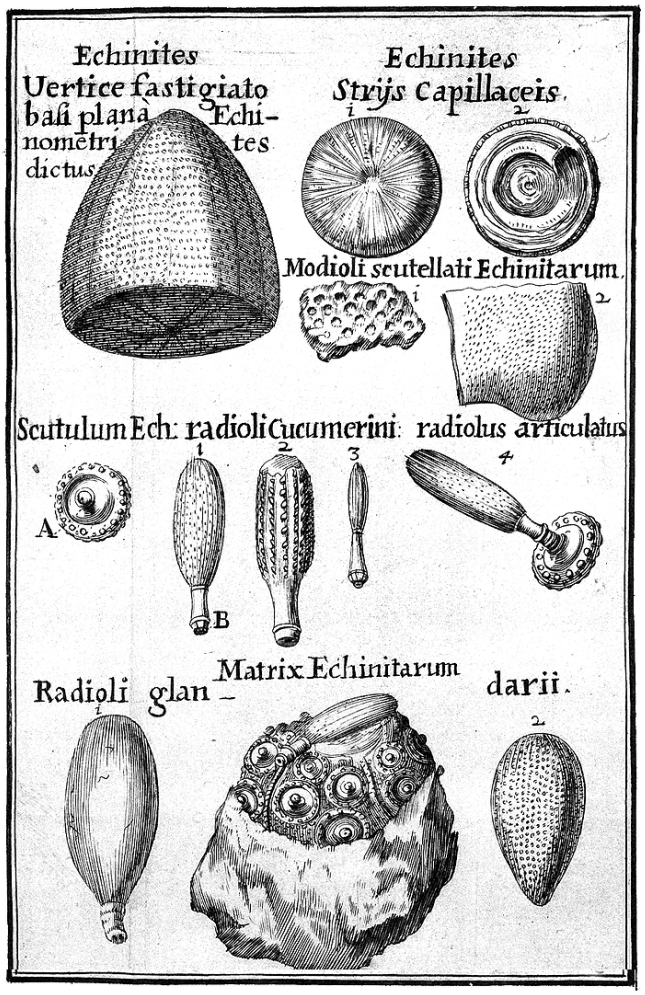
Augustus Quirinus Rivinus (1652-1723), German botanist.

Tournefort's work was quickly adopted by other predecessors of Linnaeus, for example in zoology in 1722 by Carl Nicolaus Lange (1670-1741), a Swiss medical doctor interested in fossils. The function of the specific name, however, was still to describe rather than to label; it was only intended to provide differentiae.

PART II: ENTER LINNAEUS

Biological nomenclature can be said to have begun with the first attempt to give it formal shape and structure. That this was done first in botany is due only to the fact that the man who did it was primarily a botanist, Carl Linnaeus, who held the Chair of Botany at Uppsala University in Sweden from 1742 to 1777.

The essence of the Linnaean revolution was the recognition that the function of the specific name was merely to label a concept rather than to describe an entity; the name could, therefore, be reduced to a single word. In 1751 Linnaeus enunciated 43 rules for botanical nomenclature which, by implication, were taken to apply also to zoology. Of these precepts, 23 are concerned with stating which sorts of words were eligible as generic names and with the formation of such names - matters with which all draftsmen of codes of nomenclature have been much preoccupied. His other precepts state that every plant must have a generic and a specific name, but none deals with specific names; each genus must have only one name which is universally to be used; names are not to be changed for impropriety; synonyms must be used for subdivisions of genera; names are not to be transferred from one genus to another;



A page from Carl Nicolaus Lange 's *Historia lapidum figuratorum*, 1705. Lange adopted Tournefort's nomenclature but it still was not binominal.

Carl Linnaeus (1707-1778), Swedish botanist.

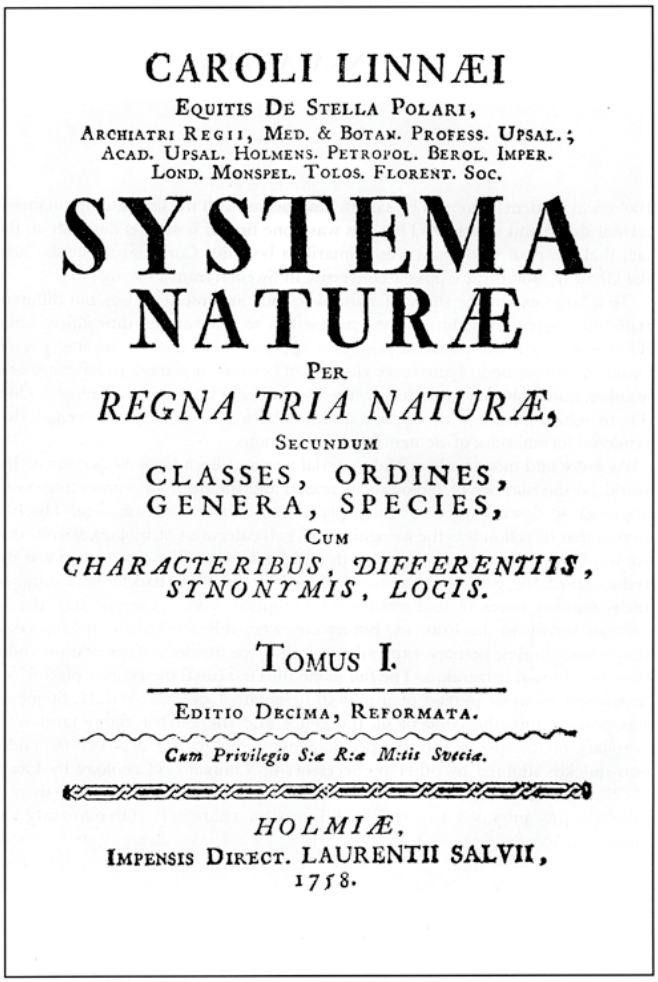
if a genus is divided, the original name must be retained for the commonest or the medicinal plant.

It was in his 1753 *Species Plantarum* that he first began consistently using a one-word "trivial name" together with a generic name in a system of binomial nomenclature and this was followed in the 10th edition of his *Systema Naturae* (1758). This trivial name is what is now known as a specific name

It has often been pointed out that Linnaeus had no idea of a principle of priority. Indeed, he was in no moral position to hold any such idea, engaged as he was in rejecting nearly all existing names of species. His intention must have been not so much to replace the earlier names as to provide a set of labels by which to trace and identify them. The uninominal specific names that he provided were thus of very small importance and he naturally regarded them as trivia.

Nevertheless, Linnaeus's trivial names introduced an important new idea, namely that the function of a name could simply be to give a species a unique label. This meant that the name no longer need be descriptive; for example both parts could be derived from the names of people. Thus Gerard's *phalangium ephemerum virginianum* became *Tradescantia virginiana*, where the genus name honored John Tradescant the younger, an English botanist and gardener. A bird in the parrot family was named *Psittacus alexandri*, meaning "Alexander's parrot," after Alexander the Great whose armies introduced eastern parakeets to Greece. Linnaeus' trivial names were much easier to remember and use than the parallel polynomial names and eventually replaced them.

In 1778 Johan Christian Fabricius (1745-1808), a Danish zoologist considered one of the most important entomologists of the 18th century, having named nearly 10,000 species of animals and established the basis for the modern insect classification, published a set of precepts on entomological nomen-



CAROLI LINNÆI

EQUITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;
ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES,
GENERA, SPECIES,

CUM

CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.

TOMUS I.

EDITIO DECIMA, REFORMATA.

Cum Privilegio S:æ R:æ M:tis Svecia.

HOLMIÆ,
IMPENSIS DIRECT. LAURENTII SALVII,
1758.

Johan Christian Fabricus (1745-1808), Danish zoologist specializing in insects.

clature. Like the Linnaean ones, these were little more than a guide to good manners but he gave more attention to specific names. Later biologists gave these names much greater importance, both for their convenience and because they allowed descriptions to be modified without changing names.

After Fabricius's publication more than 60 years elapsed before any further attempt was made to provide regulations for zoological nomenclature. During this period the number of names in circulation increased enormously, and many of these were felt to be unfortunate or even offensive to good taste and good science. To a generation in which all educated persons knew Latin and to whom the Latin influence on scientific literature was very strong, the formation of non-Latin or barbarous names, or the combining of Latin and non-Latin elements in compound names, was strongly objectionable. "Oh barbariem!" exclaimed Louis Agassiz in the long and detailed preface to his 1846 *Nomenclator Zoologicus,* in which his pursuit of classical purity led to the coining of hundreds of replacement generic names.

PART III: 1842-1895: CODES AND CONTROVERSIES

The Stricklandian Code (1843)

By the 1840s the growth of taxonomy without the control of a structured and hierarchical nomenclature was a cause of increasing confusion. In 1841, Hugh Edwin Strickland , a young Englishman who was primarily a paleontologist but with very wide zoological interests, wrote of the need for "the establishment of a uniform and permanent language among naturalists of all nations." Taking the initiative, he proposed to the British Association for the Advancement of Science that a committee should draft a Code of rules (among others, the Committee included two men well-known to aquarists: Charles Darwin, and the Rev. Leonard Jenyns who named the Chanchito) . The resulting rules were published in 1843 in the *Proceedings* of the Association meeting held at Manchester the previous June. It is clear that Strickland must have thoroughly prepared the ground in advance, for over 200 eminent men and learned societies were consulted in Britain, Europe, North America and Australia.

Hugh E. Strickland (1811-1853), English paleontologist.

The Stricklandian or British Association Code went much further than Linnaeus or Fabricius had gone with their mild recommendations for good manners. It is not the object here to analyze all the rules of the Strickland Code. However, the treatment of priority, as well as rules related to it, are commented on. The law of priority, the fundamental basis of the entire code, was defined as follows: "The name originally given by the founder of a group or the describer of a species should be permanently retained, to the exclusion of all subsequent synonyms (with the exceptions about to be noticed)."

Although priority had been adopted as a guiding principle by some naturalists for at least 30 years, no starting point had been proposed so far. In his personal draft, Strickland had already indicated that the starting point should be the *Systema Naturae*, but had not indicated which edition. The Committee decided that the starting point was the 12th edition and gave the date 1766 for a starting point. An alternative was the 10th edition, in which Linnaeus (1758) consistently applied the binominal nomenclature to all animals for the first time. However, the 12th edition was favored because Linnaeus changed quite a few names between the 10th and 12th editions of the *Systema Naturae*; selecting the 12th edition guaranteed that Linnaeus's last and supposedly preferred names would have precedence over former names that he discarded.

The starting point of zoological nomenclature, which clearly is central in the application of the principle of priority, remained discussed extensively until the end of the 19th century, when a decision was finally made to select the 10th edition of the *Systema Naturae*. Even though the British Association committee selected the 12th edition as a starting point, we owe to Strickland and the rest of the Committee to have pointed out the critical importance of a starting point for the application of priority.

The Strickland Code is divided in two parts. The first includes "rules for rectifying the present nomenclature" and deals with names that have already been created. It contains only 14 articles (rules), most of which deal with the application of the Principle of Priority. The second part includes "recommendations (not rules) for improving the nomenclature in future" and deals with the formation of new generic and specific names.

In zoological nomenclature, a type species is the species to which the name of a genus or subgenus is permanently linked, i.e., the species that contains the biological type specimen(s). A similar concept is used for suprageneric groups, the concept of a type genus. Several articles of the first part of the Strickland Code set the stage for typification within genera. In particular, the Strickland Code provided ways of determining which is the type species in case no typical species was designated originally, especially when a genus is split into several genera. The Stricklandian Code had a widespread influence on nomenclatural practice, however, and not many years elapsed before attempts began to improve on it.

Helmuth von Kiesenwetter (1820-1880), German entomologist.

The Kiesenwetter Code (1858)

The first Code published subsequent to the Stricklandian Code is *Die Gesetze der entomologischen Nomenclatur* by Helmuth von Kiesenwetter, with a French translation and comments in 1860. This makes no mention of the Stricklandian Code and might have been drafted as though that did not exist. It was adopted by a congress of German entomologists in Dresden in 1858. This Code states that a specific name consists of a combination of the name of the genus (taken as a noun) with the name of the species itself (taken as an adjective); that species and genera of insects must only be named when their existence in nature has been scientifically demonstrated; that publication must be in a language of Latin or Germanic origin and must be in a work that can be bought by way of trade or in a learned periodical; that a genus or species is named only when its publication renders it recognizable; that the addition of a diagnosis in Latin to make the taxon recognizable is absolutely necessary. In all these points the German Code clearly complements the Stricklandian. But in Article 15 it reads: "the principle of conserving the oldest of several names given to the same insect is not absolute; the choice between them is free according to greater or less convenience. This was perhaps the first formal attack on the sanctity of the principle of priority and was the opening shot of a campaign not yet concluded.

The Stricklandian Code (1866 version)

In 1865 the Strickland committee was resurrected by the British Association, although without the eponym. Strickland had died tragically at the early age of 42 when run down by a train while studying the geology of a railway cutting on his way home from the 1853 British Association meeting. There was only one significant emendation: when a species was raised to generic rank it was not the specific name but the generic name that was to be changed to avoid tautonymy, i.e., the situation where the generic and specific names are the same, as in *Danio danio;* this rule, however, is not used in zoology. The committee emphasized the importance of the recommendation that great restraint be used in naming taxa after persons, and proposed to omit the recommendation that specific names be written with a small initial letter.

The 1865 committee explicitly fixed the 12th edition of Linnaeus's *Systema Naturae* (1766) as the starting point of nomenclature, with special exceptions for generic names of Scopoli in insects, Artedi in fishes and Brisson in birds. This gave a legitimacy to binary nomenclature with unfortunate results. Binary, it should be noted, technically meant two similar or related things or concepts, and binominal meant the same except that it specifically denoted that the two similar things were names. Binary nomenclature therefore could mean either that the name of the species embodied two concepts (the genus and the species) or that the name consisted of two words.

William Arnold Lewis and David Sharp (1872-1875)

Three important pamphlets were published in London by Lewis (1872, 1875) and Sharp (1873). W.A. Lewis was a professional lawyer and an amateur lepidopterist. He deployed all the skills of the advocate and of the salesman, his mission being to attack, and if possible, destroy the law of priority as expressed in the Stricklandian Code.

Lewis repeatedly criticized attempts to use the names proposed by early authors (including Linnaeus and Fabricius) because their descriptions, while adequate when they wrote, might now cover half a dozen or more closely related species. He proposed that no name published before 1842 should ever be "used again unless it had "been kept alive by quotation as the true name in some work since 1842."

This issue could have been partly solved by going back to type specimens. However, as most authors in that period, Lewis paid much more attention to written descriptions, necessarily incomplete, than to types. In fact, he agreed with Sharp, a strong defender of the strict priority rule, that "it is clear that [types] must not be exclusively or even strongly relied on," when one wishes to determine which species is referred to by a species name.

This opinion was widely shared at the time. However, even though many of the genera named by the early authors had been subdivided, they nevertheless provided (and still provide) the main points of refer-

ence for the whole taxonomic system; their type species must perforce be found among their originally included species. But unfortunately, only primitive ideas about the type species of genera then prevailed.

According to Lewis then, some names would have to be rejected, but he offered no suggestions as to how or on what authority these were to be chosen. He rejected all appeals to type specimens because those of the early authors were in many cases damaged or of doubtful authenticity, but did not envisage any way in which they might be substituted. He failed to realize that going back to the type specimens is critical when determining the entity a name refers to, which cannot be answered if only written descriptions are considered.

David Sharp was an explorer and eminent coleopterist who wrote extensively on the fauna of the southern hemisphere. His 1873 pamphlet, by contrast with Lewis's views, is a defense of the law of priority. It makes an important point for the first time - that any system of nomenclature for species must conserve on a permanent basis the concept represented by the original binomen (i.e., a scientific name at the rank of species with two terms: a generic name and a specific name) as first established. It takes both terms of a binomen to express the concept and only the original binomen can express the original concept of its author. This was too metaphysical and neutral an idea to have impressed the one-sided mind of the advocate Lewis.

Maurice Chaper and Henri Douville

The pioneer of the sustained French initiative in matters of zoological nomenclature was Maurice Chaper, a graduate of the École Polytechnique and a railway and metallurgical engineer. He was an enthusiastic student of living and fossil mollusca and an associate of the much more eminent paleontologist Henri Douville, who was a mining engineer and Professor at the École des Mines in Paris and active in the first International Geological Congress held at Paris in 1878. This Congress set up a committee to study "the rules to be followed in the naming of species" and to report to the second Congress. Wishing to make sure that zoologists influenced the code that paleontologists intended to develop, Chaper alerted the Societé Zoologique de France and said that it would surely be wrong for the zoologists to have their rules laid down for them by the paleontologists, since the same nomenclature covered both. The reports by Douville for the Geological Congress and by Chaper for the Societé Zoologique were both presented in 1881. It is clear that Chaper was kept in touch by Douville with developments in his committee, but the two reports differ widely; these differences are of some interest and are much to the credit of Chaper.

Douville's report contained a set of 11 rules and was unremarkable except for its expression of the law of priority. It saw no need to set a backward limit to the application of this law. Any name that conformed to the law of binominal nomenclature and that was published with a clear definition of its taxon was acceptable, even if published before the time of Lin-

Henri Douville, (1846-1937), French paleontologist.

Maurice A. Chaper (1834-1896), French collector of zoological and botanical specimens.

naeus. It also insisted that no name was available unless accompanied by an illustration, but this requirement has not survived although it would be of great practical importance, especially in paleontology. The remaining Articles are unexceptionable and follow lines already well established. The accompanying report is entirely historical and deals with nomenclature from Aristotle onwards.

The committee of seven members of the Societé Zoologique de France included the Secretary-General of the Society, Raphaël Blanchard, then aged 34 but destined to acquire a towering importance in the affairs of the International Congress of Zoology and in nomenclature, and also in his chosen discipline of parasitology. Clearly, however, Chaper was the prime mover in the committee. That he was probably the sole author of the report is indicated by its completion in five months, which would have been unlikely for a group of seven if each had taken an active part, and by the numerous examples in the report taken from recent and fossil mollusca and none from the specialties of the other members. Furthermore, none of the other members had up to that time shown much interest in nomenclatural matters. Chaper's contribution attracted tributes from Douville for his "clarity and precision and extremely rigorous reasoning" and from Blanchard for his "inescapable logic communicated with great charm, and the marvelous lucidity of his thinking." Chaper's role in setting the foundations of nomenclatural rules in zoology is little recognized today, yet his influence persisted after his death into the 1905 *Règles (Rules)* and can still be detected in the present ICZN Code.

The Chaper report consisted of 17 Articles and an essay on the work of the committee and on the underlying principles of nomenclatural rules. The rules are all expressed with admirable brevity and clarity. A few points deserve mention. One detail in Chaper's (1881) rules is intriguing. Indeed, the first Article reads:

Raphaël Blanchard, (1857-1919), French parasitologist, Commissioner and President, 1895-1919.

"The nomenclature adopted for all organized beings is binary and binominal [*binaire et binominale*]. It is essentially Latin. Each being is distinguished by a genus name followed by a species name." Chaper's ideas on the meaning of binary and binominal have remained unclear, especially because both adjectives were used interchangeably in the 19th century to refer to the Linnaean nomenclature. As Melville (1995 pointed out: "It is not clear why he used both adjectives when one would have sufficed." Blanchard (1889), whose rules were deeply inspired from Chaper's rules, also used both adjectives without giving a clear distinction between them. At all events, that expression gave rise to furious disputes for some 40 years and was not officially eliminated from the Code until 1961.

All the remaining Articles are found in the 1905 *Règles* with little or no modification, except for Articles 16 - "Any barbarism, any word formed contrary to the rules of spelling, of grammar and of composition must be corrected' - and 17 - "When generic and specific names have a Latin pronunciation so nearly alike that confusion would result, only the first is to be retained." The latter Article was reduced to the status of a recommendation in the 1905 *Règles* and eliminated in later Codes.

The accompanying essay by Chaper is also admirable in attempting to set out the underlying principles in a clear, coherent and collected statement. He insisted on the committee providing a practical means to meet existing needs and avoid confusion, rather than a nomenclatural system theoretically better than any other. The committee accepted a number of points that might have been rejected on philosophical grounds; they would have preferred a single law of homonymy (the state or quality of a given word's having the same spelling and the same sound or pronunciation as another word, but with a different meaning such as race "tribe" and race "running contest") for both the plant and animal kingdoms, but practical considerations demanded their separation. The essay analyzed the importance of giving a Latin form to names since natural history was originally taught in Latin and Latin was the only medium of communication between people with different national languages: its use obviated the need to learn several languages in order to read the scientific literature. The essay stressed the cardinal importance of fixing the type species of each new genus as an integral part of its first establishment; this did not become part of the *Règles* until 1931. It closed with a disclaimer to have offered anything doctrinal or authoritative: the report merely provided, for general convenience, the rules and usages sanctioned by common sense and long practice, collected and coordinated.

The year 1889 was of special importance for France because of the International Exhibition held in Paris, which gave rise to no fewer than 70 congresses. One of these was the first International Congress of Zoology, initiated and presided over by Alphonse Milne Edwards. In addition to being the foremost French zoologist of his day he had important friends in political circles and the Congress received government support channeled through the Societé Zoologique de France. The opportunity to establish France as the leader in the international regulation of zoological nomenclature was too good to miss and Blanchard, as Secretary of the Societé, was not the man to let it slip.

The Blanchard Code (1889)

The draft Code presented to the first International Congress of Zoology by Blanchard is preceded by a lengthy report in which Chaper's 17 Articles are reprinted verbatim. Blanchard's own Code, which terminates the report, consists of 53 Articles and includes virtually all Chaper's Articles, somewhat reorganized. A large part of the remainder is concerned with the choice and formation of names. Discussion of this draft could not be completed at Paris and was accordingly deferred to the second Congress to be held at Moscow in 1892. Blanchard's second report, republished in 1895, contains the following significant passage on the application of the Articles expressing the Law of Priority: "A certain reserve is recommended to authors in applying the above rules. In particular, special cases should be taken into account where the replacement of a known name by a new name would cause a real disturbance of nomenclature recompensed by very slight advantages."

The Third International Congress of Zoology (1895): The Creation of the International Commission on Zoological Nomenclature

The achievement of the French in only six years (1889-1895) was considerable in the creation of an international framework - an ongoing Congress - in which nomenclature could be discussed. The regulation of nomenclature could be regularly examined as an integral part of zoology as a whole, thus countering a tendency for nomenclature to be discussed in isolation from other aspects. At the time of the third International Congress of Zoology at Leiden in 1895 there were three recent and partly incompatible sets of rules, from America (the American Ornithologists' Union Code), from France (the Blanchard report) and another from Germany (Deutsche Zoologische Gesellschaft Code. This Congress provided the opportunity for harmonization.

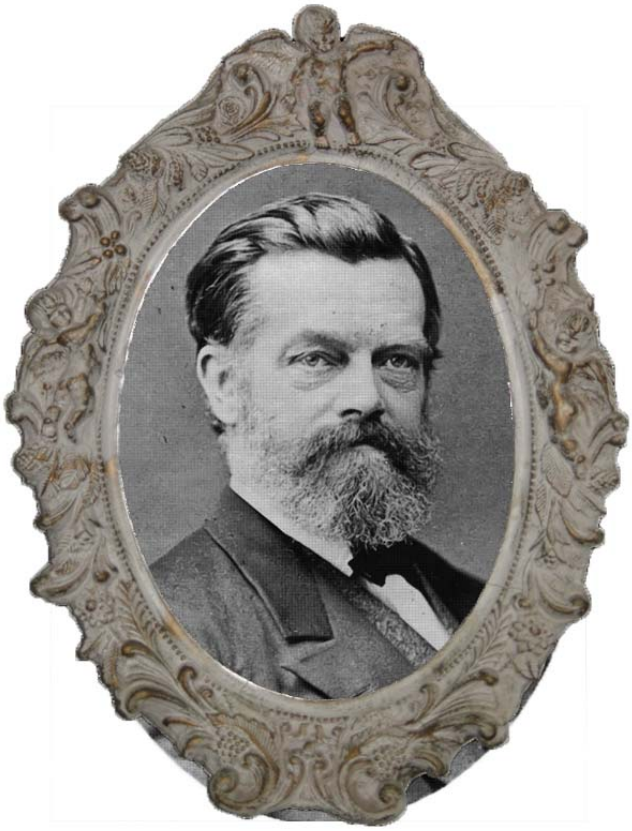
The initiative in this was taken by F.E. Schulze of Berlin with Blanchard's support. Blanchard must have realized that, if the international treatment of the subject remained in exclusively French hands, other zoologists would dissent; in that case all his and Chaper's hard work would be lost. Schulze would propose to the Congress that a commission of three members be nominated to produce one single code that could be recommended in different countries and be written in three languages, French, English and German. The accompanying image of the *Bulletin* of the Third International Congress of Zoology shows this proposal in two languages, German and French. (The German version refers to "Tierformen" or "animal forms" while the French version refers to "êtres organisés " or "organized beings" and meant plants and animals.) This proposal, with the noteworthy difference that there should be five members, was presented at the Congress's second plenary session on September 18th. It was carried unanimously and the International Commission on Zoological Nomenclature was born.

The five members appointed by the Congress were Raphaël Blanchard from Paris, one of the founders of medical parasitology; Julius V. Carus from Leipzig, pioneer in the development of comparative animal morphology and translator of Darwin's books into German; F.A. Jentink, mammalogist and Director of the Leiden Natural History Museum and also President of the Congress; Philip L. Sclater, ornithologist and Secretary of the Zoological Society of London; and Charles W. Stiles, principal zoologist of the U.S. Department of Agriculture Bureau of Animal Industry in Washington and at the age of 28 already well known both in Europe and America for his contribution to helminthology and public health.

The Commission immediately began work by correspondence and their first action was to ask Blanchard to be their President. With the exception of Jentink, the Commissioners met at Baden-Baden, Germany in August 1897 and appointed Stiles as their Secretary. They resolved to propose to the fourth Congress to be held at Cambridge in 1898 that the Commission should be enlarged to at least seven members and made permanent, with a remit to report to successive Congresses on "toutes les propositions relatives a la Nomenclature." They agreed on "un corps de *règles*" with unanimity except (ominously) on "questions secondaires." These rules were presented in French, English and German. Now, the destiny of the Code would remain in the hands of both the Commission and the Congress. It would still be ten long years before the first Code would be published, as the *Règles internationales de la nomenclature zoologique* (ICZN 1905).

The Fourth International Congress of Zoology, Cambridge (1898)

The Commission did not have an easy time. When the members arrived in Cambridge they were refused a place on the agenda to present their proposed rules. The General Secretary of the Congress, Jeffrey Bell of London, gave as the reason that their report was not in all respects unanimous. A large part of the time and energy of the three previous Congresses had been spent in discussions of nomenclature, and Bell may have thought that zoologists would stop coming if that continued. Sclater proposed that the report should be referred back to the Commission for further consideration, with power to add to its number, that all questions on zoological nomenclature should be referred to the Commission and that it



Julius Victor Carus (1823-1903), German zoologist, Commissioner 1895-1903.

Charles Wardell Stiles (1867-1941), American parasitologist, Commissioner 1895-1941, Secretary 1897-1936.

Philip Lutley Sclater (1829-1913), English zoologist, Commissioner 1895-1901.

Fredericus Anna Jentick (*1844-1913),* Dutch zoologist, Commissioner 1895-1913.

should be invited to present a final report on the Code to the next Congress. Ten additional members were elected to the Commission and the Commission approved the description of its functions as prepared by Blanchard: "This Commission of 15 members is responsible for bringing together, discussing and working out all questions relating to zoological nomenclature."

The effect of Bell's refusal to have the Commission's report discussed at the 1898 Congress was to segregate nomenclatural business from other topics in zoology and to define the Commission's status as an independent agency of the Congress as a whole. Once its reports reached the floor of the Congress they could be accepted or rejected but not discussed or amended. There was no Section on Nomenclature in which the Commission's reports could be discussed by other zoologists in advance of the general sessions of the Congress.

The Cambridge Congress adopted two resolutions of great consequence for the Commission. One ruled that no nomenclatural business could be brought before the Congress except through the Commission and having been in its hands for at least a year. This latter requirement is still in effect so far as changes to the Code are concerned and was valuable in allowing the Commission - which could work between Congresses only by correspondence - to present an orderly and considered report. The other resolution confirmed Bell's requirement for a unanimous vote on all matters concerning the rules of nomenclature and was to be a source of great difficulty for the Commission and its Secretary.

Charles Wardell Stiles, Commissioner 1895-1941, Secretary 1897-1936

The Commission's welfare, development and success were the responsibility of Stiles, who remained Secretary until 1936. Stiles (1867-1941) was an American parasitologist of immense distinction as well as a successful social engineer. He went to Europe in 1886 for five years to study at the universities of Paris, Gottingen and Berlin before taking a Ph.D. at Leipzig with the eminent parasitologist Rudolf Leuckart. As a result of this background he was well known to European zoologists. In 1898-1899 he served as agricultural attaché in the US Embassy at Berlin. Here he showed that American pig meat was not infected with worms, on which supposition its import had been banned, and this led to lifting the embargo. Among his many gifts was the capacity to move authorities to action, for example in the application of his research on hookworm *(Necator americanus)* in the southern United States and on pollution by sewage to the establishment and improvement of public sanitation.

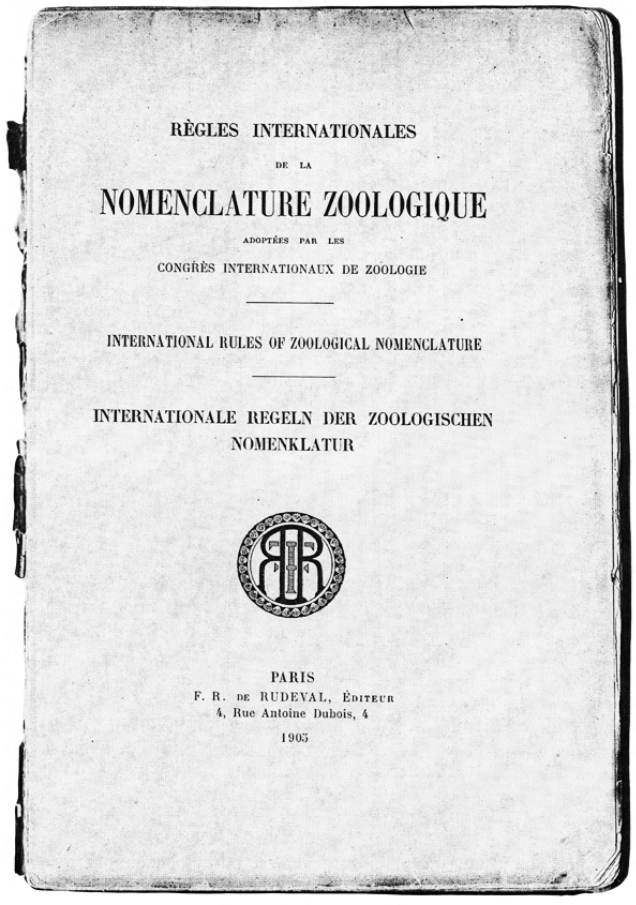
Stiles was interested in nomenclature from an early age. In an early paper on cestodes in man, he stated that "the only way to establish an international nomenclature in medical zoology…is to enforce the law of priority." He attended the first and second International Congresses of Zoology at Paris (1889) and Moscow (1892), which had devoted much of their time to discussion of Blanchard's draft Code of nomenclature. When the Commission was set up he must have seemed the natural candidate for its Secretaryship. The other four members were all senior figures and all Europeans. Stiles had already demonstrated an immense capacity for work as well as shrewd political sense. Perhaps the other four hoped much from "calling the New World into existence to redress the balance of the Old"; such hopes were more than fulfilled.

PART IV: THE RÈGLES ARE PUBLISHED (1905)

Much detailed editing of the *Règles* was still needed after the Berlin Congress and this was entrusted to a committee of three: Blanchard, von Maehrenthal and Stiles. The committee was unable to meet until the sixth Congress (Berne, 1904). In order to finalize the text it met daily for a week after this Congress had closed. The resulting *Règles Internationales* were published in 1905 in three languages — French, English and German, the French text to be taken as decisive in case of divergence of interpretation. In the Preface Blanchard noted that it was impossible to force anybody to obey the rules, but that the Commission appealed "au bon sens des zoologists" to follow them. Although they had been "longuement

deliberees par des savants de tous pays" they would not be definitive for all time — da Science marche."

It might have been thought that what the zoological world was looking for was a strong, clear code of rules that would provide a workable compromise between the adherents of rigid priority and those who favored some relaxation in the interests of practical convenience and continuity. In 1960 Stiles's successor Hemming gave a colorful account of the actual situation — "After twelve years [i.e. since the 1889 Paris Congress] of embittered debate an International Code of Zoological Nomenclature had been adopted at Berlin…but only at the cost of painful compromises only half accepted by the groups concerned. The fact that any agreement, however defective, should have been reached, came as a great relief to those zoologists, the great majority, who were less interested in polemics than in the pursuit of their zoological studies. The appearance of this document gave rise to painful surprise in many quarters."


RÈGLES INTERNATIONALES
DE LA
NOMENCLATURE ZOOLOGIQUE
ADOPTÉES PAR LES
CONGRÈS INTERNATIONAUX DE ZOOLOGIE

INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE

INTERNATIONALE REGELN DER ZOOLOGISCHEN NOMENKLATUR

PARIS
F. R. DE RUDEVAL, ÉDITEUR
4, Rue Antoine Dubois, 4
1905

Those who had not been at Berlin in 1901 were shocked to see the rigid form given to the Law of Priority; those who had attended found it a highly distasteful reminder of the compromises which had been entered into. The implementation of strict priority introduced instability rather than stability in nomenclature. The Commission, as an official agency of the Congress, could have given a strong lead to almost any imaginative and courageous move in response to public opinion, but it was too divided to do so. It was also laboring under the refusal of successive Congress Presidents to permit even a discussion of proposed amendments of any rules which did not have the unanimous support of those Commissioners present. The principle of international cooperation in areas of science other than pure research was novel, whereas the notion of priority in the framing of concepts was deeply rooted. Nevertheless, Stiles, although relatively young, could perhaps have used his position to further progress and harmony in nomenclature and promote the status of the Commission. The fact that he did not do so is perhaps not surprising in the light of the working methods that he adopted over the many years of his Secretaryship. In spite of these unhappy auspices, the *Règles Internationales*, with the support of the Congress, gained acceptance to the extent that only two alternative Codes have been put forward.

PART V: PROBLEMS FACED BY THE COMMISSION

Toward a Limitation of Priority

Early on, it was realized by the International Congress of Zoology and the International Commission on Zoological Nomenclature that, in some specific cases, the application of some of the 1905 *Règles* might need to be suspended to avoid nomenclatural confusion and promote stability. It is the reason that, in 1913, the International Congress of Zoology (Monaco) conferred upon the ICZN the plenary powers to limit the application of the 1905 rules. One of the purposes of those plenary powers was that zoologists could submit requests to the Commission to protect a junior synonym over a senior name (implying a reversal of precedence). That is the reason that, when Chapman (1923) argued that a strict

application of priority generated confusion in nomenclature by resurrecting earlier and forgotten names, ICZN commissioner Bather promptly replied:

"Mr. Chapman's letter overflows with good sense; but it has all been said before. His laments, however, will not have been entirely wasted if you will permit this consolatory reply - namely, that in the year 1913, at the International Congress of Zoologists in Monaco, an agreement was reached in the largely attended section on nomenclature and confirmed in plenary session, by which the International Commission on Zoological Nomenclature was given power, on certain conditions, to suspend the rules in those cases where their operation was contrary to the general convenience. The Commission has, on the request of various zoologists, already taken action in several cases."

The possibility of submitting requests for limiting the application of priority was not enough for some authors, who thought, as did some taxonomists from the 1870s, that the Principle of Priority should be abandoned in favor of a principle of "continuity" (i.e., junior synonyms that were widely used should be conserved over earlier names). In the first half of the 20th century, debates about priority continued among zoologists as well as botanists. Beyond the Principle of Priority, it was the notion of stability that was discussed, i.e., whether it was realistic to think that nomenclature could reach absolute and permanent stability. Against authors who argued that favoring usage over priority was the best way to build a stable nomenclature, others replied that instability could not and should not be avoided:

A major step toward a limitation of priority was the recognition (not the adoption) of the "principle of conservation" (of junior synonyms over senior synonyms) at the 14th International Congress of Zoology, Copenhagen, in 1953. Discussions that took place at the Colloquium on Zoological Nomenclature, in Copenhagen, are mentioned in the detailed Report edited by Hemming (1953), then secretary to the International Commission: "After considerable discussion, the Colloquium agreed, by a majority, to recommend the inclusion in the forthcoming edition of the *Règles*, of a provision recognizing the Principle of Conservation to a limited extent." (Hemming, 1953,) Several drafts for an article governing the application of the principle of conservation were then presented. However, "…it was unfortunately found impossible to secure agreement upon any of these drafts" (Hemming 1953) and the precise wording was left to the responsibility of the International Commission.

Another issue related to the application of nomenclatural rules and stability of names: the enormous amounts of time it takes to get acquainted with the entire literature on a given taxon. Taxonomic work is poorly rewarded, and nomenclatural work is even more poorly rewarded. What people often do not understand, however, is that sound taxonomic work requires detailed nomenclatural knowledge. Regardless of the kind of rules supported by the Code (absolute priority versus priority and possible conservation of junior names), people talking about the "stability" of zoological nomenclature need to understand that: (1) dealing with all nomenclatural situations requires valuable expertise; (2) in order to reach that level of expertise, taxonomists need to spend a great deal of time working on basic nomenclatural data (lists of names, type availability, etc.); (3) more importantly, this kind of work by taxonomists should be highly respected and regarded as a direct part of their mission and duties. Indeed, one of the reasons that nomenclature is unstable is that the history of taxon names is highly complex in all taxa; experts of that history are needed, regardless of our rules.

The Type Species Problem

As surprising as it might seem, a historical review of the type concept and the terms related to typification, as well as their practical and philosophical implications, still needs to be written. In particular, it is unclear when type specimens started being used by zoologists (and botanists for that matter). Although detailed studies clearly are needed on this topic, it seems that it was only in the 1890s that zoologists realized the critical importance of type specimens in relation to the application of the Principle of Priority for species names: in fact, many papers addressed

that particular issue as far back as 1890. Blanchard's early rules included articles on type species (because of the abundant literature on this topic published in the second half of the 19th century) but did not include anything on type specimens. Because of the literature published in the late 1890s on type specimens, the first *Règles* (ICZN 1905) provided a brief recommendation on type specimens in the appendix: "This diagnosis should state in what museum the type specimen has been deposited and should give the museum number of said specimen." Terms such as holotype, paratype, syntype, and neotype, became more widely used only later.

One important challenge at the beginning of the 20th century was to go through all the terms that had been proposed so far for types and select those appropriate for the Code. This was not an easy process as there were inventoried no fewer than 233 terms available in the literature, most of which have been completely forgotten, such as: aedoeotypus, agriotype, chorotype, graphotype, hypotype, ideotype, and tautogenotype. This long list of terms shows that taxonomists, especially those interested in nomenclature, have always been profusely creative. More importantly, it also shows that the terminology related to types was abundantly discussed before terms were chosen for the Code (as always in nomenclature).

The first Opinions and the Official List of Names

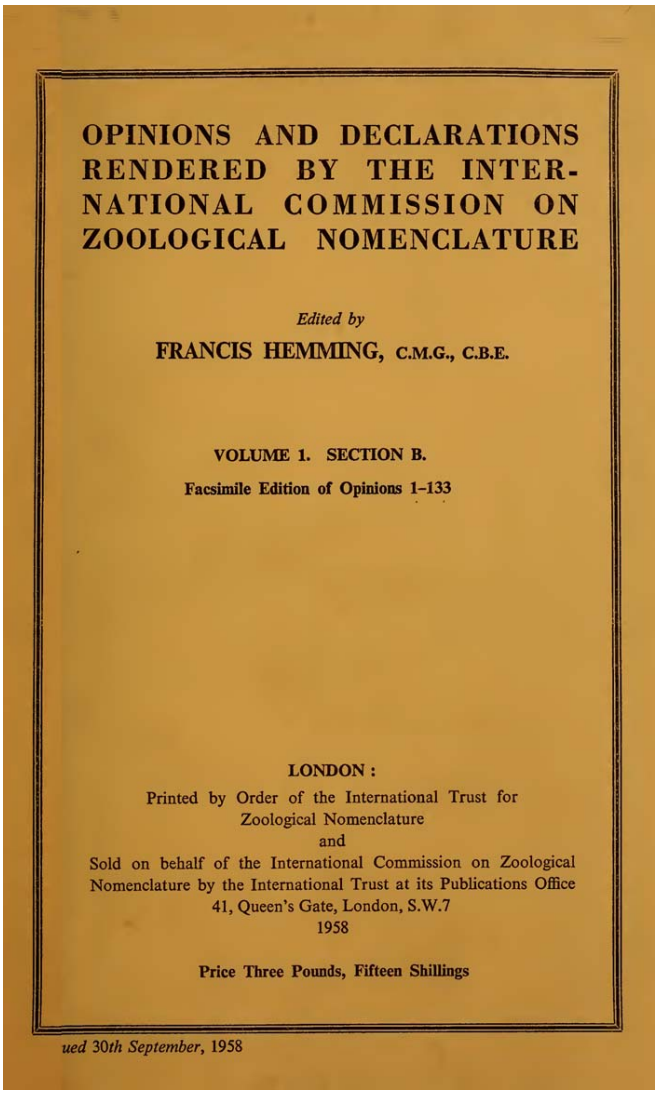
At the seventh Congress (Boston, 1907) the Commission included in its report five "Opinions" on the application of the principle of priority; these were published in *Science* in October 1907. Subsequent Opinions were until 1936 published by, and at the expense of, the Smithsonian Institution in Washington. Stiles's administrative difficulties were formidable. The Commission had neither legislative nor executive powers except to issue Opinions. To an American that term suggested a judicial verdict by the highest court in the land; to a European it would more probably indicate advice provided by an advocate and still subject to the risks of a trial in court. Stiles may have thought both to have his cake (in adopting a term familiar to American zoologists in their sense of the word) and eat it (in that by issuing mere "opinions" he could not be accused of stepping on the forbidden ground of "decisions"). His successor, Hemming, met this problem by retaining the familiar term "Opinion" but by labelling the most important part of it the "Ruling"; no objection was raised to this.

At the Boston Congress the Commission announced its intention to apply 'the provisions of the Code to the names of the more common and better known animals of the world, and of publishing results in the form of a list of several thousand such approved names, with a request to zoologists that no proposition for change of any name in said list be published until such proposition together with the reasons therefor shall have been submitted to the Commission, and shall have received its sanction under the Code. This was the germ of the present *Official Lists of Names and Works in Zoology*.

An example of an opinion that affected a fish name is Opinion 14, "The Type Species of *Etheostoma Rafinesque, 1819."* David Starr Jordan submitted a case to the Commission for an opinion on *Etheostoma* vs. *Catonotus* and *Diplesion* (all genera of darters). The Commission's ruling was as follows (in part): **"**The designation of *E. blennioides* Rafinesque, 1819, as type of *Etheostoma* Rafinesque, 1819, by Agassiz, 1854, is not invalidated by the fact that Agassiz used as basis for his generic diagnosis characters taken from an erroneous specific determination of 1839."

Funding: The Eighth Congress of Zoology, Graz (1910)

Up till 1910 there had been no method of funding the Commission's work. The most important administrative development at Graz was the announcement of a three-year grant by the Smithsonian Institution of $2700 for clerical expenses and $500 to meet the costs of publication. The Commission's work would then be published by the Institution and sent to 1100 libraries, to members of the International Congress and to a limited number of specialists. This grant must have lifted a weight of anxiety from Stiles' mind, and when his secretary was put on the established payroll of the Smithsonian and treated as one



OPINIONS AND DECLARATIONS RENDERED BY THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Edited by

FRANCIS HEMMING, C.M.G., C.B.E.

VOLUME 1. SECTION B.

Facsimile Edition of Opinions 1–133

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1958

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ued 30th September, 1958

of its regular employees he was as independent as he could have expected.

The availability of funds immediately transformed the Commission's public face. The placing of funds at the Commission's disposal in 1910 led to the republication of Opinions 1 to 5 together with Opinions 6 to 25 in the *Smithsonian Publications* in July of that year, and by the 1913 Congress 51 Opinions had been published. This was certainly remarkable given the conditions of the time.

However, considering that Stiles' secretaryship lasted until 1936, it is perhaps surprising that he produced only 133 Opinions in all and transferred a backlog of some hundreds of unfinished cases to his successor. His working methods and philosophy - in his own word, conservatism - may have had something to do with this. Moreover, it is possible that the atmosphere among American zoologists and paleontologists was not very favorable to him. There was undoubtedly a strongly individualistic spirit in the United States with perhaps the signs of an isolationist attitude as the young country felt the burgeoning of its enormous strength. Biologists there may not have seen the necessity for a worldwide Code of rules and may have been quite satisfied with the Codes such as the American Ornithologists' Union. The strongest feature of Stiles' position must have been the Commission's power to issue Opinions on nomenclatural problems, to put the authority of the International Congress behind them, and to be the only body with that power and with neutral status. The view gradually gained ground that only an Opinion by the Commission had any value in such matters.

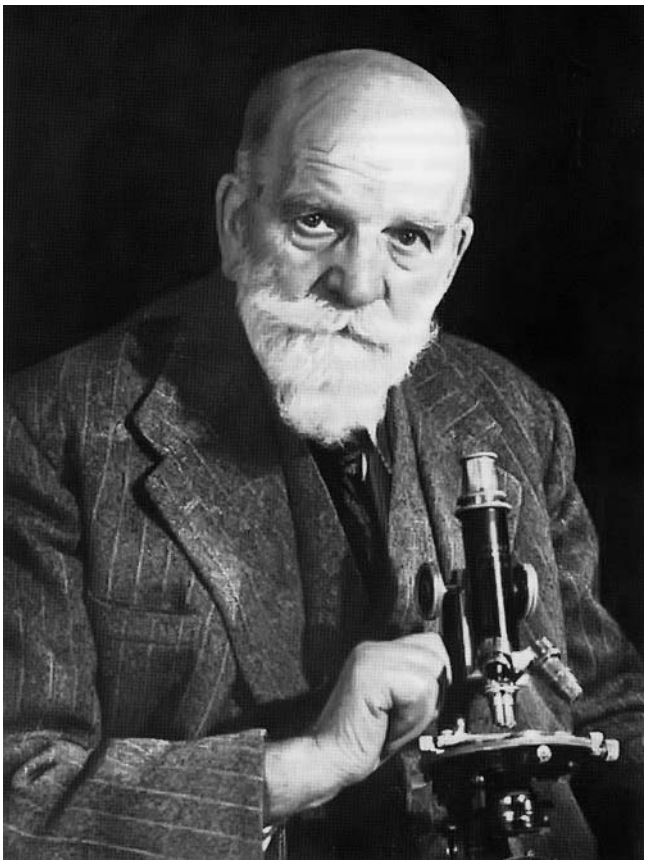
PART VI: TOWARDS A NEW CODE

Francis Hemming (Secretary 1936-1958)

Francis Hemming (1893—1964) was a high-ranking British civil servant with a flair for organization and wide administrative and political experience. He was secretary to ministers and to the International Board for Non-Intervention in the Spanish Civil War (1936—1939). At the same time, he was an international authority on the taxonomy and literature of the Palaearctic butterflies.

For the first ten years of his Secretaryship he had the active and enthusiastic support of the President of the Commission. Karl Jordan, President since 1929, was 75 when Hemming became Secretary; increasing deafness was beginning to limit his activity but, despite this, his wise governance played a major part in forming the new and more energetic arrangements that Hemming felt to be necessary.

Hemming had little to start with apart from two truckloads of unsorted papers, and it took him two years of spare-time work to sort, index and bind these (at a cost of £16). There was no money, the Commission having never had or controlled funds of



Heinrich Ernst Karl Jordan (1861-1959), German entomologist, Commissioner 1913-1950, President 1929-1948.

its own, no staff and, with the Secretary no longer in the Smithsonian Institution, no medium for publishing cases and the Commission's decisions. Yet the need for action to move affairs forward was urgent. The only official edition of the *Règles* was long out of date and out of print, and none of the amendments made by successive Congresses had ever appeared in the substantive language, French. The Official Lists of Names had never been published in a consolidated form and, like the *Règles*, the early Opinions were unobtainable.

Whoever had been elected Secretary to the Commission after Stiles's resignation would have been faced with the same problems and would have had to find his own solutions to them. Hemming's eventual solutions were fortunately successful and, in the administrative and financial arrangements that he made, exceptionally durable - the system that he set up still works today with little alteration.

The "Binaire" Conundrum

This was resolved by Francis Hemming, who defined the task before the Commission as being to determine, not what the draftsmen intended in 1901 but what, "on a due and proper construction,", the expression "nomenclature binaire" meant in the Code, for that provision demanded that the author of an available name, whether generic or specific, must have applied "les principes de la nomenclature binaire," There being nothing in the Code that defines the meaning of the expression, it was necessary to examine other passages in the Code to see if any light was thrown on the problem. This examination had to bear in mind that, in the absence of contrary evidence, the same meaning must be attached to any expression wherever it is used in a statute.

The only other use of "nomenclature binaire" was in an Article which read: "La dixieme edition du *Sys-*

Arthur Francis Hemming (*1893-1964*), British entomologist, Commissioner 1935-1964, Secretary 1936-1958.

terna naturae de Linne (1758) est l'ouvrage qui a inaugure l'application generale de la Nomenclature binaire en zoologie" ("The tenth edition of naturae Systerna Linne (1758) is the work that inaugurates the general application of the binary nomenclature in zoology"). But the one distinctive feature of the 10th edition is that it inaugurates the general application of a binominal nomenclature, i.e. species were denoted by two words only. It thus followed that "binary" and "binominal" were completely synonymous; and if this was true for one Article, it had to be true also for all the others.

The International Trust for Zoological Nomenclature

Hemming faced an invidious problem concerning the finances of the Commission, for by the end of the war in 1945 he found himself holding over £ 1000 in a bank account in his own name. This money was not his nor was there anybody else who could own it. The Commission had no corporate existence in any place and, were Hemming to have died, the money could not readily have been claimed from his estate. After obtaining the agreement of all the Commissioners who could be contacted, in February 1947 he and Jordan set up the International Trust for Zoological Nomenclature as a registered company. The Trust was (and is) a charity under United Kingdom law, meaning that it would pay no taxes on its income from subscriptions, the sale of publications or any other activities. The Trust's purpose was to hold and manage funds and apply them to the activities of the Commission, notably the expenses of publications and the salaries of the Secretariat. With regard to the latter, Hemming himself was precluded as a British civil servant from taking any payment for his work as Secretary. In the first few years of its existence the Trust recorded small surpluses of income over expenditure.

The Bulletin of Zoological Nomenclature

By June 1942 Hemming was able to give zoological nomenclature some renewed attention, but without money not even a man of his extraordinary energy and experience could do anything. Fortunately the Opinions adopted by the Lisbon Congress awaited publication and, by being put on sale in 1942, yielded a small profit over their cost of production. An appeal for funds provided a small amount (£297 by 1943) for office expenses. Hemming felt that applications to the Commission on particular problems in nomenclature ought to have wider publicity by being put within reach of the zoological public in general, rather than being distributed by the somewhat arbitrary and limited method of Circular Letters. In 1942 he and Jordan initiated the *Bulletin of Zoological Nomenclature* in wartime conditions when miracles were needed to obtain supplies of paper. Publication of the *Bulletin* began in May 1943 and generated the lifeblood of a subscription income; this enabled a revival of the Commission's activities although no new cases were voted upon until 1948.

From the inception of the *Bulletin of Zoological Nomenclature* in 1943, Hemming began to receive, and himself conceive, proposals for the correction, modification or extension of the *Règles.* To his work on this he brought the drafting skills of a trained civil servant and an extreme, some would say an exaggerated, respect for correct form. To a mind as highly organized as his, the spectacle of the 1905 *Règles* and the additions and alterations that had been made to them by various Congresses was a shambles. The additions and alterations to the original *Regies* had never even been put into French, the substantive language, so an objector could have claimed that they had no official existence and no authority. Unofficial texts had appeared at various times, such as that of the Biological Society of Washington in 1926 and the German text by Richter in 1927. Even when these defects had been cleared out of the way, there was a need to extend and develop the *Règles* in various directions to cover issues whose significance had only emerged over time.

Preparation for the new Code

The Fourteenth Congress of Zoology held in Copenhagen in 1953 finished the work of completing and developing the *Règles* that Hemming thought to be necessary. There remained the task of collating the old provisions of 1905 with all the decisions of subsequent Congresses, and with the Declarations that the Commission had adopted under Hemming's leadership, and the decisions taken at the Thirteenth

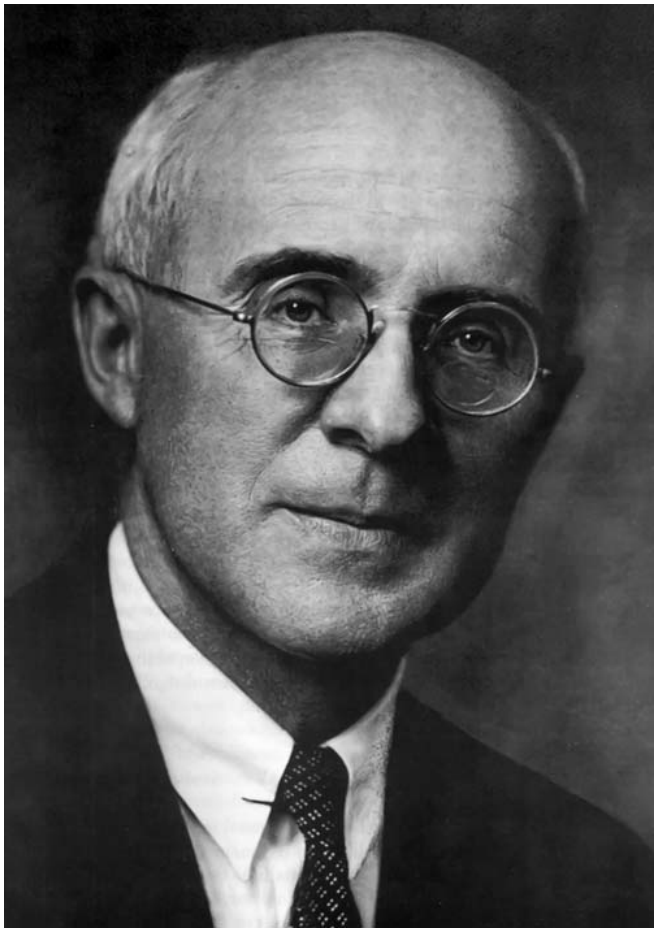
Congress of Zoology in Paris in 1948 and the following one in in Copenhagen, a modern Code could at last be produced. It would have been quite unrealistic to have expected Hemming to have added all this to the demands already made upon him by the normal work of the Commission, quite apart from the fact that he had now reached the age of 60 and was aware that he was beginning to slow down. The task of drafting the Code was therefore entrusted to J. Chester Bradley, of Cornell University, New York State, who had been at the 1948 discussions in Paris and had been elected President of the Commission in 1952. To stabilize the situation in the interim before the new Code could be adopted and published the Copenhagen Congress adopted two resolutions. The first "advised taxonomists to guide themselves ... by the decisions taken by the Congress in the light of the recommendations" by the Colloquium and Commission; the second "directed the International Commission to guide itself during this period by the decisions . . . and should treat them as binding upon it."

Parlez-vous Français?

As the close of the Copenhagen Congress drew near, it was obvious that a decision had to be taken on the substantive language of the Code that was to be put together by Chester Bradley out of the materials just enumerated. Although the 1905 *Règles* had been published in French, English and German it was the first of these texts that was to be decisive in any case of ambiguity. There were two reasons for this: the *Règles* were entirely of French inspiration and had been prepared by Raphaël Blanchard, and French was the language of international diplomacy and congresses. However, all the work done since 1905 had been in English and there was a widespread wish that the new Code should have this as the prime language. Hemming consulted zoologists from Brazil, Denmark, Germany and the Netherlands on the subject and all expressed a preference for English as the substantive language, with an official French translation; the earlier German text was not considered. Taken with those of the English-speaking countries, these made up a substantial part of the attendance at the Congress.

However, immediately before the closing plenary session objections were raised by the French zoologists present, who included both the President and the Secretary of the *Comite Permanent des Congres internationaux de Zoologie*. In view of these objections, the President of the Congress (Ragnar Sparck of Copenhagen) and Hemming took the instant decision not to proceed with the proposal to change the substantive language of the *Règles.* It has to be remembered that the Commission was not an independent organization. It was a body created by and within the Congress and was obliged to submit all its work for formal approval by a plenary session of the Congress.

Strong expressions of regret at what had occurred were immediately made. As Congress President, Sparck then directed that the English text of the Code should rank with the French as a joint substan-



James Chester Bradley (1884-1975), American entomologist, Commissioner 1944-1963, President 952-1963.

Richard Valentine Melville (1914-1993), British paleontologist, Commissioner 1968-1989, Assistant Secretary1958-1959, Secretary 1968-1985.

tive language. The reason for his decision was given as the need to avoid the delay which would be caused if the English text which Chester Bradley would produce had to be translated into French, and the equivalence of the two texts agreed, before any official Code could appear. Once it was accepted that the English text was of equal status with the French, there was no reason why the one that was the quicker in preparation should have to wait for the slower. The Trust undertook to publish the French version "at the earliest possible moment and at the same price as that proposed to be fixed for the English text"; they eventually appeared together in the 1961 Code.

The Official Lists are Finally Published

In 1958 Hemming was at last able to publish the first instalments of the Official Lists of those names and works which had been explicitly accepted by the Commission as being available, and of the Official Indexes of those which had been rejected or suppressed. This project had been initiated at Boston half a century earlier, but the Lists had never been published. The 1958 Lists and Indexes in eight separate volumes comprised 509 family-group, 2443 generic and 2052 specific names and 96 works. Some names were "withdrawn for further consideration," but most of these have since been restored to the Lists. The introduction to the Lists recorded that the 1948 Paris Congress had introduced into the *Regies* a provision that "a name on the Official List ... is not to be discarded in favor of some other name or used in a sense different. . . unless and until the Commission . . . shall so direct," the listed names were thus conserved.

Although Hemming had planned to pilot the Code through the London Congress, he was obliged on medical advice to retire at the end of April 1958, less than three months before the opening of the Congress. Fortunately, the Trust's finances enabled it to deal with this crisis by appointing Richard V Melville, a paleontologist on secondment from the Geological Survey of Great Britain, as Assistant Secretary. Melville had greatly helped Hemming at the 1953 Copenhagen Colloquium and was familiar both with the proposed nomenclatural rules and with many of the zoologists expected to participate in London.

Problems with the International Trust for Zoological Nomenclature

One major problem that came to a head in Copenhagen in 1953 concerned Hemming's publication policy and his management of the International Trust for Zoological Nomenclature. By the time of the Copenhagen Congress no regular source of income other than profit on the sale of publications had been found. A committee was proposed to examine the problems of finding an adequate financial basis for the work of the Commission and to make recommendations to the Congresses. It had also to consider the finding of a replacement for Hemming as Secretary to the Commission, for he had announced his inten-

tion of retiring as soon as the new Code could be published and this was expected before the next Congress.

The committee proposed a plan as follows: a new financial structure would be set up on the basis of an International Association for Zoological Nomenclature whose members, both individual and institutional, would subscribe to the support of the Commission; until that arrangement was in place, the existing structure of the Trust would continue and a grant-in-aid would be sought to meet expenses; financial matters would be handled by the officers of the new international society; and the work of the Secretary would be shared between an Interim Secretary and an Interim Editor, both honorary posts.

In May 1954, however, Hemming wrote to the committee to say that for various reasons the new Code ought not to be promulgated in the form proposed at Copenhagen but should first be considered by a Colloquium to be convened as a prelude to the 15th International Congress of Zoology to be held in London in 1958, and that he therefore proposed to defer his retirement to the close of that Congress. The Committee saw some advantage in this proposal and replied that they proposed to lay their report before the London Congress, at the close of which the International Association for Zoological Nomenclature could be instituted.

The report was completed in 1958 and proposed to institute drastic economies, hoping that the new source of income from subscriptions to the International Association would lessen dependence on profit from the sale of publications. The length and number of the publications and hence their price would be reduced by eliminating duplication between the *Bulletin* and the *Opinions*. The Committee proposed a structured scheme for subscriptions to the International Association, as well as measures for its organization and governance. A proposed budget showed that expenses could be matched by an equivalent income. Sufficient funds had been accumulated to ensure the transfer of work to Hemming's successor without interruption. There can be no doubt that the report of the Committee contained many excellent proposals. The Trust immediately economized by reducing the number of salaried staff. The position of Lord Hurcomb's - the Chairman of the Trust - as a Trustee of the British Museum (Natural History) facilitated the Secretariat's move into free accommodation in the Museum with its unrivalled libraries. This arrangement has continued ever since, to the great advantage not merely of the Commission but of zoology everywhere. The Trust's serial publications were confined to the *Bulletin of Zoological Nomenclature* alone by eliminating the separate *Opinions and Declarations.* However, the International Association for Zoological Nomenclature was not formed and the proposed distribution of the roles of Commission Secretary and of Editor to two honorary officers was not pursued.

The Chester Bradley Draft Code

Chester Bradley's draft of the Code was published in 1957 as volume 14 of the *Bulletin.* It was immediately seen to be a completely new Code and the thoroughness of the new document was remarkable. The structure of the Code had been carefully thought out. It was divided into three sections - one for the "Rules, Nomenclatural Regulations and their interrelations with Taxonomy," one for "Linguistic Regulations' and one for 'Regulations pertaining to this Code and to the Commission."

In spite of the enormous elaboration of the old *Règles*, this was all set out in 30 Articles compared with the 35 Articles of the *Regies.* Each Article was divided into numbered sections and lettered subsections. Recommendations were inserted as close as possible to their relevant mandatory provisions and numbered in sequence within each Article. All this is still reflected in the current Code.

The outstanding characteristics of the Chester Bradley draft were its clarity and balance. The language was plain and shorn of complexities except occasionally where the author was at pains to demonstrate the logical basis of his drafting; with perhaps a private wish to show where he thought Hemming had missed a point. He was careful to provide explanations of points that he found obscure and suggestions for dealing with defects that he thought beyond his

own authority. He also took care to give the authority for each provision - whether in the *Règles* or in the proceedings of the Paris and Copenhagen Congresses, or in a Declaration by the Commission. It is difficult to see how a plainer basis could have been provided for final decisions on the shape and content of the Code to be taken by the London Congress. The Commission later formally recorded that Chester Bradley's "occupancy of the Presidency was one of exceptional importance, comparable only with that of Professor Raphaël Blanchard fifty years earlier. Both men devoted their main attention to the international regulation of zoological nomenclature, Professor Blanchard being the principal author of the Code ultimately adopted in Berlin in 1901, Professor Chester Bradley playing a similar role in the preparation of the draft of the revised Code adopted by the London Congress in 1958."

Norman R. Stoll (1892-1976), American parasitologist.

International Code of Zoological Nomenclature (1961)

The final work on the London Code was entrusted to an Editorial Committee of two Americans (Norman R. Stoll and Curtis W. Sabrosky), two French and two English zoologists, with Stoll as Chairman and Richard V. Melville as Secretary. The task of drafting a coherent Code was demanding, and Stoll and Sabrosky spent many weekends together working on it. The Committee met in London in May 1959 and worked for over a week, "almost literally around the clock" according to Stoll. During the period 1958-1960 almost all the normal work on individual cases and production of the *Bulletin* was done by the Secretariat assistant, Miss Margaret Spillane. Joseph H. Riley saw the London Code through to publication in November 1961, with a preface by Chester Bradley giving a masterly expose of the principles of nomenclature and an introduction by Stoll describing the work of the Editorial Committee. Within 18 months 3750 copies of the Code had been sold at one £ each. Translations accepted as authorized texts soon appeared in Bulgarian, Czech, German, Japanese, Polish, Russian and Spanish, the German translation being by Otto Kraus, appointed to the Commission in 1963 and its President in the centenary year. Amendments made to the 1961 Code by the 16th

Curtis Williams Sabrosky (1910-1997), American entomologist.

Congress meeting at Washington in 1963 were incorporated in a second edition published in 1964.

CONCLUSIONS

An important aspect of nomenclature that one should keep in mind when potential changes of nomenclatural practices are discussed is that nomenclature is a means of facilitating, not an end result, of taxonomy. In fact, one can read on the front page of the American Ornithologists' Union Code of 1886: "Zoölogical nomenclature is a means, not an end, of zoölogical science." This implies that nomenclature should remain open to changes that facilitate the work of taxonomists. This is exactly why numerical taxonomists argued in the 1960s that nomenclature should be changed so that it could serve better the modern context of numerical taxonomy. This also is why it has been more recently argued that nomenclature should be changed to better serve the modern context of phylogenetic systematics.

New nomenclatural questions may arise from new techniques too. Early writers (e.g., Strickland 1835, 1843) rightly argued that names should be eligible for priority only if the species designated by that name had been properly described. What constituted a "good" description was actively discussed throughout the 19th century in relation to the Principle of Priority, but basically descriptions should include as much information as possible so that species can be re-identified.

However, standards of species description change over time because new techniques are available. For instance, when Blanchard and the other members of the International Commission devised the first *International Rules of Zoological Nomenclature* in the late 19th century, the ability of comparing nucleotide sequences for taxonomic purposes did not exist. Should the Code recommend that DNA sequences of a few standard markers be included in species descriptions as, in the 19th century, some authors thought that illustrations of specimens should be mandatory when creating a new name?

It seems that the future of nomenclature is going to be fascinating. However, taxonomists should not fear that changes may be needed in nomenclature, as long as those changes can help to better serve modern needs in systematics. Nomenclature has remained dynamic for the last 250 years, and will be dynamic for the next 250.

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THE CLASSIFICATION OF FISHES: FROM ARISTOTLE TO LINNAEUS

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, July 25, 2015)

Although I have written about nomenclature, classification is also of interest to serious aquarists. Classification is a way of categorizing animals based on their physical and genetic characteristics into groups and subgroups. As most aquarists know, the most common are (in descending order of complexity) order, family, genus and species. As Gaylord Simpson put it, "This is, as I see it, the primary purpose of classification: simply to provide a convenient, practical means by which zoologists may know what they are talking about and others may find out." Replace the word "zoologists" with "aquarists" and a simpler reason for why classification is important cannot be found. Classification is one part of taxonomy, which includes the identification, description, classification and naming of fishes.

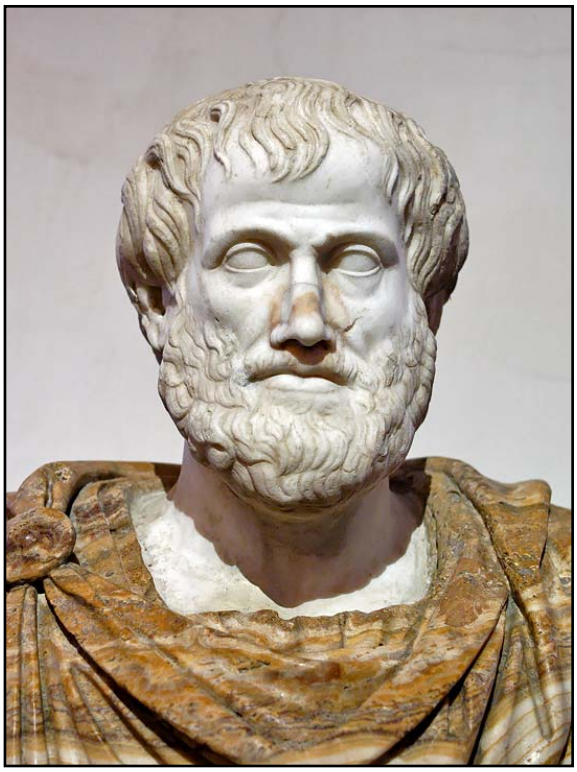
THE ANCIENTS

Aristotle

It is necessary to start with Aristotle since his views on the classification of animals lasted for thousands of years, extending into the Renaissance and even after. Aristotle (384–322 BC), the pupil of Plato, is generally considered as the real founder of zoology, though not necessarily of ichthyology as he never wrote a monograph on fishes. However, the advances he made both in practical observations of fishes and in theoretical considerations about their nature are just overwhelming, such as why bony fishes are so prolific or how the Chondrichthyes (cartilaginous fishes) and Osteichthyes (bony fishes) differ in their reproductive biology. Aristotle's zoological definition of a fish was the first clear and correct one. The following is taken from his *Historia Animalium* (*History of Animals* - written in 350 BC): **"…the tribe of fishes is a unified group, distinct from other water-animals, and includes many sorts of various appearances …they have two peculiarities, gills and fins."**

Aristotle's classification of species was his greatest contribution to the history of zoology as it was the first known attempt to classify animals into groups according to their behavior and, most importantly, by the similarities and differences among their physiologies. Using observation and dissection, he categorized species. Although his broad classifications might seem strange to modern zoologists, considering the limited equipment and store of knowledge he had access to, his zoology stands as a tribute to his systematic methods and empirical approach to acquiring knowledge.

While Aristotle's zoology and classifications were broad and often inaccurate, the sheer scale and the thorough documentation sets apart his *Historia Animalium* as one of the landmark scientific texts in the history of biology. Aristotle's work was the beginning of the science of zoology, with many of his observations preempting the studies of great naturalists such as Darwin, Linnaeus and Wallace. Sadly, the observations were spread across nine books that deal with his history of animals, and much of this work was lost.



Aristotle (384-322 BC)

An Aristotelian classification works according to a set of binary characteristics in which the object being classified is either present or present. At each level of classification, enough binary features are used to place any member of a given population into one, and only one, class. For example, Aristotle described features in binary terms: **"Some are nocturnal, as the owl and the bat, others live in the daylight."**

This system of classification is commonly called morphological, its basis being the grouping of animals according to the number, and to some extent the kind, of structural characteristics that they have in common. Each grade in a hierarchy corresponds with certain fixed characters possessed by all the animals included at a particular level. The lower the hierarchic rank, the more characters are held in common by the included animals. For instance, such a classification based on these premises might be:

A. Dorsal & anal fin same size
  a. 10 or more dorsal spines (White Crappie)
  b. 5-6 dorsal spines (Black Crappie)
B. Dorsal longer than anal fin
  a. Black corner of mouth extends to back of eye (Largemouth Bass)
  b. Black corner of mouth does not extend to back of eye (Smallmouth Bass)

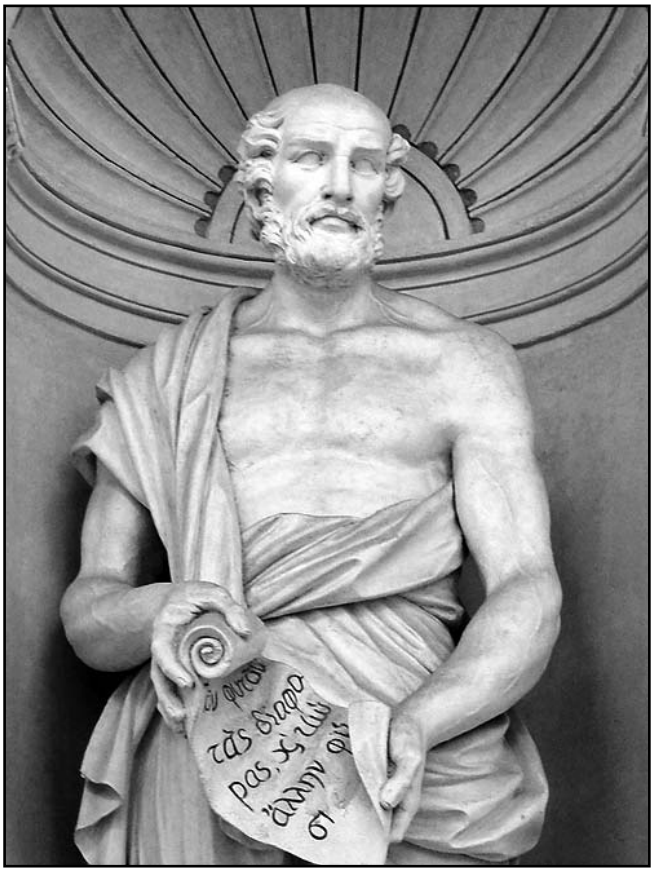
This was the sort of classification adopted by almost all early naturalists, including Linnaeus and most of his successors before Darwin.

For aid in the easier identification of specimens, classifications wholly morphological in principle are still in common use. They are entirely valid and are often more practical than any others, but they are not now accepted as the standard or ideal of zoological classification. In fact, they are not, as a rule, called classifications but keys. Keys of course are known to and are used by aquarists.

A "true" or "natural" classification on the other hand has, by intention, quite a different basis that came with the general acceptance of the theory of evolution. The belief that different animals, even very unlike animals, were actual flesh-and-blood relatives and had common ancestors suggested that it would be more natural, or philosophically preferable, to define groups by community of origin, i.e., by phylogeny. This radical change, much the most revolutionary in the whole history of taxonomy, had extraordinarily little immediate effect on the general nature and aspect of formal classifications. From their classifications alone, it is practically impossible to tell, for example, whether the zoologists of the middle decades of the nineteenth century were evolutionists or not, and classifications that were intended to be phylogenetic differed as much among themselves as they did from frankly morphological classifications.

Theophrastus

One cannot leave Aristotle without mentioning his favorite pupil, Theophrastus, who he named as his



Theophrastus (371-287 BC)

successor, bequeathing to him his library and manuscripts of his own writings. Theophrastus (371 or 372 -287/286 BC) was born in Eresos on Lesbos. He was a student of Aristotle and succeeded him as a director of the Lyceum in Athens. He held this positon for about 35 years and was a teacher of about 2000 students. He took over the philosophy of Aristotle in parts, reshaping, commenting and developing it in an original way. His thinking lead to an empirical approach that included observation, collection and classification.

If Aristotle goes down in history as the Father of Biology and Zoology, Theophrastus certainly earns the title of "Father of Botany" and perhaps of Ecology as well. He began the science of botany with his books , *De causis plantarum* (*The Causes of Plants*) and *De historia plantarum* (*The History of Plants*). He described the origin of plants from seeds, carried out germination experiments, discussed the influence of abiotic habitat factors on plants, the ecology of domestic plants and the pollination of plants. Using the example of the fig, he invented a growth form terminology which is still valid (root, shoot). He described more than 500 species and varieties of plants from lands bordering the Atlantic and Mediterranean. He classified plants into trees, shrubs, under shrubs, and herbs. He noted that some flowers bear petals whereas others do not, and observed the different relative positions of the petals and ovary. In his work on propagation and germination, Theophrastus described the various ways in which specific plants and trees can grow: from seeds, from roots, from pieces torn off, from a branch or twig, or from a small piece of cleft wood.

Note: After Aristotle observed that "one swallow doth not a Spring make," Theophrastus set to work on a treatise entitled, "On the Number of Swallows Needed to Make a Spring."

Pliny The Elder

Pliny the Elder was the son of an equestrian (the lower of the two aristocratic classes in Rome) and was educated in that city. After serving in the military he became a lawyer and then a government bureaucrat. In these positions he traveled not only throughout what is Italy today, but also what would later become Germany, France and Spain as well as North Africa. He wrote a 37-volume, *Naturalis Historia* (ca. 77-79), in which he claimed that he had compiled "20,000 important facts, extracted from about 2000 volumes by 100 authors" and was written for "the common people, the mass of peasants and artisans, and only then for those who devote themselves to their studies at leisure." This is the earliest known encyclopedia of any kind, and has been interpreted as a Roman invention intended to compile information about the empire. However, it was a rather disorganized book, whose prose has been criticized by many. Pliny seemed to be more interested in what appeared to be curiosities than what were facts. Thus, this is a large collection of fact and fiction, based mostly upon what others said.

He devoted nine of the thirty seven volumes to animals and ordered them according to where they live. Volume IX (*Historia Aquatilium*) of *Naturalis Historia* is devoted to aquatic creatures, whether living in oceans, rivers or lakes, whether vertebrate or invertebrate, real or mythical. Based on their size he catego-

Pliny the Elder (23- 79 AD)

rized as “monster” anything big, whether it was a whale, sawfish or tuna.

He grouped together all known species of cetaceans but constantly mixed their descriptions with those of other marine mammals such as seals as well as with cartilaginous fishes such as sharks. Pliny did recognize that neither whales nor dolphins have gills, that they suckle from the teats of their mothers, and that they are viviparous. In addition to these true facts copied from Aristotle, he mentioned exaggerations such as whales of four jugera (about 1000 feet) in length that because of their large size “are quite unable to move.” In addition to some of the biological facts mentioned by Aristotle, Pliny adorned his narrative with various tales about interactions between cetaceans and humans.

By lumping together all kinds of aquatic organisms, it is hard to distinguish what he called a “fish” and what he did not. His classification took a step back from Aristotle because he did not try for a comprehensive classification of animals. He failed to compare organisms based on shared or divergent characters. Many times he ordered creatures based on size, from the largest to the smallest. Yet, his work had great influence for 1700 years, which was unfortunate because he was an uncritical compiler of other people’s writings even if they were contradictory. Pliny also created a number of unfounded impressions about the reality of nature. His only positive contribution was that he established the norm of always citing the sources of his information (in actuality 437 authors, whose works, in some cases, are no longer available).

THE THIRTEENTH CENTURY

The jump to this date from the time of Aristotle and Theophrastus is enormous, but with regard to fishes no significant advances took place during this interval. To start, the Middle Ages should be judged from an ichthyological point of view mainly from their ecological aspects. The economy that expanded considerably in medieval Europe was fraught with severe environmental impacts and with complex interactions between human societies and the ecosystems in which they lived.

The hydrological conditions in many European countries changed drastically and basically. Deforestation, aggregation of people in steadily growing cities, intensification of agriculture and the proliferation of water-powered grain and saw mills caused a great change in the hydrographic balance and in the ecological conditions of aquatic habitats. Floods as well as the dewatering of streams, pollution and the cutting off of the migration routes of fish had deleterious consequences and with these, a severe impact on fish stocks resulted. Interesting social responses of medieval Europeans to rising pressures against the fish resources of inland waters included privatization, commercialization, public regulation of fish exploitation and the pond culture of fish. The Middle Ages were also the beginning of increased exploration and seafaring and with it, an interest in foreign populations, animals, plants and riches.

Though in the course of the Middle Ages Aristotle became important for his rational and logical approach to knowledge and thus influenced the scholars at the newly forming universities during the 12th Century Renaissance, his natural science gained far less interest. Scientific literature about fish did not exist except that clergymen, either by ignoring or happily accepting the findings of Aristotle, found some animals living in rivers, such as beaver, otter and some birds, to be “fishy” enough to make good eating during fasting days.

Albertus Magnus

The learned German bishop and scholar Albert the Great or Albertus Magnus (1193-1280) was known during his lifetime as *doctor universalis* and *doctor expertus* and, late in his life, the term *magnus* was appended to his name). He was born at Lavingen in Swabia, Germany in 1205 and received his education at Pavia, Italy, where he entered the order of Dominicans. Sometime later he went to Paris and delivered public lectures to great acclaim. In 1248, he was invited to Rome by Pope Alexander III., who appointed him to the office of Master of the Holy Palace, and bestowed on him the bishopric of Ratis-

Albertus Magnus (1206-1280)

bon, Germany, which he soon after resigned. Returning to Cologne, he resumed his very popular lectures.

Albertus was the greatest German philosopher and theologian of the Middle Ages. Pope Gregory X called upon him to assist at the general council, held at Lyons in 1274, where the conclave of cardinals for the election of the successor of St. Peter was first instituted. In Cologne he is not only known for being the founder of Germany's oldest university there, but also for "the big verdict" (der Große Schied) of 1258, which brought an end to the long-smoldering conflict between the citizens of Cologne and the archbishop, a matter of jurisdiction between the city and the township. Among the last of his labors was the defense of the orthodoxy of his former pupil, Thomas Aquinas, whose death in 1274 grieved him greatly.

Albertus was the first to comment on virtually all of the writings of Aristotle, thus making them accessible to wider academic debate. He wrote so many works that, when collected for a general edition at Lyons in 1651, they filled twenty one thick folios. His character was highly respectable and his treatise *De animalibus* (*On the animals*), published circa the 1260's, is certainly a remarkable production for the age in which he lived. In this book Albertus describes the common torpedo or eyed electric ray (*Torpedo torpedo*) thusly:

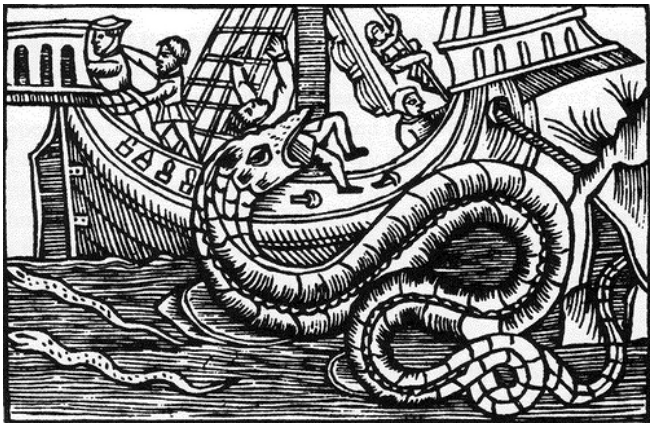
"There is, moreover, sometimes a given operation of the fish, which derives from the necessity of nature. But this operation is also carried out in an artful way, as it appears in the case of the fish that Greeks call barkis and we call torporific (stupefactorem*),* because it induces torpor in the hands of those who touch it. It is by inducing torpor that this fish captures animals that pass near it and instantly eats them. So great is its virtue in inducing torpor that a trustworthy man who touched the fish with the extremity of his finger for the sake of experience had his arm so numbed that he had to undergo treatments for more than a month with hot baths, applications of warm ointments and with friction (rubbing), in order to recover his sensibility and movement."

A page from Magnus' de animalibus, circa 1260, showing fish and other marine creatures.

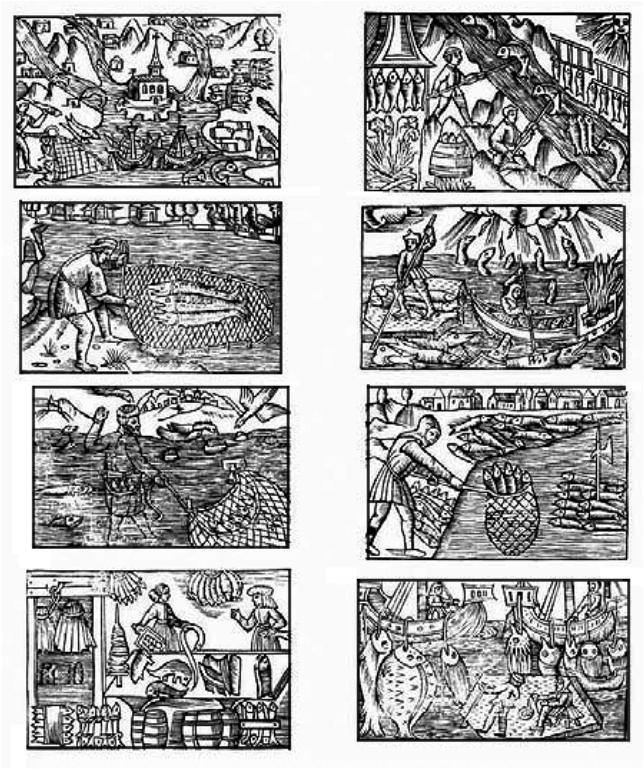
However, a limited knowledge of the actual relationships between groups is evident in these old zoological classifications. For example, in *De animalibus* Magnus classified the bats with birds, and the whales with fishes.

It is recorded that he had constructed a brazen head (among the people reputed to have one were Roger Bacon, Faust, Pope Sylvester II and Virgil). This was a legendary automaton that often appeared in literature, reputed to be able to answer any question. It was said to have been owned by medieval scholars who were believed to be wizards, or who were reputed to be able to answer any question. The device was always in the form of a man's head, and it could correctly answer any question asked of it. Mechanical variations appear in fictional literature: the head might be cast in brass or bronze, it could be mechanical or magical, and it could answer freely or it could be restricted to "yes" or "no" answers. However, these brass heads were so common that people began to believe that there was nothing supernatural about them. However, Thomas Aquinas, his pupil at the time, is reported to have broken it in a fit of terror.

Albertus died at Cologne at the age of 77 and was declared a saint by the Church in 1622. If we relax the definition a bit, we might say, tongue in cheek, that he was the only ichthyologist so beatified. The Albertus typeface, by the way, is named after him.



Woodcut of a sea serpent by Olaus Magnus (from Historia *de Gentibus Septentrionalibus,* 1555)



Pictures from Olaus Magnus' *History of the Northern people*, 1555.

THE SIXTEENTH CENTURY

Olaus Magnus

Olaus Magnus ((1490-1557) or Olaf Mansson before his name was Latinized was a Swedish historian and geographer. He first had been taken into the higher ecclesiastical service and made cathedral provost at Strengnas, and later he became the last archbishop of Uppsala. Afterwards he traveled on behalf of the king of Sweden to gather information on the very little known region of the Northern Scandinavian Peninsula and its bordering seas. His travel reports are a mixture of reliable observations and credulity. Among other things, he gained knowledge on the tremendous richness of fish thriving in these regions. Though these resources were used by the people living along the shores of the Gulf of Bothnia and the North Sea for some time already, the North and the North Sea were still largely unknown to the civilized world.

Not surprisingly, Olaus' reports contain much new information on fish, fishing, fish behavior, fish trade

and mysterious aquatic beasts as well. In his famous *Carta marina* of 1555 (the earliest detailed map of the Nordic countries) as well as his 1555 *Historia de Gentibus Septentrionalibus* (*History of the Northern People*), Magnus tells about river migration and catch of salmon at the Baltic, fishing with light, salting of fish and the rich herring fisheries near Bohuslän in Western Sweden and at the coast of Skåne (Schonen). Much of this was seen by him, but he regarded strange fishes and sea monsters of the North Sea as real, trusting in the reports of others.

Gregor Mangolt

The first book of modern age addressing entirely fishes was written in 1557 by Gregor Mangolt (1498-1576), a German chronicler, former priest, bookseller and publisher. It deals with the fishes of Lake Constance and may be called the first ichthyological book on the whole. It is the first treatise on this subject not written in Latin but rather in a native language. Its title reads: *Fischbuch von der Natur und Eigenschaft der Vischen, insbesondere derer so gefangen werden im Bodensee und gemeinlich auch in anderen Seen und Wassern, durch den wohlgeleerten Gregorium Mangolt beschrieben vormals nie gesähen* (*The fish book of the nature and characteristics of fishes previously never seen, especially those caught in Lake Constance and commonly described from other lakes and waters, by the highly qualified Gregorium Mangolt*).

Fischbuch
Von der Natur vnd
Eygenschafft der Fischen / Insonderheit deren so gefangen werden im Bodensee/ vnd gemeinlich auch in andern Seen vnd Wassern / Durch den wolgelehrten Gregorium Mangolt beschrieben / vormals nie gesehen.
Item / ein ander Büchlein / wie man Fisch vnd Vogel fahen solle / mit dreissig newen vnd bewehrten Recepten. Auch zu was Zeiten im gantzen Jahr ein jeder Fisch am besten sey.
Jetzo auffs newe gedruckt.

Title page of Gregor Mangolt's Fish Book, 1557.

His simple descriptions relate to the reproduction and food of fishes, their value as human food and, in detail, to the nature and characteristics of many of them. The book surely was intended to inform local people of "their" fish as well. Mangolt mentions 76 fish names which were commonly used only by people of Konstanz. This high number of common names is partly to be explained by the fact that for some of the fish more than one name was in use and it cannot be decided in each of the case whether some of the species Mangolt mentioned are just duplicates of others.

THE RENAISSANCE

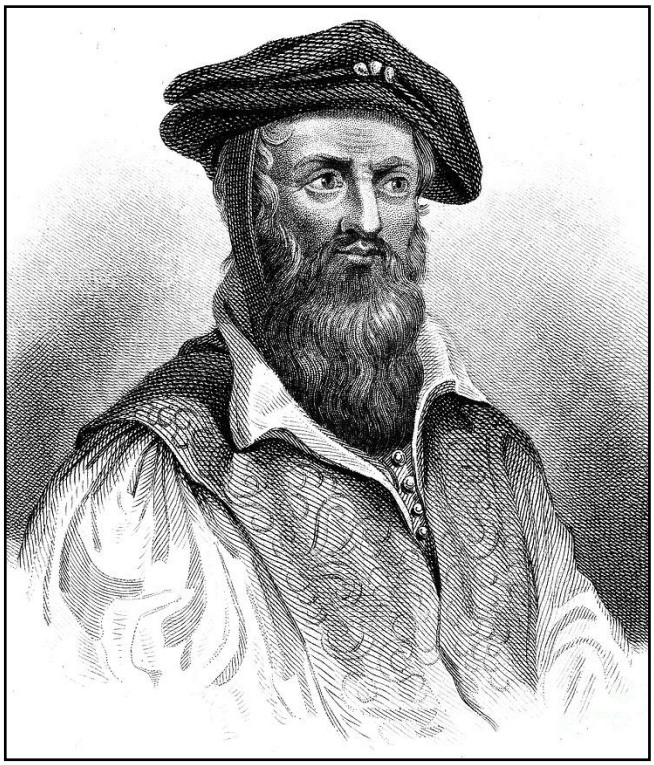
For nearly 2000 years after Aristotle, few original observations about fish were recorded because Aristotle was considered to have completely covered all areas of natural history. In the 16th century, however, a general interest in fishes (especially marine species) increased and interest in fishes gained a deeper and newer scientific interest once again. Aristotle's grip on ichthyology (and science) was finally broken.

Within the short period of 15 years, five men were born in the first quarter of the 16th century who were destined to revolutionize the study of natural history in southwestern Europe and to lay a broad, deep and solid new foundation of ichthyology. These scientists were in order of birth: Guillaume Rondolet (French) (1507-1566), Ippolyto Salviani (Italian) (1514-1572),

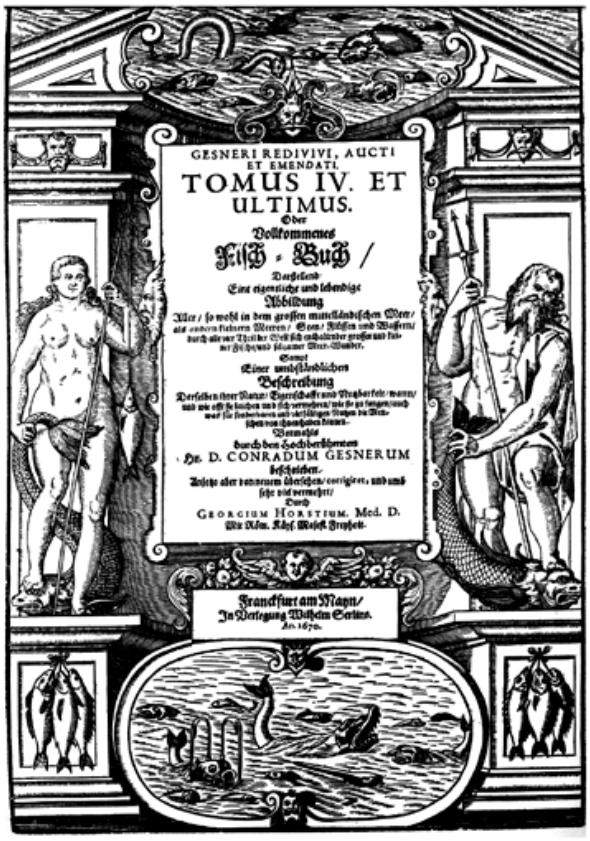
Conrad Gesner (German-Swiss) (1516-1565), Pierre Belon (French) (1517-1564) and Ulysse Aldrovandi (Italian) (1522-1605). They can be considered as a product of the Renaissance, the time of intense mental ferment which had as its precursor the "Revival of Learning" stirred on by the resurrection of Greek and Roman art and literature, and the development of humanism by Dante, Petrarch, Boccaccio and others who led the way to overcome the Dark and Middle ages.

Conrad Gesner

A scientific interest in the diversity of life on Earth was awakened in the publication of encyclopedic works, such as those devoted to the animal world by the Swiss Conrad Gesner and the Italian Ulisse Aldrovandi. Their bulky compilations (Aldrovandi's books sum up to some 7000 large-size pages) recorded everything that had been written on zoological matters up to that time. Their value, however, was severely limited by the authors' limited critical attitude, so that reliable behavioral or anatomical observations were presented on the same footing as folk legends or purely literary, fanciful accounts.



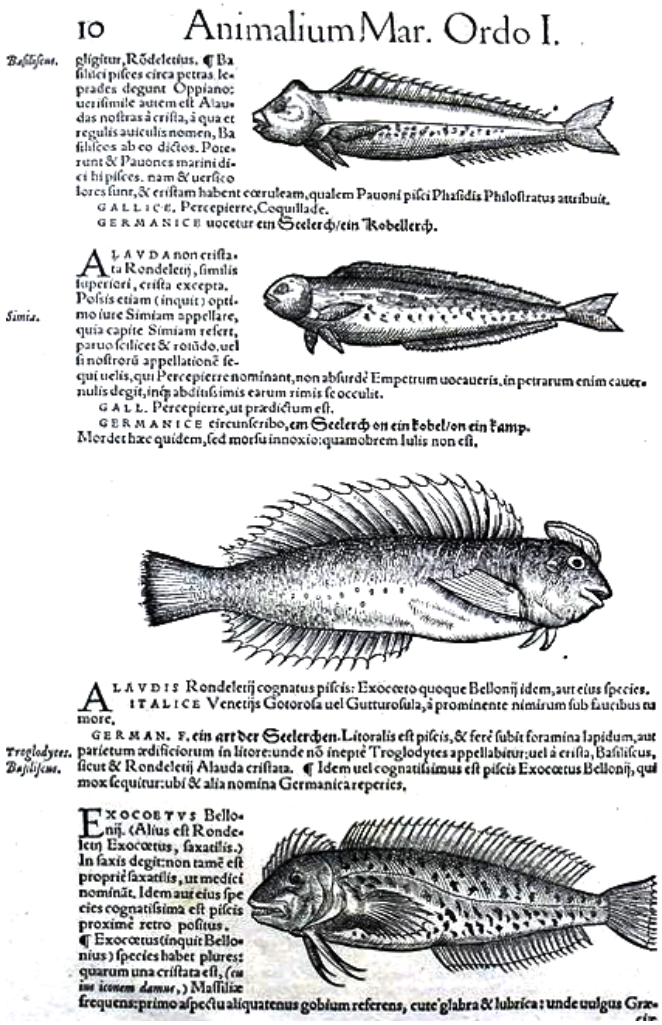
Konrad Gessner 1516-1565)



Title page of Gesner's *Fischbuch*.

Conrad Gessner 1516-1565) was a Swiss naturalist and bibliographer. He was well known as a botanist, physician and classical linguist. His five-volume *Historiae animalium* (1551–1558) is considered the beginning of modern zoology, and the flowering plant genus *Gesneria* and its family Gesneriaceae are named after him. A genus of moths, *Gesneria*, is also named after him. Gesner was an encyclopedist of the early modern age, the first one after Aristotle and 1800 years later. One of the six volumes of Gesner's *Historia Animalium* is on fishes and in contrast to Aristotle some of his work is ichthyology in the strict sense. This part was translated into German in 1598; it became extremely popular and many reprints followed. As its subtitle stated, the author had intended to describe all the fishes of the world: those from the Mediterranean, from lakes, rivers, and from waters not only of Europe but also of Asia, Africa, America, and the East and West Indies.

Gesner labeled imaginary groups with names and regarded water mammals and invertebrates as fish.


10 Animalium Mar. Ordo I.

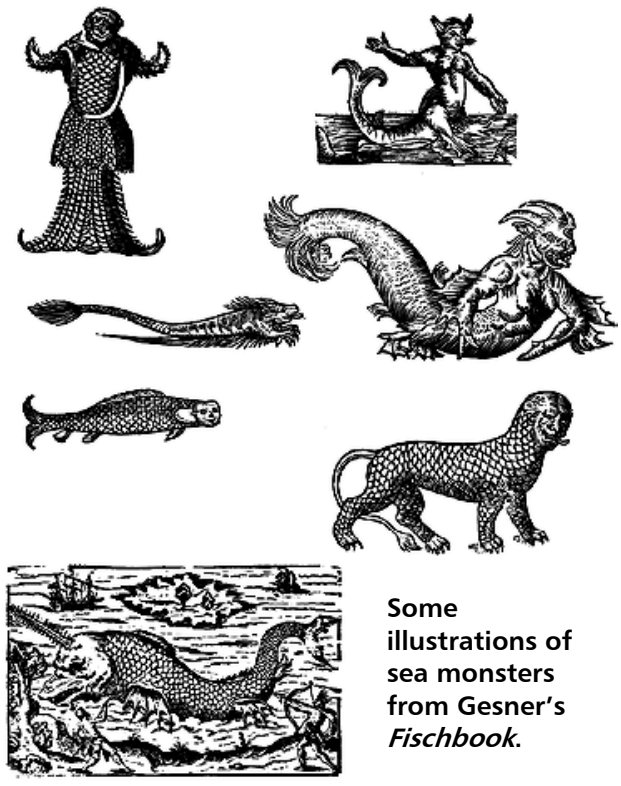
Basiliscus. gligitur, Rödeletius. ¶ Basilici pisces circa petras lepades degunt Oppiano: uerisimile autem est Alaudas nostras à crista, à qua et regulis auiculis nomen, Basiliscos ab eo dictos. Poterunt & Pauones marini dici hi pisces. nam & uersico lores sunt, & cristam habent cœruleam, qualem Pauoni pisci Phasidis Philostratus attribuit.
GALLICE. Percepierre, Coquillade.
GERMANICE uocetur ein Seelerch/ein Kobellerch.

Simia. ALAVDA non crista. ta Rondeletij, similis superiori, crista excepta. Pisis etiam (inquit) optimo iure Simiam appellare, quia capite Simiam refert, paruo scilicet & rotundo, uel si nostrorū appellationē sequi uelis, qui Percepierre nominant, non absurdè Empetrum uocaueris, in petrarum enim cauernulis degit, inq; abditissimis earum rimis se occultat.
GALL. Percepierre, ut prædictum est.
GERMANICE circunscribo, ein Seelerch on ein Kobel/on ein Kamp.
Mordet hæc quidem, sed morsu innoxio: quamobrem Iulis non est.

Troglodytes. Basiliscus. ALAVDIS Rondeletij cognatus piscis: Exocœto quoque Bellonij idem, aut eius species.
ITALICE Venetijs Gotorosa uel Gutturosula, à prominente nimirum sub faucibus tumore.
GERMAN. F. ein art der Seelerchen. Litoralis est piscis, & ferè subit foramina lapidum, aut parietum ædificiorum in litore: unde nō inepte Troglodytes appellabitur: uel à crista, Basiliscus, sicut & Rondeletij Alauda cristata. ¶ Idem uel cognatissimus est piscis Exocœtus Bellonij, qui mox sequitur: ubi & alia nomina Germanica reperies.

EXOCOETVS Bellonij. (Alius est Rondeletij Exocœtus, saxatilis.) In saxis degit: non tamē est propriè saxatilis, ut medici nomināt. Idem aut eius species cognatissima est piscis proximè retro positus. ¶ Exocœtus (inquit Bellonius) species habet plures: quarum una cristata est, (cuius iconem damus,) Massiliæ frequens: primo aspectu aliquatenus gobium referens, cute glabra & lubrica: unde uulgus Græ-

Some illustrations of marine fishes frtom Gesner's Fischbuch.



Some illustrations of sea monsters from Gesner's *Fischbook*.

Even more uncritical, he included each of the sea monsters he ever heard about into his book, many of them copied from Olaus Magnus. It is obvious that many of the fishes in Gesner's book were illustrated just by hearsay or copied from others and not collected or seen alive or as fresh specimens by the author himself. Nevertheless, it became a standard work in the Europe of the 16th and 17th centuries.

Several of the woodcut figures were quite acceptable and allowed a rough identification of certain species. Many pictures were poorly drawn, surprisingly even those showing domestic fresh water fishes. But the figures of monsters, "Wallfischen" (whales, sea monsters, and other "sea miracles"), are well-done. A classificatory effort is evident as he distinguished 17 orders of aquatic animals. Eleven of these included different kinds of fishes, mostly distinguished on the basis of body shape, rather than their habitat (as was fashionable at the time) or skeletal peculiarities (as would become general practice a couple of centuries later). The other orders were those of cetaceans (including, however, seals and sea turtles), cephalopods, crustaceans, "testaceans" (i.e., molluscs with shells), "insects" (which included several kinds of marine worms, plus isopod crustaceans and even the sea horse!) and zoophytes (i.e., corals and the like).

Ulisse Aldrovandi

Aldrovandi was born in Bologna to a noble family and sent him to apprentice with merchants. However, after studying humanities and law at the universities of Bologna and Padua and becoming a notary, he found his vocation. Successively his interests extended to philosophy and logic, which he combined with the study of medicine. He obtained a degree in medicine and philosophy in 1553 and started teaching logic and philosophy in 1554 at the University of

Ulisse Aldrovandi (1522–1605)

Bologna. In 1559 he became professor of philosophy and in 1561 he became the first professor of natural sciences at Bologna.

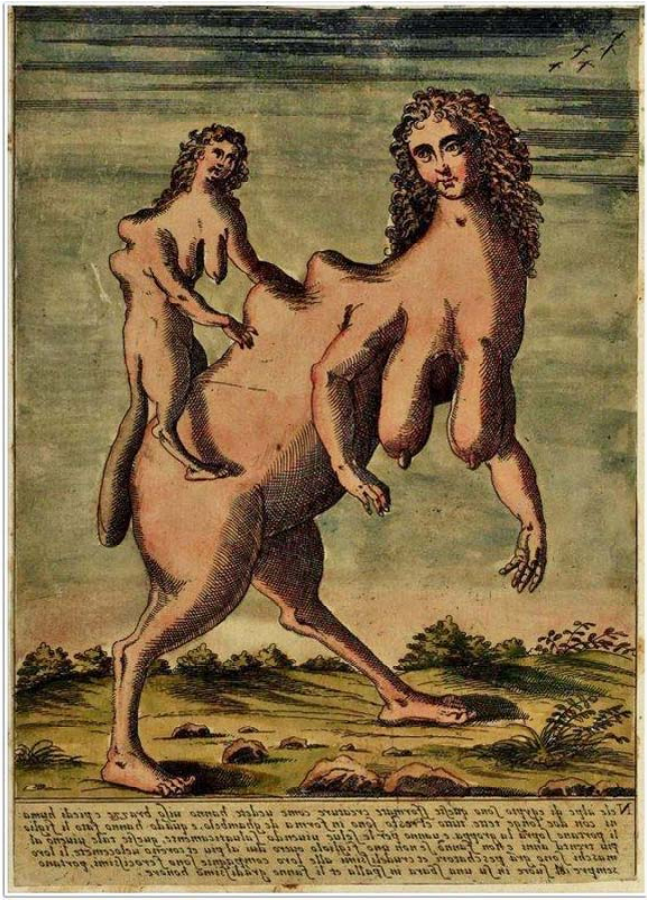
Aldrovandi was also a naturalist and the moving force behind Bologna's botanical garden, one of the first in Europe. Carolus Linnaeus and the Comte de Buffon reckoned him the father of natural history studies. Aldrovandi taught for many years at the University of Bologna during the latter half of the sixteenth century. He was of a well-off family and his fortune enabled him to travel extensively to collect materials for his books and to employ artists in painting and engraving suitable illustrations. A contemporary of Shakespeare, he was one of the first great specimen collectors and regularly organized expeditions for that purpose.

Aldrovandi was nicknamed both the "Bolognese Aristotle" and the "Second Pliny." Like Pliny, much of his life was devoted to compiling an enormous encyclopedia. Moreover, it had the same name as Pliny's work. Aldrovandi's *Storia Naturale* (*Natural History*) was many thousands of pages long. It filled 14 folio volumes (10 published posthumously between 1606 and 1668). It had fine illustrations, and to a large extent, the descriptions were based on direct observations, unlike those of so many of his predecessors. The only comparable work of the era was Gesner's *Historiae animalium*.

Of Aldrovandi's innumerable books and papers, relatively few were published in his lifetime. One of the many books he wrote was *Monstrorum Historia* (*A History of Monsters*), a compendium of reported human and animal monstrosities. The book included accounts not only of monstrous natural births but also of what now seem to be extremely far-fetched monsters. This sort of juxtaposition was common at the time, since there was not as yet a distinction between the literary and the scientific. If a given monster had been described by previous authors it was considered proper to mention it, whether or not it was fabulous. Another of his books mixing fable with reality was *Historia serpentum et draconum* (*The History of Serpents and Dragons*), published in 1640. It pictured real snakes alongside fanciful creatures.

Aldrovandi was certainly one of the most zealous naturalists of his time but although he added considerably to the stock of information, he can only be considered as a laborious collector of materials. Cu-

A drawing from Aldrovandi's Natural History.



From Ulisse Aldrovandi's Monstrorum historia: human monsters.

vier pronounceg his works "an enormous compilation without taste or genius," and agrees with Buffon in thinking, that were the useless parts removed, they would be reduced to a tenth of their bulk. Moreover, his materials were to a great extent borrowed from Gesner. However, in all ages writers on natural history have been so much addicted to the practice of borrowing that Aldrovandi is hardly to be censured on this account.

Some portions of his museum have successfully struggled with the destructive energies of time, and are still to be seen in the collection of the Institute of Bologna. His manuscripts, of which there is an immense mass, are preserved in the public library of the same city and the drawings from which the engravings for his work were taken were carried, at the time of the Italian Revolution, to the Museum of Natural History at Paris.

The Three Magi

Of more limited scope, but of much greater scientific value, were the monographs and books on fishes and other aquatic animals written by the French Pierre Belon - *Histoire naturelle des estranges poisons*, 1551 and *De aquatilibus*,1553 - the Italian Ippolito Salviani - *Aquatilium animalium historiae*, 1554 to 1558 and the French Guillaume Rondelet - *Libri de piscibus marinis in quibus verae piscium effigies expressae sunt*, 1554. In short, it can be said that essentially Belon published the first modern systematic treatise on fishes, Salviani created the first regional work on an ichthyofauna and Rondelet wrote the first text on ichthyology.

Each of their works is complemented by rich illustrations of fishes; those by Rondelet and Belon are quite simple to naïve although a few of them are just fantastic. The ninety-nine copperplate engravings Salviani had added to his book, however, are not only very well done but also especially famous because of their accuracy. Salviani had been a private physician to three popes and according to his social status became acquainted with several well-known artists who helped him with his drawings.

Unlike the others who came after Aristotle, these three saw and examined for themselves the fishes of which they spoke. Too faithful, however, to the spirit of their time, they took more pains to find out the names which these fishes bore among the ancients and in selecting fragments for their history, rather than in describing them in a distinct manner so that, were it not for the figures, it would in many instances be almost impossible to determine their species.

Pierre Belon

Belon was typical of the renaissance scholar and took an interest in "all kinds of good disciplines" in his lifetime. He was interested in zoology, botany and classical Antiquity. He was born at Souletière, in the parish of Oisé, in Le Maine, about the year 1518. It is supposed that his parents were poor and we accordingly find that he was indebted for his education to René du Bellay, bishop of Mans, William Duprat, bishop of Clermont, and the Cardinals of Tournon and Lorraine. At an early age he began the study of

Pierre Belon (1517–1564)

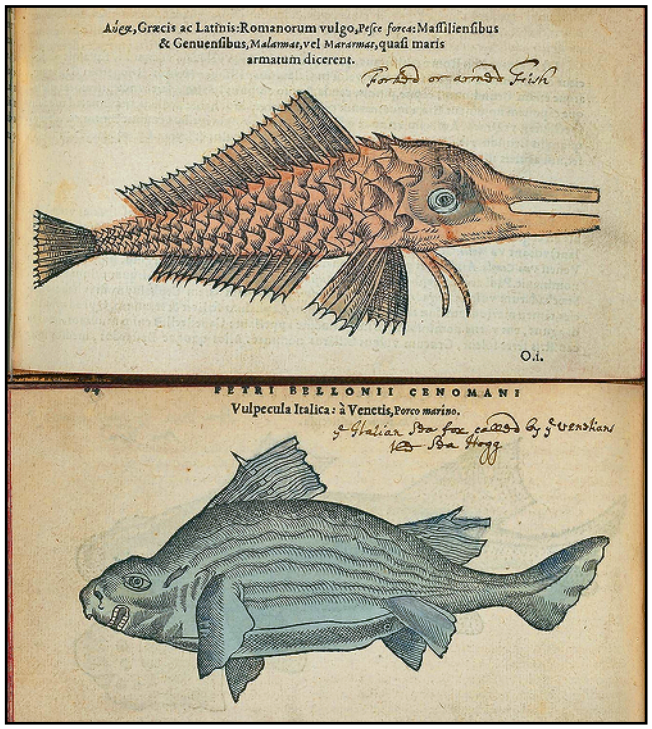
medicine and botany, and having distinguished himself among the pupils of Valerius Cordus, the professor of natural history at Wirtemberg, was allowed to accompany his master on the excursions that he was in the habit of making into Germany and Bohemia for the purpose of obtaining specimens.

On finishing his education he traveled through Greece, Egypt, Palestine and Asia Minor, whence he returned to Paris in 1550, with a valuable collection, after an absence of three years. He now arranged the materials which he had thus procured and published several interesting works. Notwithstanding the merit of which, he experienced great difficulty in obtaining admission into the medical faculty of Paris. In 1557, he undertook another journey into Italy, Savoy, Dauphiny and Auvergne. On his return, he engaged in a translation of Dioscorides and Theophrastus, and was preparing an important work on agriculture, when he was murdered in the wood of Boulogne, as he was proceeding from Paris to his place of residence at the Chateau de Madrid. This happened in 1564, when he was about forty-five years of age.

Besides the narrative of his travels he wrote several scientific works of considerable value, particularly the *Histoire naturelle des estranges poissons* (1551) and *De aquatilibus* (1553). At that time the concept of fishes included all aquatic animals including mammals and *De aquatilibus* included the first French illustration of a hippopotamus. A French translation of this treatise on fishes, a foundation of modern ichthyology, was published in three editions at Paris and the volume was reprinted in Frankfurt and Zurich. His works were held in high authority by Aldrovandi. As a botanist, Belon ranks not less highly than as a zoologist and, to do honor to him in the former capacity, an American genus of lichen was given the name of *Belonia.*

Ippolito Salviani.

Ippolito Salviani was born in the year 1514, in La Citta di Castello, situated on the Tiber, twenty seven miles from Urbino, the capital of the Duchy of that name. He was of noble descent and after having finished his general education, he studied medicine and having visited the cities of Italy, he finally settled at Rome, where he long practiced the healing art with great celebrity, and taught the science of medicine in



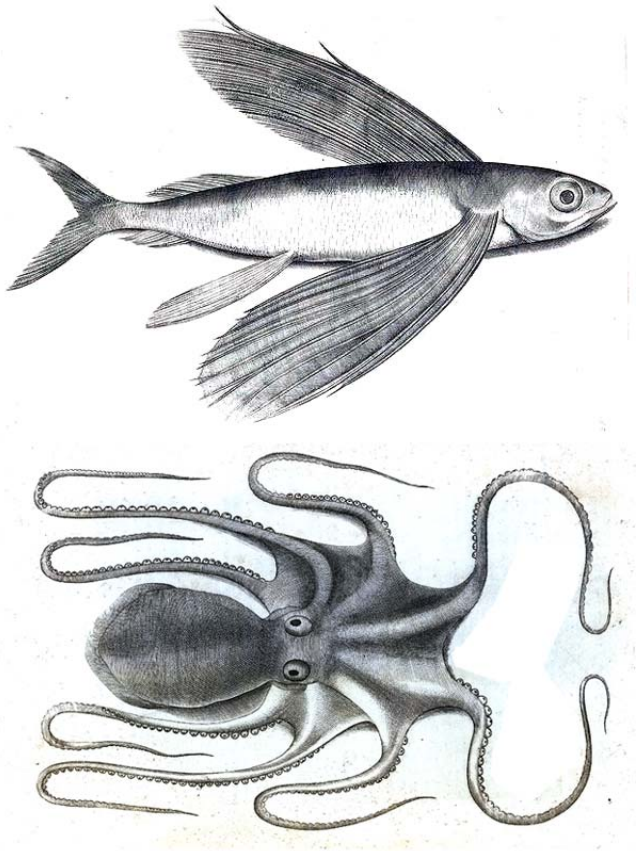
Illustrations from Pierre Belon's *De aquatilibus*.

Hippolito Salviani (1514-1572)

its University with much success. His varied talents, and peculiar taste for natural history, obtained for him the friendship of Cardinal Cervini, who procured for him the situation of Physician to Pope Julius III.

Salviani selected the class of fishes as the chief object of his researches, and used every effort to collect such as he could procure in Italy, while he extended the range of his knowledge by obtaining, with the help of his protector, accurate drawings of those which were known in Greece, France, Germany and Britain. He established in his own dwelling a regular printing establishment, from where he issued his lesser treatises and corrected his great work, entitled *Aquatilium Animalium Historia*. The author had first dedicated his work to his benefactor Cardinal Cervini but this prelate, one of the presidents of the Council of Trent, having become Pope, under the title of Marcellus II, having died of apoplexy twenty one days after his election, he substituted another dedication to his successor, Pope Paul IV.

In general, he was regarded as the principal and most distinguished naturalist of his day in the Great City. Thus we learn, that when anything curious in animated nature found its way to Rome, he was almost invariably and immediately apprised of it and he, in his turn, lost no time in informing ail his scientific friends, who immediately resorted to him, to inquire and examine for themselves. “I communicate the tidings (he remarks), not only that I may not deprive them of the gratification which I myself enjoy, but also that from our mutual conversations on these new and strange objects, we may be able more satisfactorily to arrive at correct conclusions.” After all were in this way satisfied, Salviani was in the habit of examining the internal parts of the animal, and of making preparations, always retaining the skin, and preparing, when possible, a stuffed specimen, together with accurate drawings.



Images from Salviani’s *Aquatilium Animalium Historia.*

The *Aquatilium Animalium Historia* of Salviani is chiefly remarkable for the beauty of its engravings, some of which have scarcely been surpassed by the efforts of modern art. The title page bears the date of 1554, but the work was not completed till 1558. It contains descriptions of ninety-nine species of fishes, each including the synonymy, the extremal appearance of the animal, the places in which it occurs, its habits, the manner in which it is caught and prepared, and its medical properties. He also points out the passages in Aristotle, Pliny and other ancient writers, who have spoken of them, and to the observations of these authors adds many excellent ones of his own. Consequently, the work, on account of the general accuracy of the plates and descriptions, is one that may be considered indispensable to the modem ichthyologist.

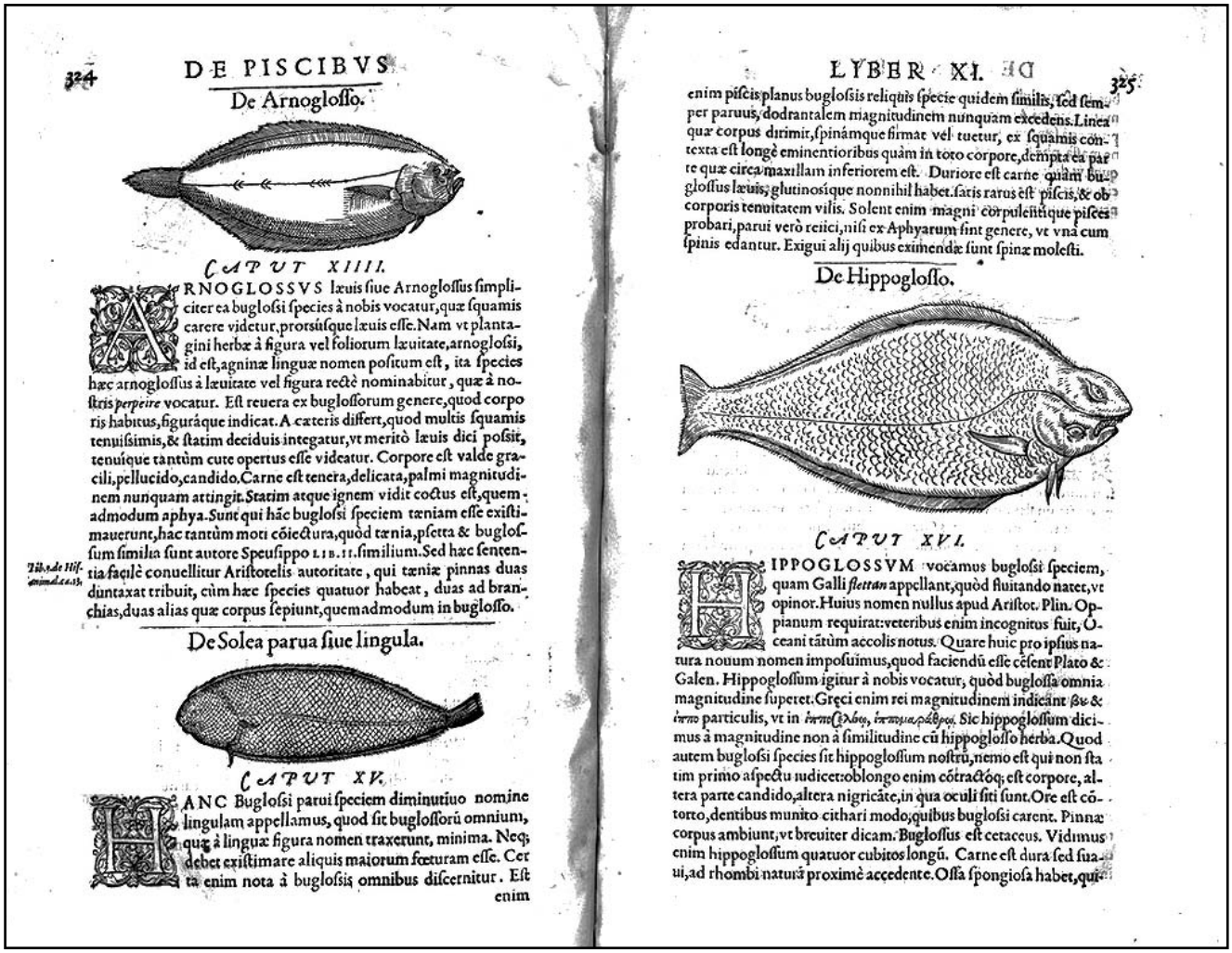
Guillaume Rondelet

Rondelet, the son of an apothecary, was born at Montpellier on the 27th September 1507. Being originally of a very infirm constitution, he was judged incapable of performing a part in active life, and, accordingly, when his father's fortune was distributed, he received a sum merely sufficient to procure his admittance into a monastery. As he grew up, however, he improved in strength, and having no affection for a monastic life, he commenced his studies at the age of eighteen, and finished his general education at Paris, where he was supported by his elder brother. Having resolved to embrace the medical profession, he returned in 1529 to his native city, and afterwards settling at Pertuis, a small village in Provence, he began to practice. However, not meeting with success in the healing art, he endeavored to earn a living by setting up a grammar school.

Guillaume Rondelet (1507-1566)

This expedient also failing, he went again to Paris in order to improve his knowledge of the Greek language, and, being unwilling to burden his brother any longer, became tutor to a young nobleman. Sometime after, he removed to Maringues, in Auvergne, where he again entered the medical practice and, in 1537, received a medical degree at Montpellier. The following year he married a young lady endowed with many estimable qualities, but destitute of fortune. As his brother at this time was dead, this alliance increased his difficulties. However, he settled finally at the place of his birth and, being assisted by his wife's sister, began to extend his acquaintances and succeeded so well in his profession, that, in 1545, he was appointed professor of medicine in the university.

He also obtained the office of physician to the Cardinal of Tournon, whom he accompanied on his missions in France, Italy and the Low Countries. O these occasions he eagerly availed himself to increase his knowledge of natural history. Returning once more to his usual place of residence he established an anatomical theatre, at which he lectured several hours daily to large audiences. His passion for dissection was so strong, that he opened one of his own children after death, and this circumstance has naturally enough given rise to the opinion that he must have been a man destitute of sensibility. However, this does not appear to have been the case. His wife having died in 1560, he soon remarried another, a poor and handsome woman like the first. While on a journey to Toulouse he was attacked by dysentery, occasioned by eating too many figs, and he died at



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De Arnoglosso.

CAPVT XIIII.

ARNOGLOSSVS lævis siue Arnoglossus simpliciter ea buglosi species à nobis vocatur, quæ squamis carere videtur, prorsúsque lævis esse. Nam vt plantaginis herbæ à figura vel foliorum lævitate, arnoglosi, id est, agninæ linguæ nomen positum est, ita species hæc arnoglossus à lævitate vel figura rectè nominabitur, quæ à nostris *perpeire* vocatur. Est reuera ex buglossorum genere, quod corporis habitus, figuráque indicat. A cæteris differt, quod multis squamis tenuissimis, & statim deciduis integatur, vt meritò lævis dici possit, tenuique tantùm cute opertus esse videatur. Corpore est valde gracili, pellucido, candido. Carne est tenera, delicata, palmi magnitudinem nunquam attingit. Statim atque ignem vidit coctus est, quemadmodum aphya. Sunt qui hãc buglosi speciem tæniam esse existimauerunt, hac tantùm moti cõiectura, quòd tænia, pfetta & buglossum similia sunt autore Speusippo LIB. II. similium. Sed hæc sententia facilè conuellitur Aristotelis autoritate, qui tæniæ pinnas duas duntaxat tribuit, cùm hæc species quatuor habeat, duas ad branchias, duas alias quæ corpus sepiunt, quemadmodum in buglosso.

Lib. de Hist. animal. c. 13.

De Solea parua siue lingula.

CAPVT XV.

HANC Buglosi parui speciem diminutiuo nomine lingulam appellamus, quod sit buglossorũ omnium, quæ à linguæ figura nomen traxerunt, minima. Neq; debet existimare aliquis maiorum fœturam esse. Certa enim nota à buglosis omnibus discernitur. Est enim

LYBER XI. 325

enim piscis planus buglosis reliquis specie quidem similis, sed semper paruus, dodrantalem magnitudinem nunquam excedens. Linea quæ corpus dirimit, spinámque firmat vel tuetur, ex squamis contexta est longè eminentioribus quàm in toto corpore, dempta ea parte quæ circa maxillam inferiorem est. Duriore est carne quàm buglossus lævis, glutinosíque nonnihil habet. Saris rarus est piscis, & ob corporis tenuitatem vilis. Solent enim magni corpulentíque pisces probari, parui verò reiici, nisi ex Aphyarum sint genere, vt vna cum spinis edantur. Exigui alij quibus eximendæ sunt spinæ molesti.

De Hippoglosso.

CAPVT XVI.

HIPPOGLOSSVM vocamus buglosi speciem, quam Galli *flettan* appellant, quòd fluitando natet, vt opinor. Huius nomen nullus apud Aristot. Plin. Oppianum requirat: veteribus enim incognitus fuit, Oceani tãtùm accolis notus. Quare huic pro ipsius natura nouum nomen imposuimus, quod faciendũ esse cẽsent Plato & Galen. Hippoglossum igitur à nobis vocatur, quòd buglossa omnia magnitudine superet. Græci enim rei magnitudinem indicant βυ & ιππο particulis, vt in ιππο(ελινο, ιππομυρμηκο. Sic hippoglossum dicimus à magnitudine non à similitudine cũ hippoglosso herba. Quod autem buglosi species sit hippoglossum nostrũ, nemo est qui non statim primo aspectu iudicet: oblongo enim cõtracto{q; est corpore, altera parte candido, altera nigricãte, in qua oculi siti sunt. Ore est cõtorto, dentibus munito cithari modo, quibus buglosi carent. Pinnæ corpus ambiunt, vt breuiter dicam. Buglossus est cetaceus. Vidimus enim hippoglossum quatuor cubitos longũ. Carne est dura sed suaui, ad rhombi naturã proximè accedente. Ossa spongiosa habet, qui-

Pages from Rondelet's *De Piscibus Marinis Libri .*

Realmont, where he had gone to visit a patient. His death happened on 30th July 1566, in the fifty-ninth year of his age.

Rondelet greatly surpassed Gesner, Belon and Salviani in the extent of his knowledge as an ichthyologist, and although his figures, being only woodcuts, are inferior in beauty to the copperplate engravings of the last of these authors, they are yet more correct in characteristic details. His work is entitled *De Piscibus Marinis Libri XVIII, in qui bus vivæ piscium imagines expositae sunt* (*Book of the fish of the sea in which they are shown in their true images*), and was published at Lyons in 1554. A second part appeared in 1555, under the name of *Universae Aquatilium Historiae Pars Altéra, cum veris ipsorum Imaginibus* (*The entire history of aquatic animals with true images*). The first part treats of marine animals, including the cetacea, turtles and seals, mollusks and crustacea.

In the second part, shells, insects, zoophytes, and freshwater fishes, are described. These objects, although not methodically arranged, are often placed in such a manner as to indicate that the author had some idea of generic affinity. The anatomical details which he presents were pronounced by Cuvier to be frequently correct, but his descriptions, it must be granted, are inferior to the figures which are truly surprising for the period in which he lived. In reference to the fishes of the Mediterranean this work is indispensable, and indeed, to the ichthyologist generally it is one of the most important that exists. The descriptions and figures were copied by Gesner, in his work *De Aquatilibus*, while Ray, Artedi and Linnaeus, have also obviously profited by them.

He was a man of very small stature, but robust and active. At the age of twenty-five from an apprehension of gout he gave up the use of wine and spirits, but he compensated for his abstemiousness in these articles by indulging his appetite for fruit and pastry. Although he had acquired considerable sums of money in the practice of his profession, he expended them in the gratification of his taste for building and in various acts of generosity so that he left very little behind him.

THE SEVENTEETH CENTURY

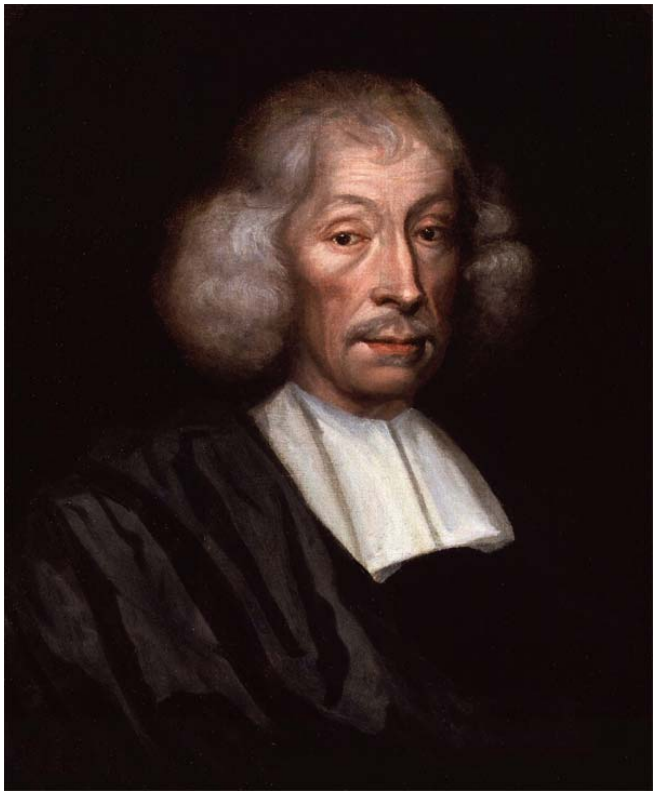
The authors of these times looked less to nature than to the writings of Aristotle, Pliny and their other predecessors so that in their works we find little more than a repetition of what had been previously said. Their descriptions are rude, frequently incorrect, and in few cases characteristic. The alphabetical arrangement was followed by some, while others possessed a rude notion of the affinity of species. But although attempts were made to separate the animals into classic groups, yet from the days of Aristotle to those of John Ray, we find no traces of the anatomical knowledge necessary for the accomplishment of such an undertaking. We have, indeed, little reason to expect in the writings of the ancients, or in those of the succeeding naturalists, any example of a just classification.

Still we cannot but marvel when we find, that very few of them endeavored to represent objects as they might have seen them with their own eyes. Whatever may be the causes of this defect, those who are extensively conversant with the publications of our own times must be aware, that the practice of copying from books, instead of having recourse to Nature herself, has not yet been relinquished, though nothing is more clear than that there can be no real progress in natural history without authenticating the observations of preceding writers by examining the objects which they have described, and by noting the particulars in which they are erroneous.

John Ray

John Ray (1623–1705) was the greatest naturalist and natural theologian of his time. He was the first naturalist to emphasize that natural history must be founded on an ability to identify plant and animal species, yet systematics was never the goal of his studies. His interest in natural theology encouraged his investigation into how nature works and although his adult life was something of a struggle, he was nevertheless a constantly productive naturalist who produced numerous publications. The cumulative impact of his work was a major contribution to the Scientific Revolution during the 1600s.

Ray (until 1670, he wrote his name as John Wray; from then on he used "Ray" after having ascertained that such had been the practice of his family before him) came from modest circumstances. His father was a blacksmith and his mother was an herbal healer. He studied at the University of Cambridge, pursuing comparative anatomy although initially his main interest was botany. He taught Greek, mathematics and humanities at Cambridge but abandoned his teaching position after refusing to comply with the Act of Uniformity of 1662, an Act of the Parliament of England. It prescribed the form of public prayers,



John Ray (1628-1705)

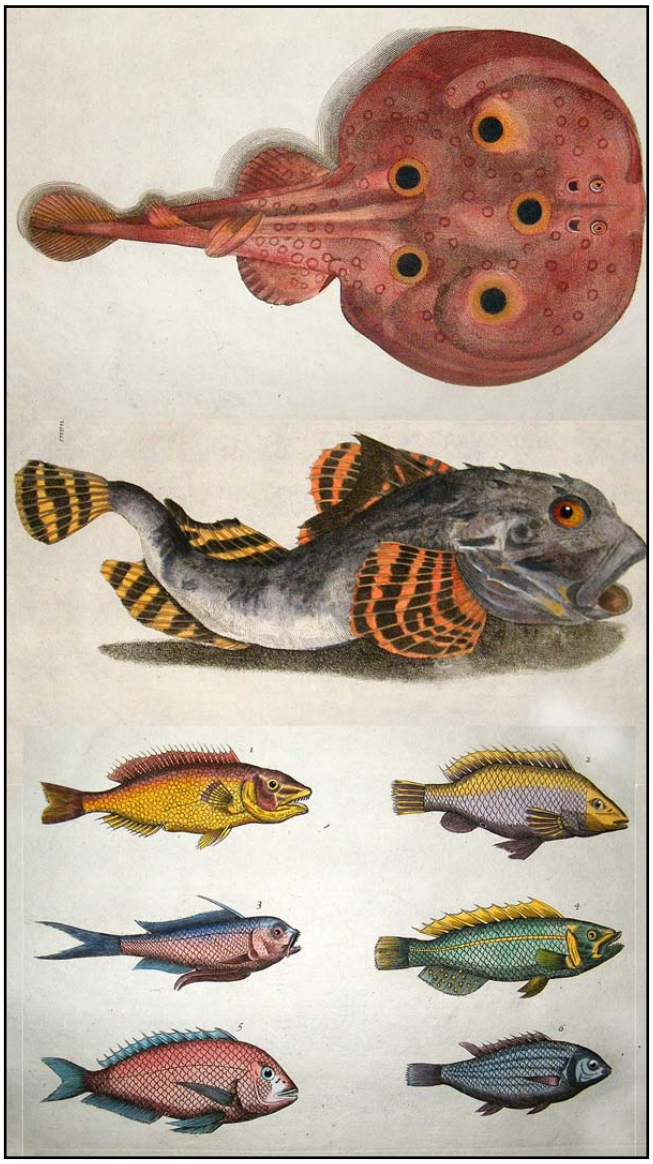
administration of sacraments and other rites of the Established Church of England, following all the rites and ceremonies and doctrines prescribed in the Book of Common Prayer. Adherence to this was required in order to hold any office in government or the church. In spite of this, Ray was a very religious person who undertook the study of nature to understand God's creation.

Fairly early on he developed a plan with his student and patron, Francis Willughby to produce a joint general natural history. To that end they went on an extended tour of England and Europe (1662-1666), including the medical school at Montpellier. Although they did not always travel together, both collected specimens, got involved in dissections and acquired books and illustrations, the endeavor bankrolled by Willughby.

When Willughby died, Ray took over his parts of the general natural history. Willughby left him an annuity of £60 and Ray stayed on as tutor to Willughby's children until 1675, when Willughby's mother, also his patron, died, and the widow immediately terminated the relationship. Ray inherited a small farm that also contributed to the family's maintenance while he earned money from his productive publishing. Therefore Ray had the financial freedom to pursue his intellectual interests.

Ray's first published work on cetaceans was *Dissection of a Porpess* (1671). He does a much better job in describing the internal anatomy of this animal when compared with Rondelet but does not get into the detail that Tyson (Edward Tyson, 1651-1708, was a British scientist and physician, commonly regarded as the founder of modern comparative anatomy) achieved later. During the narrative of his findings he keeps noticing that a porpoise has a lot in common with the "quadrupeds," yet he persisted calling them "fishes."

Ray published *Historia piscium* (1686), under Willughby's name fourteen years after his patron's death, though Ray himself contributed the vast majority of the content. He carried out the first serious attempt to achieve a systematic arrangement, the success of which can be attributed by the fact that it served as a basis for the systematics work of the following century. His approach was based on direct observation, collaboration with other researchers, and critical reading of previous authors.



Images from Ray's *Historia Piscium.*

Historia Piscium is divided into two parts that were printed separately: the first is the narrative and the second, titled *Ichthyographia,* were the illustrations. Many libraries today have both bound together. As sources Ray used authors mentioned earlier in this essay: Rondelet, Salviani, Gessner, Aldrovandi and Belon, among others. Yet, far from merely compiling

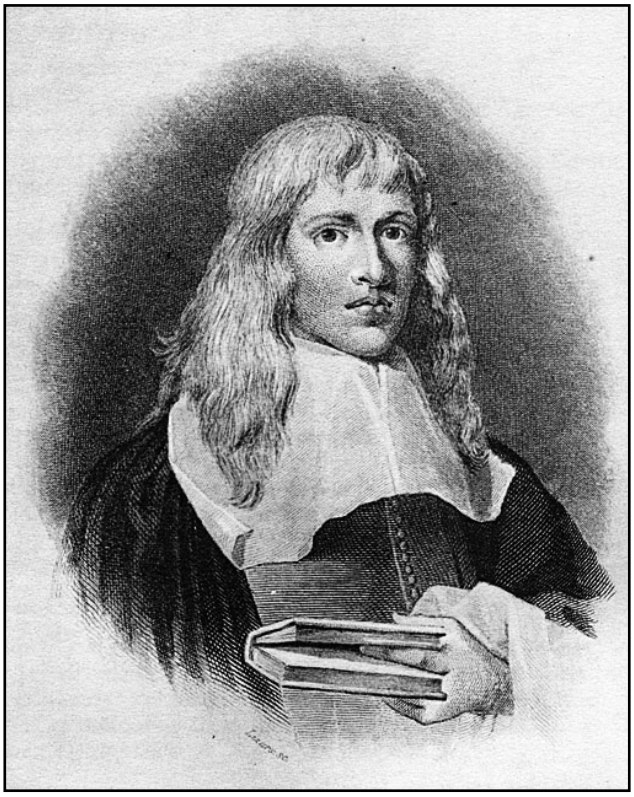
information from them, Ray insisted in very comprehensive descriptions of species and discarded all monsters and mythical creatures mentioned by his predecessors. Ray not only removed narratives of marine invertebrates but also other aquatic animals such as the crocodile and the hippopotamus. He divided his subject matter into three groups: cetaceans, cartilaginous fishes and bony fishes. He recognized that when it comes to reproduction and internal anatomy cetaceans are identical to the "viviparous quadrupeds." Still, he kept cetaceans within the "piscium" despite the fact that he was well aware that they were biologically distinct from fishes.

In his narrative of species Ray moved away from in the practical aspects related to these animals. Aspects such as usage for medical purposes were very common among previous authors because of their medical background. Yet, Ray was very keen at compiling names on the belief that a universal language could be constructed based on the knowledge of nature. Ray believed that there was a need for "a construction of a universal language based on a table that properly expressed the natural order and relations between things." Hence a precise description and classification was the route to achieve that goal. The final product counted not only on the intellectual support of the Royal Society's members who provided constructive criticism and moral support but also their financial support.

Ray's third publication related to marine mammals was *Synopsis Methodica Animalium Quadrupedum et Serpentini Generis* (1693). By then he was totally convinced that cetaceans were not fishes: "For except as to the place on which they live, the external form of the body, the hairless skin and progressive swimming motion, they have almost nothing in common with fishes, but remaining characters agree with the viviparous quadrupeds." He placed today's terrestrial mammals (including the manatee) among the "hairy animals" very close to the *Cetaceum* genus (cetaceans).

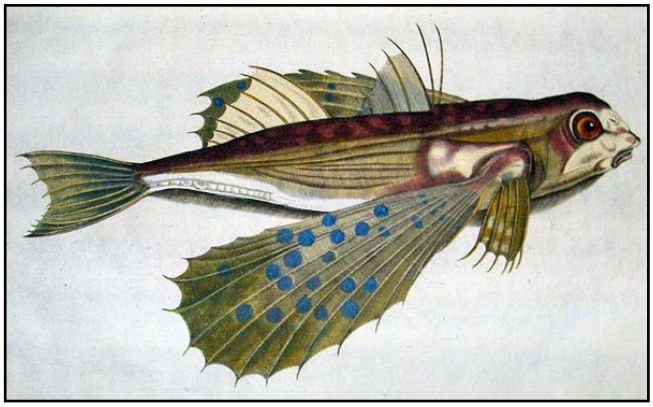
In *Synopsis* Ray included a section called *Pisces Cetacei seu Belluae marinae* where he expressed that these animals breathe and give birth like the "oviparous quadrupeds." He grouped them into two categories according to the presence of teeth much as we do today separating odontocetes (toothed whales) from mysticetes (finback and humpback whales). Ray was the first in doing so. The species he cited were *Balaena vulgaris* (Rondelet), *Balaena* (Fin-Fish), *Physeter* or *Balaena physeteris*, *Orca* (Rondelet & Belon), *Cete* (Sperm whale), Pot Walfish, *Albus piscis cetaceus* (white fish), *Monoceros cetaceo* (*Narhual islandis*), *Delphino antiquorum* (dolphin, from Rondelet), *Phocaeno* (Rondelet & Belon), dissecting a specimen of the latter in 1669.

Clearly the fish volume depended heavily upon previous books by Rondelelt, Belon, Salviani and Gesner. Even the observation from *Historia Piscium* about sharks having the mouth on their bottom side as a provision of nature to ensure safety of other fish and to prevent sharks from dying from gluttony, is actually repeated from Aristotle's *De Partibus Animalium*. Thus it came under some criticism and as one critic stated: **"It cannot be said that this is a very important contribution to natural history."**



Francis Willughby (1635-1672)

Nevertheless, two historians of ichthyology thought highly of this work. Cuvier in 1828 wrote: **"Ray and Willughby had the honor of being the first to write an ichthyology in which the fishes were clearly described according to nature and classified based on characteristics drawn only from their structure, and in which their natural history was finally rid of all passages from ancient writings…"** Later (1905), David Starr Jordan (the "Dean" of American iconologists) wrote that **"The basis of classification was first fairly recognized by Ray and Willughby in *Historia Piscium*, which brought "order out of the confusion left by their predecessors."**



Lavish engravings in *Historia Piscium* nearly did in the publication of Isaac Newton's great work, *Principia Mathematica*

Ray's classification of plants in his *Historia Plantarum*, was an important step towards modern taxonomy. He remarked, in particular, that classification must proceed upwards, beginning with the description of species, to proceed then with the comparisons upon which the species may be grouped into genera, the genera into families, and so on. This was a basic upside down revolution in respect to Cesalpino's method (Andrea Cesalpino (1519-1603) was an Italian physician, philosopher and botanist; in his works he classified plants according to their fruits and seeds, rather than alphabetically or by medicinal properties), in which Aristotle's logic was applied by dividing the whole of the plant kingdom into progressively smaller subgroups, down to the individual species.

Ray rejected the system of dichotomous division by which species were classified according to a preconceived, either/or type system, and instead classified plants according to similarities and differences that emerged from observation. Thus he advanced scientific empiricism against the deductive rationalism of the scholastics. He was the first to give a biological definition of the term species. In his 1686 *Historia Plantarum* he wrote:

"… no surer criterion for determining species has occurred to me than the distinguishing features that perpetuate themselves in propagation from seed. Thus, no matter what variations occur in the individuals or the species, if they spring from the seed of one and the same plant, they are accidental variations and not such as to distinguish a species…Animals likewise that differ specifically preserve their distinct species permanently; one species never springs from the seed of another nor vice versa."

The lavish engravings in *Historia Piscium* were so expensive to publish that they nearly bankrupted the young Royal Society, at that time only 26 years old. Short of cash, the Society had to rescind its promise to help pay for the production of Newton's masterpiece, *Philosophiae Naturalis Principia Mathematica* (*Mathematical Principles of Natural Philosophy*).

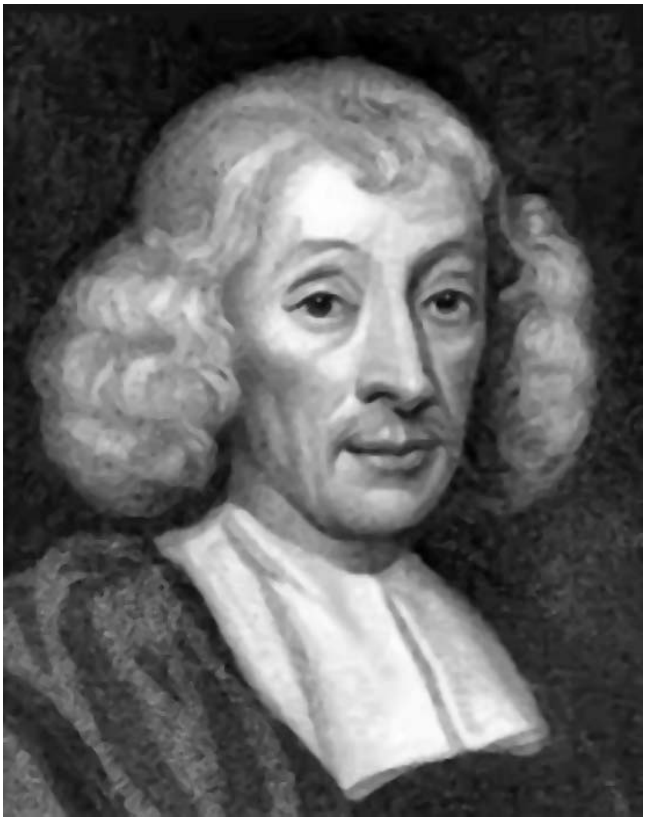
Fortunately for Newton (and for science), his *Principia* caught astronomer Edmond Halley's eye. Halley is remembered mainly for computing the orbit of the comet that bears his name, but at the time he was a young Royal Society clerk. Halley took on the *Principia* as a personal project, raising funds (many from his own pocket) to get the work published in 1687. Newton's book included his three laws of motion, which along with his law of universal gravitation, was able to explain the orbits of planets. In fact, his book is still widely considered to be one of the most important scientific works of all time, covering physics and mathematics.

Finally, Ray had a sense of humor. The following is one of his aphorisms: **"Fish must swim thrice - once in the water, once in the sauce, and a third time in wine in the stomach."**

Peter Artedi

Before examining Linnaeus' contribution to classification, it is necessary to say a few words about his good friend, Peter Artedi. Artedi was the son of a parish priest who developed an interest in fishes from an early age. He studied medicine at the University of Uppsala, devoting most of his time at studying natural history. At 29 years of age he went to London for a year to study natural history collections and described the sighting of a whale in November 1734, probably downstream of the London Bridge. He then moved to Leiden, The Netherlands, to complete his medical studies and there he met Linnaeus, whom he knew from their native Sweden, forging a lifelong personal and professional relationship.

They took an immediate liking to each other and soon formed an intense intellectual bond. Sharing their revolutionary ideas about order and hierarchy in nature, the pair developed elaborate plans to classify plants and animals in ways never seen before - Linnaeus focusing on plants and Artedi concentrating on fishes. In September 1735, though, just as Artedi was set to publish his work, he drowned under puzzling circumstances. Following up on a pledge to his lost friend, Linnaeus recovered his manuscripts and published *Ichthyologia* (1738) without amending Artedi's original work.



Peter Artedi (1705-1735)

Despite the fact that this was an unfinished work, it was a fundamental publication that marked the origin of ichthyology as we know it today. After a long (96 pages) introduction describing previous authorities on ichthyology the second part deals with the taxonomic terminology he used, particularly regarding the concept of genus and distinguishing between species and varieties. His system set the basis for the modern systematic classification of living organisms later established by Linnaeus. In part three he went into the classification of species including detailed description of them, some of which he had dissected himself. For this Artedi is considered the father of ichthyology.

Artedi established the basic classification of fishes that lasted for about 200 years and separated cetaceans into a totally different order than fishes; he apparently knew that they were different, but still tradition was difficult to break and thus he included them into his ichthyological treatise. He also established the basic branching of animal groups into Class, Maniples (Families), Genera, and Species, a system that was to be closely followed by Linnaeus. His work set the foundations for what Linnaeus would culminate as the definitely recognition of cetaceans as distinct group within mammals. Iit should be remembered that Ray's contribution is the first scientifically valid introduction to a zoological system using the concepts of genera, families, orders and classes based on thorough morphological investigations.

After defining what was to be understood by genus and subjected genus-names to a severe scrutiny, Artedi discussed species in general and went on to critically examine the names in use for them:

"A species name," he stated, "is the epithet, consisting of some few words, which is append-

ed to the genus-name, in order to distinguish one fish species from the others in the same genus. These epithets must be effective for the function they are thus required to perform; if they only state the more or less general occurrence of the species, its assumed sequence in the genus, home, mode of occurrence, size, varying color or markings, etc., they are, as being of no use to the reader, spurious and reputable. Genuine species-names, on the other hand, are those which serve to mark off at a glance, or with a minimum of effort, one species from the others in the same genus. They must, in other words, state such genuine species-characters as have been mentioned in the foregoing."

In having solved the question of genus-names so excellently, by enunciating such clear and definite rules for their use, Artedi was on the very threshold of a complete solution of the nomenclature problem; there would seem to have been but one simple step for him to take, to arrive at binominal nomenclature; however, in treating species-names he drifted away from the right track, owing to the exacting demands he made upon them. He transformed generic names, into real names, but in dealing with species names he confused the two ideas of name and diagnosis. In demanding of species-designations that they should express the differences existing among the several species, it was no longer possible for him to insist on unity in a species-name which was to fulfil those conditions, and still less possible as time went on and more and more forms became known and had to be scientifically treated. Consequently it was reserved for Linnaeus**,** 20 years later, to publish to the world the system of binominal nomenclature, and so to arrive at the final solution of the problem of how successfully to name natural history objects. The foundation laid by Artedi should not, however, on that account be forgotten or discredited.

Further, Artedi set a positive example in taking the earlier literature into consideration most comprehensively. Artedi's species characterizations **"are even now models of exactitude and method"** as Günther put it in 1880. In the year of Linnaeus' 300 anniversary (2007) it should be recalled that Artedi (if he would have survived for some more years) would likely be named always together with Linnaeus and many fish species might have carried a capital A. instead a L. behind their scientific names.

Artedi was buried in a pauper's grave in St Anthony's churchyard in Amsterdam on October 2, 1735. His grave was never marked and the churchyard site has since been appropriated for other purposes. An epitaph, written in Latin by Anders Celsius (he proposed the Celsius temperature scale which bears his name), and translated into English by George Bernard Shaw, is known because it was inscribed on the back flyleaf of Linnaeus's own copy of *Ichthyologia*:

Here lies poor Artedi, in foreign land pyx'd
Not a man nor a fish, but something betwixt,
Not a man, for his life among fishes he past,
Not a fish, for he perished by water at last.

Linnaeus

Born Carl Linné (or Carolus Linnaeus; he loved Latin and used it for everything, including changing his name to the Latin version) in 1707 in Rashult, Swe-

Carl Linnaeus (1707-1778)

den, Linnaeus had as a father a country person who loved plants. Linnaeus followed a medical career but was actually more interested in botany than in anything else. What Linnaeus learned from Artedi set the basis for a better classification not only of plants but also animals in general. Linnaeus is often called the Father of Taxonomy and his system for naming, ranking, and classifying organisms is still in wide use today (albeit with many changes). His ideas on classification have influenced generations of biologists during and after his own lifetime, even those opposed to the philosophical and theological roots of his work.

With all of this background, the botanist Linnaeus was ready to revolutionize biological classification and in the 10th Edition (1758) of his fundamental work *Systema Naturae*, he introduced the term Mammalia, and included *Cete* (whales and dolphins) among them. For Linnaeus, mammals were united by having hair, being viviparous and producing milk. He coined the term *cetacea* and separated them from fishes and grouped them with the rest of the viviparous quadrupeds based on the following characteristics: two-chamber heart, breathing by lungs, hollow ears, internal fertilization and production of milk.

However, even some of Linnaeus students were in the process of developing a better understanding of cetaceans as being really close to "viviparous quadrupeds." That was the case of Pehr Löfling, one of Linnaeus' students who came very close to making major contributions to the true nature of dolphins and manatees based on his observations of these animals in South America. In his description of Amazon freshwater dolphin or boto, Löfling was clear about when writing that whales and dolphins were different from fishes: "Pisces per pulmonibus spirantibus (fish breathing through the lungs)." However, his early death and the fact that his manuscripts were never published prevented him from gaining recognition in the scientific community.

Linnaeus revolutionized the science of systematics by developing a fully natural system of classification, consistently using binomial nomenclature and designing species with Latinized names (genus and species). He developed a hierarchy (class, order, genus, species) as proposed by Artedi, with species defined as similar individuals bound together by reproduction, which also set the basis of the biological species concept. The use of telegraphic speech-like (very short sentences) diagnosis for species descriptions and the standardization of synonymies (same species with different names) in order to reach a taxonomic consensus made his classification even more useful since from now on one could find clarity on what a particular species was tracing its description to other authors. He also doubled the number of species described by Ray. Thus, despite the fact that he was not a zoologist *per se* nor was he involved in dissection of animals, he was far from a compiler in that he applied critical thinking to the way he ordered nature.

This progress is even more remarkable when considering that Linnaeus was also far from being an evolutionist. For him species were fixed except for small variations due to climatic and/or local conditions. Yet, Linnaeus was, without question, the founder of systematics and the one who laid the foundations for the naturalists to become specialists and, therefore,

"Heaven welcomes ichthyologists - we've millions of fishes that need classifying!"

opened the door for the first group of marine mammal specialists, now that these creatures were no longer considered "fishes." It was not until Linnaeus that the science of taxonomy made the strides that have lead us to where we are today in our understanding of the natural world. Linnaeus understood biological principles and placed animals in groups based on existence of shared ancestry between a pair of structures, or genes, in different species rather than using environment to drive classification, and this was what allowed him to recognized cetaceans as a distinct group within mammals.

COMMENTS ON THE TWENTIETH CENTURY TO THE PRESENT

Phenetics

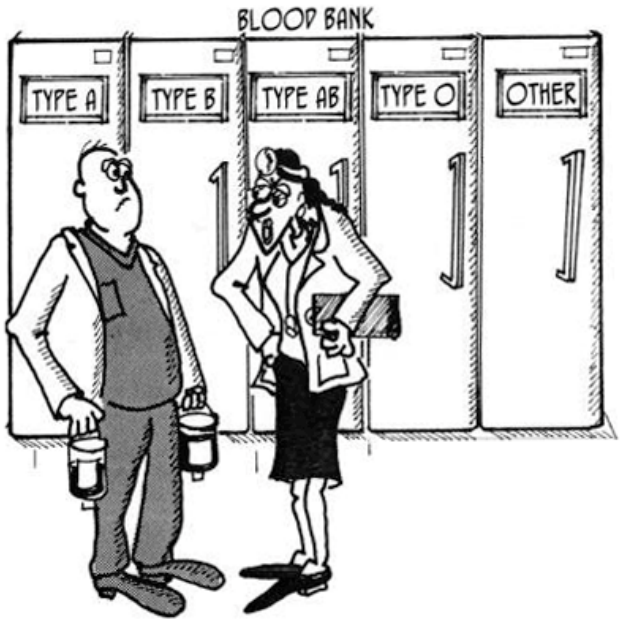
From Linnaeus up to the twentieth century, classification was largely carried out by "gentlemen" scientists who based their identifications of organisms upon a few "important" characteristics and a "gut feeling" developed during many years of experience. This was followed by phenetic classification methods, invented by those who thought that this type of classification scheme was too subjective. They argued that taxonomy should not be based on a few characteristics arbitrarily judged to be "important," but rather upon the degree of overall similarity between organisms. Thus they collected data on as many characteristics of the organisms being classified as possible. Each organism was then compared with every other for all the characters measured, and the number of similarities (or differences) was calculated. The organisms were then clustered in such a way that the most similar were grouped close together and the more different ones were linked more distantly.

Because of the enormous amount of data involved in this process, these calculations were usually made using specially programmed computers (desktop computers were not available at the time). The dependence of phenetics on the use of computers made it particularly unpopular with some "old-school" biologists. Paul Ehrlich, one of the early converts to phenetics, was reportedly once asked by an irate taxonomist at a conference, **"You mean to tell me that taxonomists can be replaced by computers?"** Ehrlich responded, **"No, some of you can be replaced by an abacus!"**

The clusters that resulted from such an analysis did not necessarily reflect genetic similarity or evolutionary relatedness. Pheneticists argued that this was acceptable because nobody really knew the true evolutionary histories of these organisms and at least this system was objective. However, the lack of evolutionary significance in phenetics has meant that this system has had little impact on animal classification and, as a consequence, interest in and use of phenetics has been declining in recent years.

Cladistics

An alternative approach to diagramming relationships between taxa was developed, called cladistics. The basic assumption behind cladistics is that members of a group share a common evolutionary history, and are thus more "closely related" to one another than they are to other groups of organisms. Related groups of organisms are recognized because they share a set of unique features which were not present in distant ancestors, but which are shared by most or all of the organisms within the group.

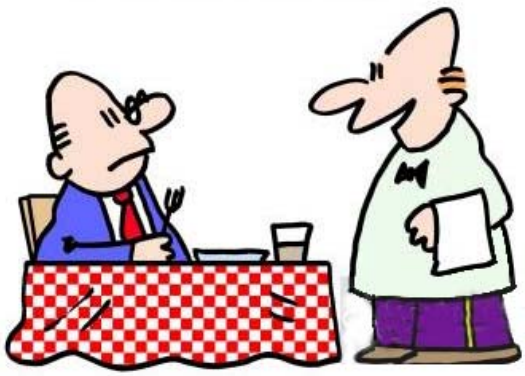


"McWit, I'd like to talk to you about your blood clsification system."

In contrast to phenetics, cladistics groupings do not depend on whether organisms share physical traits, but on their evolutionary relationships. Indeed, in cladistic analyses two organisms may share numerous characteristics but still be considered members of different groups. For example, consider a jellyfish, a sea star, and a human: jellyfish and sea stars both live in the ocean, have radial symmetry and are invertebrates, so phenetic analysis might place them together in a group. However, this would not reflect evolutionary relationships, as sea stars are actually more closely related to humans than they are to jellyfish. Thus in cladistics, the emphasis is not upon the presence of all shared traits, but upon the presence of shared derived traits. In the example above radial symmetry, aquatic habitat and invertebrate structure are all traits that are believed to have been present in the common ancestor of all animals, and so such traits are not considered to be very useful in determining relationships using cladistic analysis.

Evolutionary Systematics

Like cladistics, evolutionary systematics is based strongly on evolutionary relationships. However, its supporters suggest that the degree of genetic differences between lineages should be used in addition to their genealogical (evolutionary) similarities when developing taxonomic classifications. Among other ways in which evolutionary systematics and a cladistic analyses differ are that evolutionary taxonomists are more tolerant of multiple branches developing from an ancestral line, rather than just two as in cladistics, and they tend to treat organisms that are unchanged when a new branch arises from their lineage as the same species that existed before the branching event (i.e., the original species is not always believed to become extinct every time a branching event occurs).



It's nice of you to ask, but the recipe is classified."

U.S. Postal Service classification system.

However, the biggest difference between the two approaches is that, when creating groupings, evolutionary taxonomists seek to maximize the way in which the groupings they create communicate information about the group (in the way the word "mammal" or "reptile" does for an untrained person). This type of division is also intended to increase the ease with which a field biologist, or even someone coming in from the outside, can retrieve information about a group of organisms of interest to him using the taxonomic divisions formed.

An example of the differences between cladistics and evolutionary systematics is the following involving birds and crocodilians. It has been shown that these two groups diverged from the same ancestral reptilian line. A cladist would insist that these "sister groups" be placed in the same taxon, even though the amount of change from the common ancestor is much greater for the birds than it is for the crocodiles. An evolutionary taxonomist would suggest that the large number of similarities between crocodilians and reptiles would

justify grouping them within the same general taxon, while placing birds in a separate taxon due to the large number of unique characters possessed by members of this group.

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"Make it look like natural selection."

THE CLASSIFICATION OF FISHES: THREE CONFLICTING APPROACHES

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Yahoo Files, August 8, 2015)

The task of systematics is to find the best possible general reference system, but finding it is not so easy since it turns out that there are several approaches or ways to go about performing this task.

During the 1950s, and much more so during the 60s and early 70s, there was much confusion and debate over the principles of systematics. Reflecting this basic uncertainty about the methods and goals of systematics is the fact that during a fifteen-year period from 1960 to 1975 over a dozen books were published in which the methods and goals of systematics were argued back and forth. From all this intellectual fervor came three competing theories of classification, each claiming to be more objective than the other two and each claiming to produce a better general reference system than the other two:

1. Phenetics or Numerical Taxonomy
2. Cladistics or Phylogenetic Systematics
3. Evolutionary Systematics

PHENETICS

The major criteria are:

1. It is based on overall similarity;
2. Numerous characters are used (as many as can be found);
3. All are given equal weight;
4. The resulting branching diagram (tree) is computer generated;
5. The branching diagram (tree) that is produced is called a phenogram (from the Greek "phenomen," that which is seen), a branching diagram that links organisms by estimates of overall similarity as evidenced by an analysis of characters (see Figure 1).

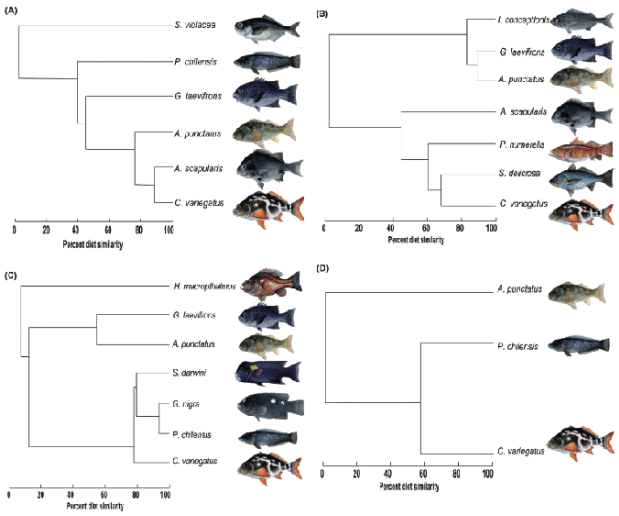


Figure 1: Phenograms of Fishes from Northern Chile.

The phenetic method was all the rage in the early and mid-sixties, popularized primarily by Robert R. Sokal and Peter H. A. Sneath.

CLADISTICS

Sometimes called phylogenetic systematics, the major criteria are:

1. One criterion for classification, i.e., the recency (i.e., of late occurrence, appearance or origin) of common descent;
2. The method allows only the use of specialized or derived character states, character states that we call apomorphic (primitive characters states are called plesiomorphic). So, in this sense, characters, or more precisely, character states, are more heavily weighted over others;
3. Taxa that share derived or apomorphic characters states are said to be related. Shared apomorphic character states are called synapomorphic, whereas shared plesiomorphic character states are called symplesiomorphic;

4. Grouping and ranking are given simultaneously by branching points in a diagram called a cladogram (from the Greek "clad" or "klados," meaning to branch' see Figure 2).

This concept of primitive versus derived character states can best be illustrated by examples. Picking an example from fishes, let's take a simple one like the skeleton. Skeleton is the character, but thinking about it you realize that skeletons among fishes consist of at least two states, a bony skeleton and a cartilaginous skeleton. We know that a skeleton of bone evolved very early in vertebrate history and that those vertebrates with a skeleton of cartilage are the result of a loss of the ability to ossify the skeleton. A bony skeleton is thus the primitive or plesiomorphic character state, while a cartilaginous skeleton is clearly the derived or apomorphic character state.

Let's pick another, slightly more complicated example, forelimbs. Thinking about forelimbs among fishes and other vertebrates, we can list at least three character states: pectoral fins, arms and wings. We know that pectoral fins evolved early on in vertebrate history and that these structures are the evolutionary forerunners of arms and wings. Thus pectoral fins represent the primitive character state of a character called forelimbs. What about arms and wings? We know that arms evolved in the earliest four-legged vertebrates (i.e., the first amphibians) long before wings first appeared in birds or mammals (bats), so we conclude that arms are a derived character state relative to pectoral fins, but a primitive state relative to wings. Wings clearly represent the derived character state relative to both pectoral fins and arms.

Cladistic systematics, or cladistics for short, was first articulated in a formal way by a German

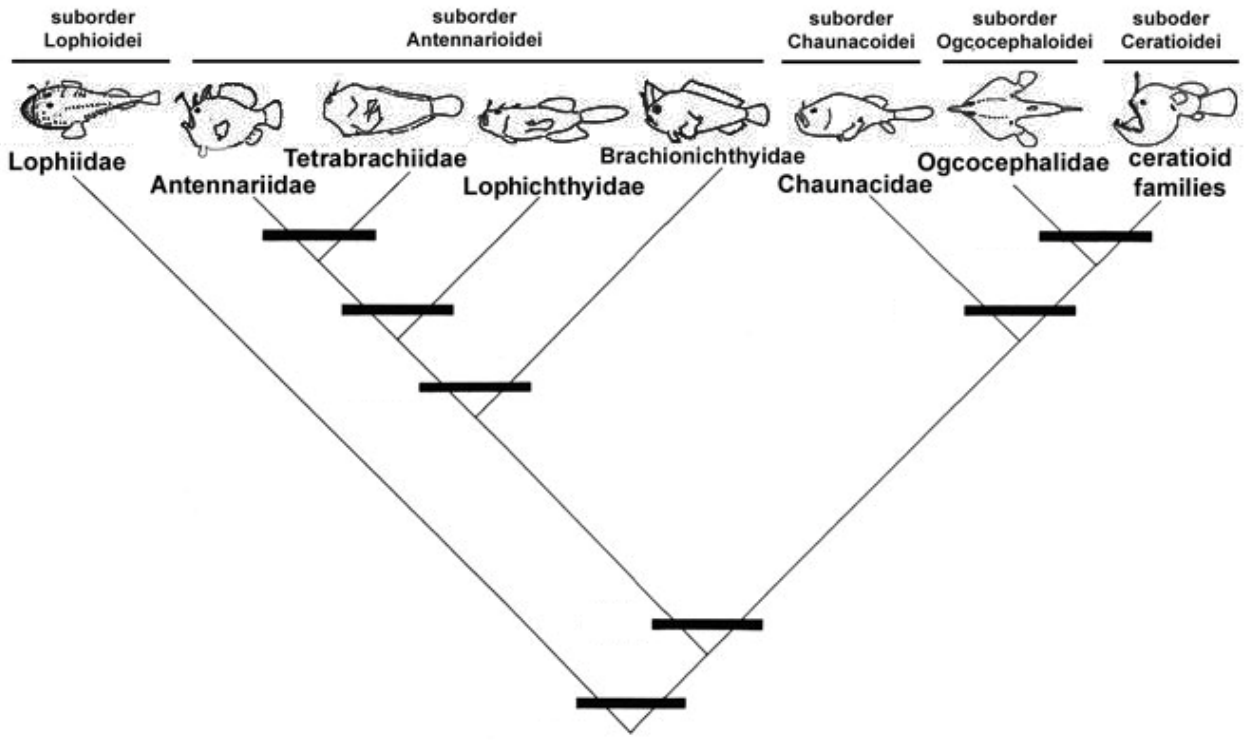


Figure 2: A Cladogram Showing the Phylogenetic Relationships of Families of Anglerfishes. The black bars indicate a change of character states

entomologist named Willi Hennig, a world's authority on the systematics of flies (order Diptera). He wrote a book, first published in German and later translated into English.

The cladistic method immediately became popular among entomologists and quickly spread to systematists working on other groups, particularly ichthyologists. The primary proponents of cladistics in the fish world were Donn E. Rosen and Gareth Nelson, both formerly working in the Department of Ichthyology at the American Museum of Natural History in New York. They, and a host of followers, beginning in about 1970, began publishing theoretical as well as applied papers in a number of prestigious scientific journals, most important among them being *Systematic Zoology* (since then renamed *Systematic Biology*).

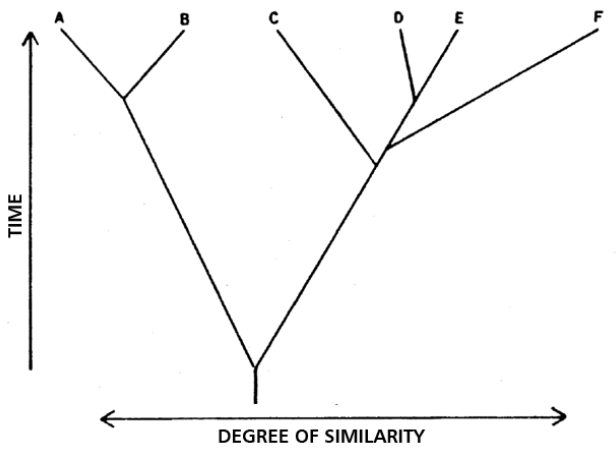


Figure 3. A hypothetical evolutionary tree showing the relationships of terminal taxa A through F. In contrast to a phenogram and a cladogram, which give only two kinds of information (geological time on the vertical and a measure of similarity on the horizontal), this diagram provides three kinds of information: geological times on the vertical, degree of similarity on the horizontal, and degree of divergence by the angle of divergence.

EVOLUTIONARY SYSTEMATICS

This is sometimes called the synthetic method, because in some ways it combines the criteria of phenetics and cladistics.

Evolutionary systematics relies on:

1. Two criteria for classifying and ranking organisms: recency of common descent and the amount and nature of evolutionary change between branching points;
2. The method allows the use of plesiomorphic (primitive) character states as well as apomorphic (derived) character states;
3. Character states thought to be more evolutionarily or functionally significant are often heavily weighted over others;
4. Grouping and ranking are given simultaneously by branching points in a diagram called a phylogenetic tree (Figure 3).

The major proponents or defenders of evolutionary systematics were George Gaylord Simpson and Ernst Mayr, each of whom wrote classic texts on this subject.

THE PROBLEMS WITH PHENETICS

Today, very few if any systematists employ phenetics or numerical taxonomy. When first proposed, the methodology seemed to resolve the problem of the lack of objectivity in evaluating characters for purposes of determining evolutionary characters. But early on, detractors pointed out serious deficiencies. According to Ernst Mayr ("Evolution and the Diversity of Life," p. 429, Belknap Press, 1976), "the phenetic approach…has been largely a failure when applied to higher organisms." One of the criticisms is that it totally ignores the possibility of evolutionary convergence, i.e., the process whereby organisms not closely related independently evolve similar traits as a result of having to adapt to similar environments or ecological niches.

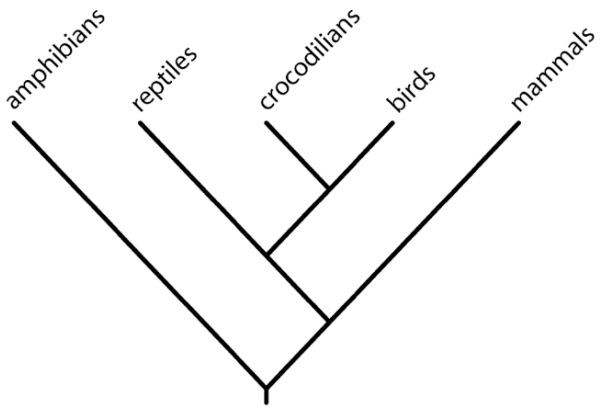


Figure 4: A cladogram showing the evolutionary relationships of five kinds of vertebrates. Each level in the hierarchy is defined by one or more similarities interpreted as derived character states.

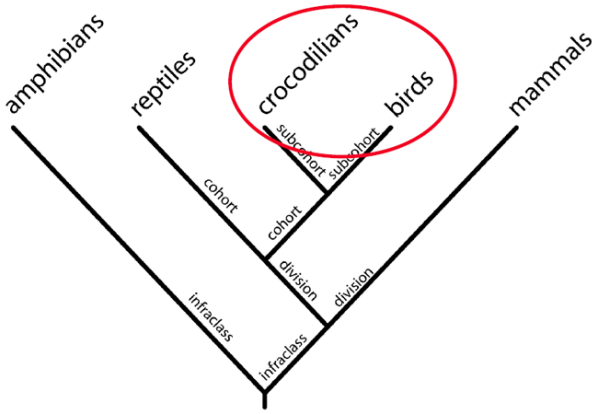


Figure 5. Cladists lump birds and crocodiles (the latter usually thought of as a subgroup of reptiles) together in a taxonomic category called Archosauria, which is given equal rank with reptiles. Ranking and classifying are based solely on a single criterion, recency of common descent.

CLADISTICS VERSUS EVOLUTIONARY SYSTEMATICS

The primary controversy is between those who support cladistics and those who back evolutionary systematics. The proponents on both sides declare that their method provides the greatest number of conclusions and predictions about the organisms being classified and is therefore the best approach.

To better understand the differences between these two methods. Let's forget about fishes for a moment and take a look at the famous crocodile-bird controversy.

The branching diagram in Figure 4 shows how the major groups of tetrapods diverged from one another through evolutionary time (the tetrapods comprise the first four-limbed vertebrates and their descendants, including the living and extinct amphibians, reptiles, mammals and birds). Everyone agrees, cladists as well as evolutionary systematists, that this is the way tetrapods evolved. What remains in question is how a classification should be derived from this sequence of branching.

The classification that cladists construct from the branching diagram in Figure 5 looks like this:

A CLADISTIC CLASSIFICATION OF TETRAPODS

Infraclass AMPHIBIA
Infraclass REPTILOMORPHA
Division SAUROPSIDA
Cohort REPTILIA
Cohort ARCHOSAURIA
Subcohort CROCODILIA
Subcohort AVES (birds)
Division MAMMALIA

Notice a couple of things. First off, the classification is a perfect reflection of the pattern of branching in the branching diagram. Everything is laid out in pairs. There are two infraclasses, two divisions, two cohorts, etc. Just as the diagram is perfectly dichotomous, so is the classification. Thus, the classification can be constructed easily by simply following the sequence of branching in the branching diagram.

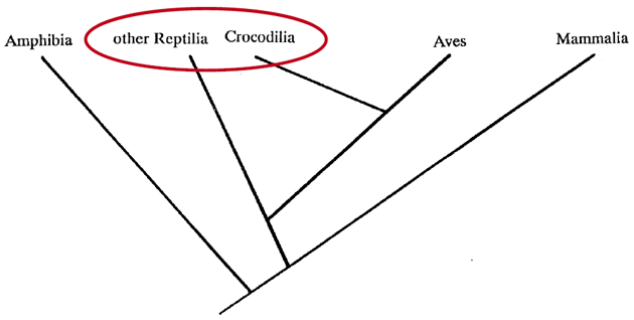


Figure 6. The branching diagram of the evolutionary systematicists.

At the same time, given the classification, it is very easy to draw the branching diagram.

Notice also, how crocodiles and birds are given equal rank. Cladists say that these two taxa are sister-groups, that is, the subcohort Crocodilia (crocodiles) is the sister group of the subcohort Aves (birds) and, vice versa, Aves is the sister-group of the Crocodilia. Cladists also say that the division Sauropsida, containing the reptiles, crocodiles and birds, constitutes the sister-group of the division Mammalia.

Let's now take a look at the other side of the controversy. Non-cladists see Figure 5 and go ballistic. They argue that this cladistic approach completely ignores the drastically different evolutionary fates of the groups in question. That is, cladists ignore genetic change that may have occurred within a group subsequent to branching away from an ancestral group. To stick with the example we started with above, non-cladists argue that birds have invaded an entirely new adaptive zone—that is, they've evolved wings and they fly—yet in the cladistic view they are given equal rank as the sister-group of the crocodiles, a group that has remained in the old ancestral adaptive zone. Of course, the problem immediately arises, how do you measure the extent to which a group of organisms has entered a new adaptive zone? How new is new? How does one quantify the differences?

Non-cladists, in constructing their classification of tetrapods, from the same pattern of evolutionary branching accepted by cladists, give birds a much higher status than crocodiles. In fact, they give birds equal rank with reptiles (reptiles now containing both "other reptiles" and crocodiles), thus emphasizing the amount of evolutionary change between branching points. Their branching diagram is shown in Figure 6.

Notice that the pattern of branching is identical to that in the diagram of the cladist, but the angles formed between the branches vary in accordance with estimates of the amount of evolutionary change (morphological divergence) between branching points.

Here is their classification—four classes of equal rank:

AN EVOLUTIONARY CLASSIFICATION OF TETRAPODS

Class AMPHIBIA
Class REPTILIA
Subclass ARCHOSAURIA
Subclass CROCODILIA
Class AVES
Class MAMMALIA

Notice a couple of things. First off, the classification is not at all a reflection of the pattern of branching in the branching diagram. Thus, the classification cannot be constructed by following the sequence of branching in the branching diagram. And, vice versa, it is impossible to draw the branching diagram based on the classification alone.

Notice also that in lumping crocodiles with "other reptiles," non-cladists violate a major premise of the cladistic approach: they violate the concept of recency of common descent.

Cladists therefore view the "Reptilia" of the non -cladist as an "unnatural assemblage."

Followers of evolutionary systematics say that their evolutionary tree and classification provide much more information than a cladogram and a cladistic classification. They say their approach provides important information about the (1) extent of radiation and the (2) amount of evolutionary divergence between groups. Cladists come right back and say, this is all well and good, but how does one go about measuring, i.e., quantifying the extent of radiation (an evolutionary radiation is an increase in taxonomic diversity or morphological disparity, due to adaptive change or their environment) and the amount of evolutionary change? Cladists argue that these values are unknowable, they can't be determined, and thus any attempt to use these concepts to order the diversity of life is not science!

THE CONCEPT OF "RELATIONSHIP"

To compare these competing methodologies and provide another example that will help to differentiate between pheneticists, cladists and evolutionary systematists, let's take a look at the word "relationship."

Phenetic approach: for the pheneticist, relationship simply means similarity. Pheneticists operate on the assumption that the total phenotype accurately reflects the genotype. They believe that an unweighted measure of overall similarity provides an accurate determination of relationship. In so doing, pheneticists ignore the possibility of evolutionary convergence.

Cladistic approach: cladists define relationship in a strictly genealogical sense—the measure of phylogenetic relationship is the relative recency of common descent.

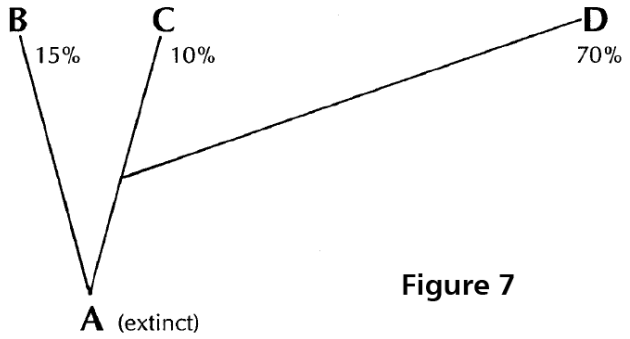


Figure 7

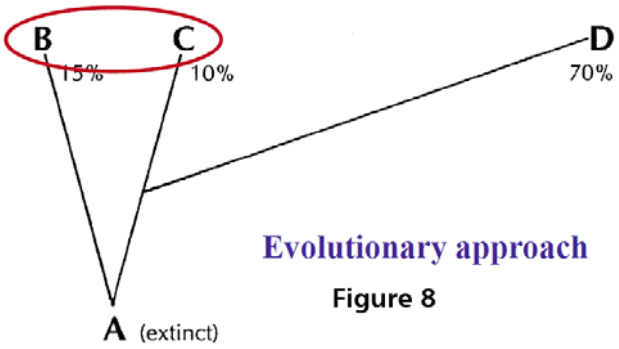
Evolutionary approach: for the evolutionary systematist, relationship means more than just kinship in a strictly genealogical sense—it also involves a measure of genetic change that may occur within a group subsequent to its divergence (branching) from an ancestral group.

Let's illustrate this with the diagram shown in Figure 7.

Imagine an ancestral species A that gives rise to three modern-day species, B, C and D.
Imagine further that
15% of the genetic content of species B differs from that of species A,
10% of the genetic content of species C differs from that of species A, and
70% of the genetic content of species D differs from that of species A.

There is, therefore a *maximum* genetic difference of 25% between the genomes of B and C, but 80% between C and D. Note: The maximum genetic difference between the genomes of B and C, for example, occurs when B's 15% is entirely different from C's 10% and so we add their genetic content to get this number; a similar calculation is made for C and D.

The evolutionist would say B and C are more closely related than either is to D, because there is much less genetic difference or genetic



Evolutionary approach

Figure 8

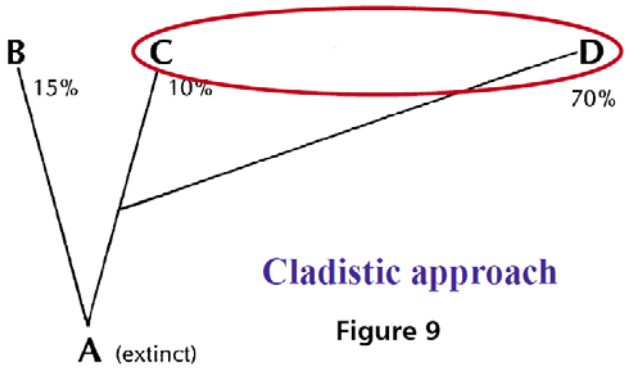
change between them, that is, they have a much greater inferred amount of shared genotype (Figure 8).

The cladist, in direct opposition to the evolutionary systematist, would conclude that C is more closely related to D than to B because of greater recency of common descent (Figure 9).

Over the years, the cladistic approach has become widely accepted over any alternative approach, so that today nearly everyone in the field of biosystematics is a cladist!

WHAT'S IT ALL MEAN TO AQUARISTS?

The answer is, "very little." At times, an aquarist will find it more useful to adopt Aristotle's binary classification, as when a key to a group of fishes is consulted. Generally speaking, however, aquarists are more interested in similarities than in phylogeny so it might seem that phenetics



Cladistic approach

Figure 9

got us into the millennia-old error in the first place of confusing a porpoise with a fish. And, philosophically and practically speaking, cladistics is not going to be much of a help to an aquarist when it insists that there is no such thing as a fish.

Aquarists are not picky when it comes to nomenclature (and here they are in good company since Linnaeus didn't much care, either, although he did prefer that it be in that pesky Latin), nor are aquarists picky about classification.

In addition to these the methods of classification discussed in this essay, differences may also exist among classification systems depending on whether the worker is a "lumper" or a "splitter." A lumper constructs a classification with categories containing more groups than that of a splitter. There are no rules for the amount of difference necessary to designate various categories. A lumper recognizes one family for salmon, whitefish and grayling; a splitter, 2 or 3 families. Aquarists often get the urge to gather up feathers and heat up tar when an ichthyologist moves half of his favorite species to a dozen or so newly-minted genera, most of which are impossible to pronounce. Finally, an interesting classification of fishes based upon ecological factors is shown in Figure 10 (from Allen, 2006).

Some ichthyologists see classification as an expression of theories about the relationships between taxa and others see it as an information storage and retrieval system. Aquarists see it mostly as the latter since it benefits them more. This view imposes limits on both the number of taxa a higher taxon can sensibly contain, and on the number of levels appropriate in a hierarchy. Cladistics, with its deep hierarchies, can be seen as a move towards greater scientific accuracy at

the expense of efficient information retrieval. This inefficiency with regard to information retrieval helps explain why many authors - including aquarists - continue to organize their material using Linnaean ranks rather than hierarchies of clades.

In any event, with regard to aquarists involving themselves in the quarrel between cladists and evolutionary systematists, I end with this quote from the bible: "Whoever meddles in a quarrel not his own is like one who takes a passing dog by the ears."

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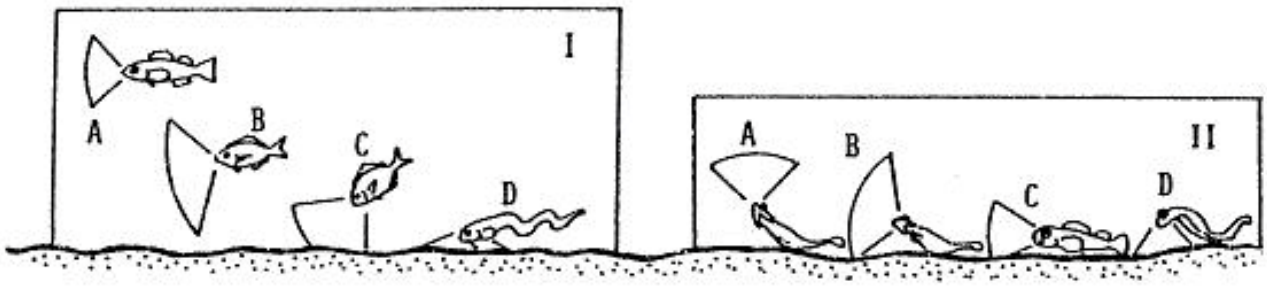


I. Water-column Fishes
- A. Pelagivores
  - 1. Schooling
  - 2. Bottom-refuge
    - a. Visual
    - b. Nonvisual
- B. Pelagobenthivores
- C. Benthopelagivores (Cruising)
  - 1. Diurnal
  - 2. Nocturnal
- D. Benthivores (Cruising Nonvisual)

II. Bottom-living Fishes
- A. Pelagivores
- B. Pelagobenthivores
- C. Benthopelagivores
  - 1. Pursuing
  - 2. Ambushing
- D. Benthivores
  - 1. Visual
    - a. Extracting
    - b. Excavating
  - 2. Nonvisual

Figure 10. Classification of foraging groups of soft-bottom fishes on the southern California shelf.

SEX AND THE SINGLE BOTANIST

by Albert J. Klee, Ph.D

(Aquarium Hobby Historical Society of America, Facebook Files, August 29, 2015)

The fame of Carl Linnaeus (1707-1778) - ennobled Carl von Linné in 1757 - rests upon his reform of natural history. Among other things, by introducing binominal nomenclature in *Systema naturae* (1735) and finally adopted in *Species plantarum* (1753), he created order in a period when there was great confusion in naming animals and plants. No uniform system existed. Every biologist gave names according to his own method. Linnaeus shared the frustration of many of his contemporaries at some nomenclature experiments, once remarking, "The names bestowed on plants by the ancient Greeks and Romans I commend, but I shudder at the sight of most of those given by modern authorities." He had good reason to shudder; one "formal" name for the tomato was *Solanum caule inerme herbaceo, foliis pinnatis incisis, racemis simplicibus*. Linnaeus standardized the terminology for 8,000 plants and 6,000 animals. His reform consists essentially of giving a one-word name such as *Acipenser* or *Cyprinus* to a genus and a two-word name such as *Perca fluviatilis* or *Malapterurus niloticus* to an individual species within this genus.

The Swiss philosopher Jean-Jacques Rousseau sent Carl Linnaeus the message: "Tell him I know no greater man on earth." The German writer Johann Wolfgang von Goethe wrote: "With the exception of Shakespeare and Spinoza, I know no one among the no longer living who has influenced me more strongly." Swedish author August Strindberg wrote: "Linnaeus was in reality a poet who happened to become a naturalist." Among other compliments, Linnaeus has been called Princeps botanicorum (Prince of Botanists), "The Pliny of the North," and "The Second Adam." *Time Magazine* named Linnaeus the 31st most influential person in human history and the 5th most influential scientist. According to the German biologist, Ernst Haeckel, the question of man's origin began with Linnaeus, as he helped future research in the natural history of man by describing humans just as he described any other plant or animal.

From the time it was introduced, the Linnaean system had both competition and detractors. Michel Adanson of France proposed a different system that organized plants globally and incorporated indigenous terms to name them. (Linnaeus scoffed that many of those terms "can scarcely be pronounced by our tongues.") Buffon, meanwhile, argued that nature "advances by imperceptible nuances" that no naming system could capture.

Encyclopedist Denis Diderot took offense at Linnaeus's classification of man as a quadruped. Diderot - no fundamentalist - thought Linnaeus had given short shrift to the human mind. Further, he repeated the Linnaean classification system for man to show its absurdity: Man is not a rock or a plant, so he must be an animal. Man has more than one foot, so he's not a worm. Man has no antennae, so he's not

Carl Linnaeus (1707-1778)

an insect. Man has no fins so he's not a fish. Man has no feathers, so he's not a bird. Man must be a quadruped.

As for man, Linnaeus concluded there were four types of *Homo sapiens: europaeus, asiaticus, americanus* and *afer*. And that was not including people in "a state of nature" (*Homo sapiens ferus*) and pathological types (*Homo sapiens monstrosus*). In all fairness to Linnaeus, belief in separate human species and even separate human origins for different races persisted long after he died. However, this business of including man along with plants and animals caused a religious uproar in some quarters and is the subject of this essay.

AN EARLY FRIENDSHIP

Linnaeus and Johann Georg Siegesbeck (1686-1755), initially had had a friendly relationship. Siegesbeck was born at Seehausen, near Magdeburg, and took his doctor of medicine degree in Wittenberg in 1716. After this he practiced as a physician in his hometown, then at Helmstedt, from 1730-1735 meanwhile studying botany under Lorenz Heister. Botany eventually took over from medicine for Siegesbeck and he was appointed a demonstrator at the Botanical Garden of St Petersburg in 1735 (a demonstrator's job was to explain to his pupils, i.e., the apprentices of the Garden, the names, classes, and medicinal uses of the plants, according to the order in which they are placed in the garden). He went on to take up the post of Professor of Botany at the Russian Academy of Sciences and director of the Botanical Gardens, where he remained until 1747. Afterwards he returned to Seehausen, again working as a physician, until his death in 1755.

Between November 14, 1735 and April 12, Siegesbeck wrote four very ingratiating letters to Linnaeus when Linnaeus lived on Hartecamp in the Netherlands, the estate of his Dutch benefactor, George Clifford (1685-1760). Siegesbeck also sent Russian plants to Clifford for his collection. On May 24, 1736, Siegesbeck informed Linnaeus that by order of the Russian Empress Anna, medical gardens had been founded the year before in both St. Petersburg and Moscow. Siegesbeck was in charge

George Clifford (1685-1760), Linnaeus's Dutch benefactor

of the former and another German botanist, Traugott Gerber, of the latter. It was their task not only to examine domestic plants, especially those that were rare and not yet described, but also to start a botanical correspondence so as to collect exotic plants for their medical gardens.

The common opinion of Siegesbeck is that he was a poor botanist. In fact he is mentioned in the history of botany only for having criticized the famous Linnæus and, because of which, he has been considered something of a fool.

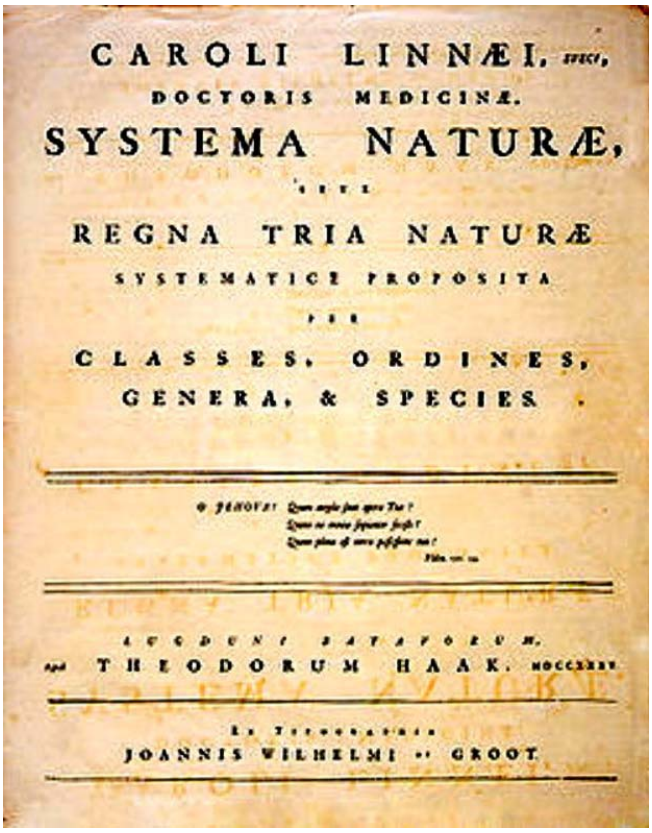
THE BACKGROUND OF THE QUARREL

In *Systema naturae* Linnæus gave a full account of his sexual system for the classification of plants, which was founded on the organs of reproduction, i.e., the stamens and pistils. These ideas were refined in *Fundamenta botanica* (1736), *Genera plantarum* (1737) and *Critica botanica* (1737). Linnaeus was very sensitive to criticism all his life and his new system for the classification of plants met with much

resistance. If Linnaeus's critics chafed at his naming system, they were truly disgusted by something else he publicized: Plants reproduce sexually. Up to that time, the gentle study of botany had been sufficiently delicate to serve as a pastime for well-bred ladies. Then Linnaeus ruined everything with his new classification system and the Pope forbade the introduction of his works to the Vatican. It was not until 1774 that a botany professor was appointed in Rome to lecture the Pope on the basis of Linnaeus's work.

However, another objection to the system was that it was repugnant and immoral. One of those critics was Siegesbeck. In December 1737 Siegesbeck published a work in which he tried to refute Linnaeus's sexual system, but the scholarly argumentation was poor, to say the least.

Linnæus asserted that the species are constant and serve God's purposes. According to him, there is an order in Nature, which goes back to God. God is present everywhere. The Creation is the glory of God and nothing has therefore been created at random. It is up to botanists to show this divine order and the Creator's hand behind it all. Linnæus says himself in *Systema naturae* that he saw the eternal, omniscient and almighty God "on his back" and he was amazed. He saw the footsteps of God in nature and noticed everywhere an eternal wisdom, an incredible perfection. Linnæus believed that he was guided by God himself and that he had a mission to reveal


CAROLI LINNÆI, SVECI,
DOCTORIS MEDICINÆ.
SYSTEMA NATURÆ,
REGNA TRIA NATURÆ
SYSTEMATICE PROPOSITA
PER
CLASSES, ORDINES,
GENERA, & SPECIES.
LUGDUNI BATAVORUM,
apud THEODORUM HAAK. MDCCXXXV.
JOANNIS WILHELMI DE GROOT.

Cover of the first edition of *Systema Naturae* (1735). This edition had only 11 pages. Further editions of the work were regularly updated; the 13th edition, published in 1770, had about 3000 pages.

God's plan for the Creation. Everything comes from the egg (omne vivum ex ovo). As a consequence of this, plants too were thought to come from the egg, i.e., the seed.

Hartecamp, in the Netherlands, the estate of Linnaeus's Dutch benefactor, George Clifford.

In this regard Siegesbeck strongly questioned Linnæus's new system: According to the Bible, God created all plants on the third day. God did not think of seeds, but created complete plants with flowers and fruits. Animals have different sexes, but from this fact we cannot conclude that the same

can be applied to the vegetable kingdom. Siegesbeck admits that the research of John Ray (1627-1705) and others showed that it is true that plants do have some sort of sex, but all the same we cannot talk of stamens and pistils as male and female organs respectively by which the plants can reproduce themselves. What really made Siegesbeck so upset was, as he put it, "the immorality" of the Linnaean system.

Siegesbeck openly mocked Linnæus asking whether God would allow twenty men or more (i.e., the stamens) to have one wife in common (i.e., the pistil) or the wedded man, apart from his legitimate wife, to have adjacent flowers as concubines. It seems fair to say that what Siegesbeck did is only to draw certain conclusions from Linnæus's own statements. Siegesbeck tried to see God's plan behind the sexual system, but failed totally when he saw its strange moral consequences. Thus Siegesbeck concluded that God would never allow such an abominable lack of chastity among his innocent plants, his dearest little creations. He called Linnaeus's ideas "loathsome harlotry" and wondered "who would have thought that bluebells, lilies and onions could be up to such immorality?" Such a method could never be proposed to young, innocent students!

LINNAEUS GETS IN A DIG

One of Linnaeus's ideas in *Critica botanica* (Critique of botany) was that there should be a link between the flower and the botanist whom it was named after. For example, *Magnolia,* Linnaeus said, has very handsome leaves and flowers, which recall the splendid botanist Magnol. But *Dorstenia* has insignificant flowers, faded and past their prime, like the works of Dorsten. According to Linnaeus there was such a "charm" in these associations of his that they would never fade from memory. Following this philosophy and being warned of Siegesbeck's attack, in *Hortus Cliffortianus,* a work of early botanical literature as a collaboration between Linnaeus and Georg Dionysius printed during the summer of 1737, Linnaeus had named a smelly little weed, *Siegesbeckia orientalis.*

***Siegesbeckia orientalis*, a low-growing plant.**

Today, although naming an unsavory organism after someone you want to insult is considered bad form, it sometimes happens. Quentin Wheeler, for example, a self-described life-long Republican and admirer of beetles that ingest slime molds, named three slime beetle species, *Agathidium bushi, Agathidium rumsfeldi* and *Agathidium cheneyi*!

LINNAEUS IN TROUBLE

Linnaeus realized that Siegesbeck's criticism had had serious consequences. When he came back to Sweden in 1738 after four years obtaining his

***Critica botanica*, 1737. In this publication Linnaeus recommended that there should be a link between the flower and the botanist whom it was named after.**

doctorate and visiting with eminent botanists, he found that the whole of Stockholm was in fact laughing at him - not at Siegesbeck. This tells us something about how Linnæus's new ideas were received. From a theological point of view people seemed to strongly favor Siegesbeck. The situation was so bad that Linnaeus could not even find one servant to work for him. Actually in one of his biographies he states that nobody even dared to send him his dog to be cured, a pretty state of affairs for a medical doctor. And he, Linnaeus, who had been honored everywhere abroad as a Princeps botanicorum, was in Sweden like a Klimius returned from the Underworld (a reference to the Norwegian-Danish author Ludvig Holberg's Niels Klim's *Underground Travels*, originally published in Latin as *Nicolai Klimii Iter Subterraneum* (1741), one of the first science fiction novels in history, along with Johannes Kepler's *Somnium* (Dream) of 1634).

Hermann Boerhaave (1668-1738) was the foremost professor of medicine of the time. Linnaeus, who was his student, promised never to partake in any scientific quarrels, and he kept that promise.

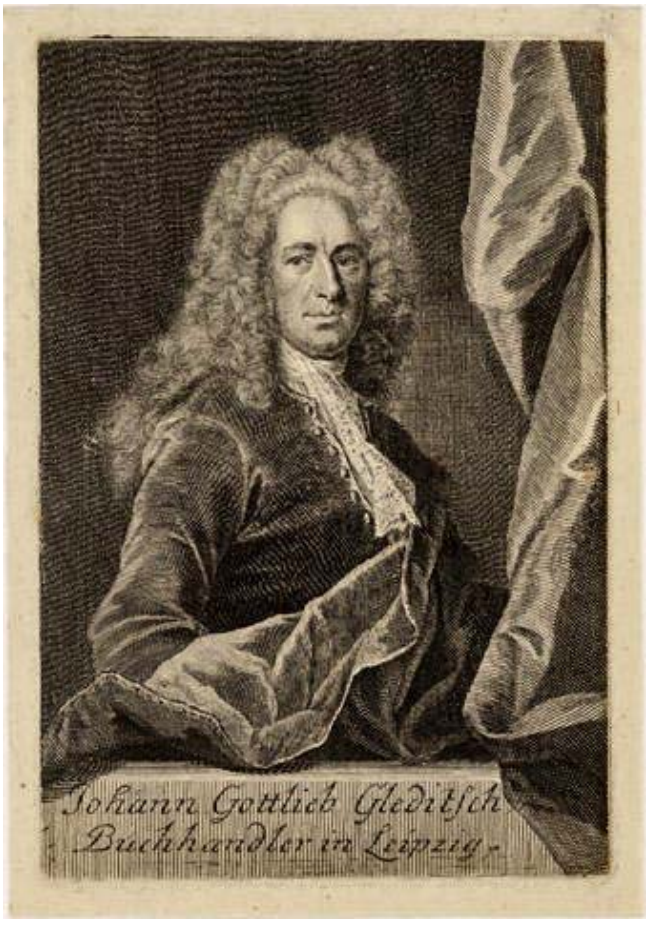
Johan Browall (1707-1775).

LINNAEUS MOUNTS A DEFENSE

Linnaeus was finally forced to defend himself against Siegesbeck's attack. In a letter on September 13, 1748, he confided to a friend that in Leiden he had promised his teacher, Hermann Boerhaave (1668 -1738), the foremost professor of medicine in those days, never to partake in any scientific quarrels. He had kept his promise in so far as he had not attacked Siegesbeck's thesis in his own name. It was Linnaeus's old friend, Johan Browall, who undertook the defense. Browall (1707-1775) was a Finnish and Swedish Lutheran theologian, physicist and botanist (Finland was part of Sweden for almost 700 years from around 1150 until the Finnish War of 1809 that saw Finland becoming an autonomous part of Russia as the Grand Duchy of Finland). He was a Professor of Physics from 1737–46, Professor of Theology 1746–49 and was the Bishop of Turku (a town on the southwest coat of Finland; its Swedish name is Åbo), then a diocese of the Church of Sweden, and Vice-

Chancellor of The Royal Academy of Turku from 1749 until his death in 1755.

In 1737 Browall published his *Examen epicriseos in Systema plantarum sexuale* (The examination of the Epicriseos system in sexual plants), where Siegesbeck's opinions were raked over the coals and shown to have no merit whatsoever. Browall asserted that the criticism that could be made against Linnaeus's sexual system is that widely different plants are brought together within the same class. But this criticism can be attributed to every artificial system and cannot be avoided until a true natural system is discovered. Linnaeus's system still contained more natural classes than any other previous system. In one of his autobiographies Linnaeus says himself that he supported Browall when he wrote the thesis, *Multa communicavit* (many things shared).



Johann Gottlieb Gleditsch (1714-1786), another of Linnaeus's German correspondents who came to his defense.

Another attempt aimed to refute Siegesbeck was published in 1741 by Johann Gottlieb Gleditsch (1714-1786), another of Linnaeus's German correspondents, under the title *Vaniloquentiae botanicae specimen* (*Idle talk about botanical specimens*). Siegesbeck's replies to these defenses of Linnaeus, however, in no way improved his own reputation. He remarked, for example, that he did not know whether Linnaeus was competing with botanists, poets or orators since he calls the seeds ovaries and talks of matrimony, happiness and love of the plants. He concludes by saying that Linnaeus's sexual method should be called the lascivious method and that there was a great difference between polygamy and associations with prostitutes. The one is sanctioned in the Old Testament, the other not!

THE ST. PETERSBURG OOPS!

The hostility between Linnaeus and Siegesbeck was intensified in the 1740's through a series of coincidences. Linnaeus found a seed packet with some fruits of *Siegesbeckia orientalis* in the University Botanical Garden at Uppsala and he could not restrain himself. All his bitterness towards Siegesbeck burst out anew. He relabeled the packet with the name *Cuculus ingratus* ("the ungrateful cuckoo"). This would not have caused such embarrassment if the packet had not ended up at St. Petersburg and finally found its way to Siegesbeck himself.

These were the unfortunate circumstances. In 1744, Count Sten Carl Bielke (1709-1753) - a private student of Linnaeus - together with Linnaeus's future disciple Pehr Kalm, made a journey to Russia to collect plants. A rich collection of dried plants, seeds and more than 200 sorts of herbs, all Siberian, was brought back to Uppsala. However, at St. Petersburg Bielke happened to trade the packet by chance for Russian seeds. Thus it eventually came into Siegesbeck's own hands. He sowed the seeds with great curiosity and harvested - a *Siegesbeckia.* Naturally enough Siegesbeck was absolutely furious. Linnaeus's little mischief was to have damaging

effects on the botanical interchange as Siegesbeck now stopped all exchange of herbs with Uppsala.

This was a severe blow to Linnaeus, who was very interested in the Siberian flora, as its plants were ideal for the barren soil of Uppsala. Bielke repeatedly tried to put things right by urging Linnaeus to send a letter of apology to Siegesbeck saying the fault was that of the gardener who had written the label, not he. As a last resort Bielke tried to persuade Linnaeus by offering all the Siberian plants that he could have in return, reminding Linnaeus that Georg Wilhelm Steller (1709-1746), who sailed with Vitus Bering (1681-1741), would soon return with great collections from Kamchatka (in those days this comprised the whole of the Russian far East). However Linnaeus replied:

With regards to your last letter I must say with Pilate, 'What is written is written.' Siegesbeck shows himself to be cruel; death and cruelty will always have some cause. Nobody has ever been able to give me a rarer gift than the one you, dear Count, gave me of Siberian herbs, but if someone told me, 'apologize to Siegesbeck, and I will give you an equally big and rare collection,' I must admit that this would be impossible for me, because of a public malice without reason. He then tried to escape, but it is an idiot and fool, under which I have suffered, such a thing cannot be eradicated from a mortal heart. The more he writes, the more he rages, the better it is. If you, dear Count, writes to him, you had better pray him right away to open all his sources of evilness and rush forward as an example to posterity, an *ingratissimus cuculus et nebulo* (ungrateful cuckoo and blockhead). Let him also know that I will never forgive him his roguery, but also that I do not meet wickedness with wickedness, but smile at the idiot and fool, who pretends to be a botanicus, something that he will never become.

THE COUP DE GRAS

Linnæus had many critics. But in the 1760's his works had long been accepted and he allowed himself to make an assessment of contemporary botanists by listing all the "officers of Flora." No less

Albrecht von Haller (1708-1777. Like Linnaeus, he was a pupil of Herman Boerhaave. Haller was a stubborn critic of Linnaeus but was on friendly terms with him. They corresponded frequently and Linnaeus often provided intimate details of his family life and when Haller published these letters he was severely criticized for doing so.

than thirty-three contemporary botanists were listed and given various ranks. Although Albrecht von Haller (1708-1777, a Swiss anatomist, physiologist, naturalist and poet; he is often referred to as "the father of modern physiology" and like Linnaeus, he was a pupil of Herman Boerhaave) was a stubborn critic. To Linnaeus's credit, however, he lists him as the third botanist in rank and thus places him among the colonels ("öfwerstar"). Not surprisingly Siegesbeck was listed at the absolute bottom of the list with the grade of sergeant major ("fältväbel"). In accordance with his title of omnium seculi sui botanicorum princeps (the worlds' prince of botany), Linnæus placed himself at the top of the list as the general.

CONCLUSION

In his *Nemesis Divina*, a work with edifying and moralizing stories for the education of his son, also

called Carl, Linnaeus reveals a rather primitive sort of religion, i.e., if you suffer, it is God's punishment for something that you have done yourself; there always seems to be a just connection between guilt and punishment. "Wicked" Siegesbeck was to prove himself an excellent example of Linnaeus's interpretation of divine revenge, especially as he was to live to see his only son commit suicide, which meant the end of his family line.

Finally, as I have already suggested, humility was not one of Linnaeus's virtues. In his autobiography Linnaeus concludes, writing in the third person.

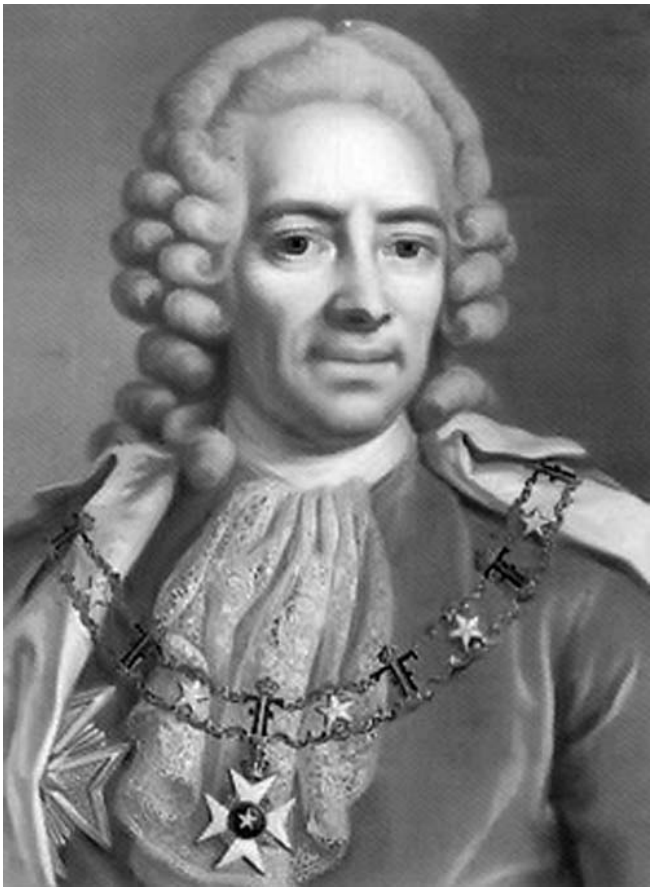
God has been with him [i.e., Linnaeus], wherever he has gone, and has eradicated all his enemies for him and made him a great name, as great as those of the greatest men on earth… Nobody has been a greater botanist or zoologist. No one has written more books, more correctly, more methodically, from personal experience. No one has more completely changed a whole science and started a new epoch.

In Linnaeus's defense, in classical literature there are a number of examples of writing an autobiography in the third person. Caesar's Wars is a very obvious example, written in the third person by Julius Caesar, e.g., "Caesar did this, Caesar did that, The Helvitiae having been thrown into confusion Caesar advanced with his cohorts to the river…" etc. Pope Pius II (1405-1464) wrote his account of his life in the third person too, in imitation of these classical exemplars. Third person autobiographies can be useful even in this day and age. For example, I wouldn't consider writing a resume today in anything but the third person.

ADDENDUM: A BROKEN FRIENDSHIP

Linnaeus and Browall ultimately had a falling out. In 1732, Linnaeus paid a visit to Claes Sohlberg (1711-1773, his friend and fellow student, in Falun, the capital of the copper-mining region of Dalarna, in central Sweden. At the time, it was necessary for Swedish medical students to complete their doctoral degrees abroad in order to open a successful medical practice in their homeland. In an agreement with Sohlberg's father, who was the royal inspector of the Falun copper mine and impressed with Linnaeus's botanical and mineralogical abilities, Linnaeus received an annual stipend to offset medical school expenses in the Netherlands. In return, Linnaeus promised to take young Sohlberg with him on the trip and serve as his academic mentor. Linnaeus, of course, accepted the offer. While in Farun, Linnaeus was introduced to Baron Nils Esbjörnsson von Reuterholm, governor of the province, who was fond of natural history. There he became fast friends with Johan Browall, the tutor of the baron's children

In James Smith's *A Selection of the Correspondence of Linnaeus, and other Naturalists, from the Original Manuscripts*, London, 1821, we have the following letter in September 1739 from Linnaeus to Haller:



Baron Nils Esbjörnsson von Reuterholm (1676-1758).
Browall tutored Reuterholm's children in Farun and it was there that Linnaeus met Browall.

In the year 1730 I taught botany in the garden at Upsal (i.e., the old name for Uppsala). Our common friend Dr. Rosen returned thither the same year. I, then a student of medicine, was Professor Rudbeck's deputy in botany, as Rosen was in anatomy, he being likewise the adjunctus, or coadjutor, in medicine. In 1732 I went to Lapland, and returned; after which I read lectures on botany and metallurgy for a whole year. I then quitted Upsal, and, as Providence ordained, went into Dalecarlia. Having accomplished my journey, I returned to Fahlun, the principal town of that province. Here I lectured on mineralogy, and followed the practice of physick. I stayed a month at Fahlun, where I was received with universal kindness.

A physician named Moraeus resided there, who was esteemed rich by the common people. Indeed he was one of the richest persons in that very poor country. With regard to learning, he might undoubtedly claim the first rank among the medical men of Sweden. I have heard him say, a thousand times, that there was no line of life less eligible than the practice of physick. Nevertheless, he was much attached to me. I found myself frequently a welcome visitor under his roof. He had a handsome daughter, besides a younger one, the former of whom was courted, but in vain, by a gentleman of rank and title. I was struck when I first saw her, and felt my heart assailed by new sensations and anxieties. I loved her, and she at length, won by my attentions, listened to my proposals and returned my passion. I became an accepted lover. I addressed myself to her father, avowing, not without much confusion, my total want of fortune. He was favorable on some accounts, but had many objections. He approved of me, but not of my circumstances; and desired that things might remain as they were for three years, after which he would tell me his determination.

A young Linnaeus. He in the traditional dress of the Sami people of Lapland, holding the twinflower, later known as *Linnaea borealis*, that became his personal emblem.

Having arranged my affairs, and made the necessary preparations for a journey, I quitted my native country with 36 gold ducats in my pocket (Linnaeus left in 1735**). I immediately took my medical degree (at Hardewick in Holland), but was not in circumstances to return home with much comfort. I remained, as you know, in Holland. In the meantime my most intimate friend B ... regularly forwarded the letters of my mistress by the post. She continued faithful. In the course of last year, 1738, which I passed at Dr. Van Royen's, with the approbation of the young lady, though it was the fourth year of my absence, and her father had required but three, B…thought he had himself made considerable progress in her favor. By my recommendation he was made a Professor; and he took upon him to persuade my betrothed that I should never return to my own country. He courted her assiduously, and was very near obtaining her, had it not been for another friend, who laid open his treachery. He has since paid dearly for his conduct, by innumerable misfortunes.**

The "B" was, of course, Browall. The recommendation Linnaeus mentioned was for the position of Professor of Physics at the Academy in Turku, Finland, a position Browall held from 1737 to 1746.

When Linnaeus returned to Falun after a four year's absence he was, as we have seen, in pitiful circumstances due to Siegesbeck's attack. A year later, however, things improved, as Linnaeus relates in his letter to Haller:

Soon afterwards I was appointed first physician to the navy. The magistracy immediately conferred upon me the regius professorship, that I might teach botany in the seat of government at Stockholm, with the addition of an annual stipend. Then my fondness for plants revived. I was also enabled to present myself to the bride to whom I had been for five years engaged, and was honorably received as her husband. My father-in-law, rather fond of his money, proved not very liberal to his son-in-law; but I can do without it, and those who come after me will enjoy it.

After a five-year engagement, Linnaeus and Sara Lisa were finally married in 1739.

The following is an interesting attempt that appeared in many accounts of the life of Linnaeus to weave together a story of three *Browallius* species that purported to explain the chronology of events of the break between Browall and Linnaeus. The entry under *Browallia grandiflora* in *Curtis's Botanical Magazine* of 1831, for example, reports:

The intimacy and subsequent rupture between Browall and Linnaeus were commemorated by the latter in the specific appellations which he bestowed on the only three individuals of the genus then known. *Browallia elata* expresses the degree of their union; *Browallia demissa* its cessation; while the ambiguous name of a third species, *Browallia alienata*, while it intimates the uncertain characteristics of the plant, implies the subsequent difference between the two parties.

This story was repeated in similar form many times over the years. However, Linnaeus first described *Browellia* before the rift in his *Hortus Cliffortianus* in 1737, but he described it without designating any species. The only time all three species appeared was in the 10th edition of *Systema Naturae* of 1759. This was after the original rift and after Browall became a bishop. However, these three species can be viewed in an entirely different way.

"*Demissa*" also means low and the plant is low-growing. Linnaeus observed that *alienata* differed slightly from the original outline of the genus (it actually is another plant, *Ruellia paniculata*) and in Latin *alienata* can also be translated as "strange." Finally, "*elata*" is also Latin for "arrogant," thus describing Browall's behavior after he was made a bishop. It is doubtful that Linnaeus would have played this kind of three-species name game, especially when two of their Latin translations are not necessarily pejorative at all. This, however, is not the whole story about *Browallia elata.*

Sara Elisabeth Linné (1716-1806), painted in 1739.

Anders Celsius (1701-1744).

A MATTER OF WATER LEVELS

To maintain in the seventeenth century that the sea had had any role in shaping the contours of the earth, other than through the catastrophe of the Flood, was to enter dangerous theological waters. Coastal erosion was explained as a phenomenon of decay: the sea was seen as the maleficent and unpredictable agent of such destruction of God's creation. In 1743, by inviting hunters in northern Sweden to inform him about the elevation of stones used as resting-places by seals, Anders Celsius calculated that there had been a drop in the water-level of more than a meter every hundred years. He also had marks engraved on the rocks recording the water level, for future research.

Celsius' result caused a considerable scientific interest. Support for the water decrease came from two of his compatriots, Linnaeus in 1745 and the physicist and medical officer Nils Gissler in 1747. On the island of Gotland in the Baltic Sea, Linnaeus had come across a sequence of ridges, all parallel to the coast, which he interpreted as old shore-lines having successively lost contact with the sea because of the water decrease. Further north Gissler studied similar sequences of shorelines, supposing, quite correctly, that they might be formed by severe storms occurring with intervals of many decades. They agreed reasonably with Celsius' value of the rate of the water decrease.

Linnaeus added to Celsius's conclusions as a kind of supplement, the following:

The Lord did not create many individuals nor were they scattered over the whole world - to what end the creation of many when the same object may be attained by means of one pair or even one individual? Year by year the sea recedes, and the outlines of the mainland are correspondingly extended. Originally the mainland was only a little inland containing everything which the Creator had appointed for the use of the human race. This island, that is to say Paradise, we may imagine as a lofty mountain under the equator; over the slopes, from foot to snow-covered summit, every species of plant found the climate suited to it. As the mainland increased in size the seeds of these plants, often of peculiar and specially adapted structure, were distributed by winds, rivers, and birds.

The conclusions of Linnaeus were on all sides favorably received, owing to their conformity with biblical tradition, whereas those of Celsius, although the outcome of the same general view, culled forth the most violent opposition, particularly his reference to the approaching destruction of all living things. Affairs reached such a point, that when the historiographer, Olof Dalin, attempted to reconstruct the earliest shape of Sweden according to Celsian principles and concluded that the country had consisted of scattered islands until shortly before Christ when the water began to withdraw, he was accused in the Swedish parliament of offending the dignity of the realm and expressed its disapproval of his theory by a special decree.

Among those who attacked the theorists of the diminution of the waters was Bishop Browallius who tried to explain Celsius' observations as what we today call systematic and random errors (thereby also defending the biblical view of the history of the Earth). Since Celsius was a friend of Linnaeus and because the latter as I have pointed out had promised his teacher, Hermann Boerhaave, never to partake in any scientific quarrels, Linnaeus was reduced to expressing his opprobrium by naming a species of *Browallia* as *elata*, thus poking fun of the Bishop on three counts; his attempt to win over Sara Lisa in 1738, his attack on his friend Anders Celsius and the bishop's propensity for pomp and pageantry. At this apparent reference to his own exalted bearing, Browall became furious and vented his anger in vindictive pamphlets against his former friend. It is the greatest of ironies to observe that only a decade earlier, Browall was defending Linnaeus against theological attacks and now Browall was attacking Linnaeus on the same grounds.

Olof von Dalin (1708-1763). Espousing Celsius's theory, Dalin was accused in the Swedish parliament of offending the dignity of the realm and the parliament expressed its disapproval of his theory by a special decree.

HOT AND COLD HAS ITS UPS AND DOWNS

Finally, a bit of trivia. Celsius used the boiling and freezing points of water to obtain his temperature scale. Celsius' own instrument with its linear scale was of glass and designed for more experimental purposes starting with 0° at the boiling-point and 100° at the freezing-point, thus creating a reversed scale with increasing numbers for decreasing temperatures and avoiding negative numbers. Linnaeus however, had the original Celsius scale turned so that 0 was marked for the freezing-point and 100 for the boiling-point of water for his instrument. By that, Linnaeus got a thermometer better suited for biological conditions. Plants are at risk to die at 0° C. The Celsius-scale, altered in this way, gives the reading below zero for minus-degrees and above zero for plus-degrees. But it also gives a much wider use, as one can even measure extreme temperatures as, e.g., the melting point of iron (+1535°C). With Celsius' original thermometer-scale this would have been quite difficult. Linnaeus realized that it would be more useful if these values were reversed and persuaded the rest of the scientific world to follow his example.

A thermometer made for Linnaeus at the end of the 1770's in the workshop of the Royal Swedish Academy of Sciences by Johan Gustav Hasselström .

Robert Warington—A Biography

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, October 4, 2015)

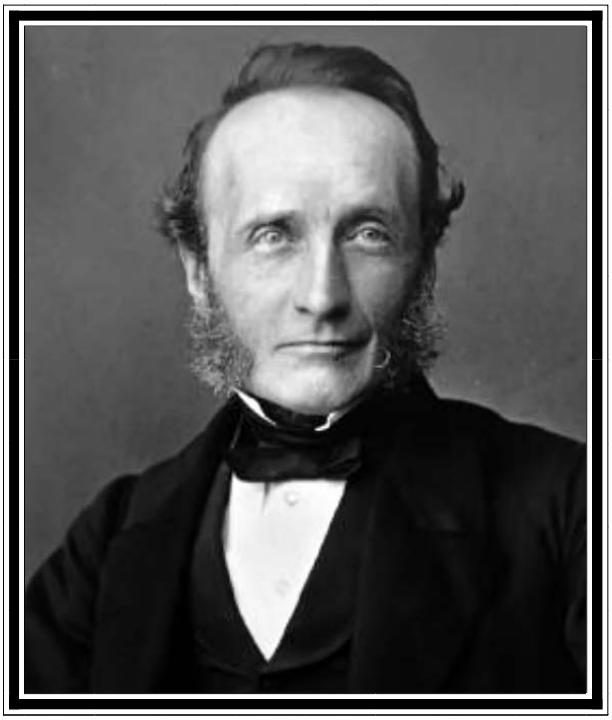
THE EARLY YEARS

Robert Warington was born in 1807 at Sheerness, a town located on the north-west corner of the Isle of Sheppey in north Kent, England. He was the son of Thomas Warington, a victualler, a person providing or selling food or other provisions, of ships. After an early childhood spent in Portsmouth, Boulogne and other places, in 1818 he entered Merchant Taylors' school (one of the most prestigious boys' schools in England; Edmund Spenser as well as Boris Karloff were educated here!). The school at that time was located in Suffolk House in London, and although it was intended he would be a land surveyor, within a few months of leaving in 1821 he became the house pupil to John Thomas Cooper to study chemistry, Cooper being both a drug manufacturer of potassium, sodium, iodine and other then rare chemical substances, and a lecturer in chemistry in a number of medical educational establishments.

With the opening of the London University (later University College) in 1828 and by now having gained his articles, Warington took up the post of assistant to Professor Edward Turner (1796-1837), a chemist known for his work on atomic weights, a popularizer of the atomic theory of Dalton and the author of a popular chemistry textbook that was the first to incorporate chemical symbols and formulae as well as organic chemistry. Holding the Chair of Chemistry at the newly opened university, Turner appointed Warington to take charge of the practical chemistry classes, which he continued for the three years of his tenure. In 1831 he published his first research - on a native sulfide of bismuth. In the same year, on Turner's recommendation, he was appointed chemist to Messrs. Truman, Hanbury & Buxton, the brewers, with whom he remained until midsummer 1839.

A FORTUITOUS MARRIAGE

In 1836 in Spitalfields, an area of London, he married Elizabeth Jackson, the daughter of surgeon George Jackson F.R.S. (1792-1860), a keen microscopist of repute. It was around this time that Warington joined the Mathematical Society of Spitalfields, which he attempted to regenerate by organizing a number of lectures at their meeting place in Crispin Street, but with little success. It was here that he was introduced to his father-in-law's close associate, James Scott Bowerbank. Bowerbank had created what appears to have been the first ordinary-sized aquarium, complete with a piece of glass on top to make it closely glazed. It was this jar of Bowerbank's that attracted the attention of the Secretary of the Zoological Society, David Mitchell, and gave him the idea for the public aquarium that was opened in 1853 in the Zoological Gardens in Regent's Park.



Robert Warington (1807-1867).

By the midsummer of 1839, having sufficient funds to support his family, Warington was able to leave Truman's brewery to concentrate his attention on other interests. By associating with the friends of his father-in-law, Warington was able to join them in supporting Edwin J.Quekett, an early worker in botany and histology, and a microscopist, to eventually form the Microscopical Society of London. Warington's experience and close connection with Jackson were enough to ensure that at the inaugural meeting of the Society, both would be offered seats on its Council.

A FOUNDER OF THE ROYAL SOCIETY OF CHEMISTRY

In 1839 Warington, occupying then no official position and having the necessary leisure, started a movement to found the Chemical Society of London (from 1848 on the Royal Society of Chemistry), the first meeting being convened by him at the Royal Society of Arts on February 23, 1841. The account of the first meeting stands thus in the first minute book of the Society:

1841, Feb. 23rd, Society of Arts, John Street, Adelphi. A meeting of gentlemen, convened by Robert Warington, was held in the rooms of this Society for the purpose of taking into consideration the formation of a Chemical Society. Present: A. Aikin, Esq., Dr. Thos. Clark, [W.] J. Cock, Esq., J. T. Cooper, Esq., D. Cooper. Esq., Thos., Everitt, Esq., Win, Ferguson, Esq., J. P. Gassiott, Esq., Professor T. Graham, W. R. Grove, Esq., Henry Hennell, Esq., T. U. Henry, Esq., C. Heisch, Esq., G. Lowe, Esq., [W. H.] Miller, Esq., Apsley Pellatt, Esq., Richard Phillips, Esq., Dr. Lyon Playfair, Robert Porrett, Esq., Dr. G. O. Rees, E. Solly, Esq., J. Tennant, Esq., E. K. Teschenacher, Esq., Dr. R. D. Thomson, Robert Warington, Esq.

Mr. R. Phillips moved that Professor Graham do take the chair.

On the motion of Mr. J. T. Cooper, Robert Warington was requested to act as Hon. Secretary pro tem.

It was then put from the chair, and carried unanimously - that it is expedient that a Chemical Society be formed.

Moved by Dr. Thos. Clark, and seconded by Dr. R. D. Thomson - That the following gentlemen constitute a Provisional Committee for carrying this resolution into effect: Messrs. A. Aikin, W. T. Brande, H. J. Brooke, J. T. Cooper, J. Gumming, J. F. Daniell, Thos. Everitt, Thos. Graham, W. R. Grove, H. Hennell, G. Lowe, R. Phillips, R. Porrett, R. Warington.

Proposed by Robt. Warington, and duly seconded - that the thanks of the meeting he given to the Society of Arts for the very liberal and handsome manner in which they had allowed Mr. Warington the use of their rooms for the purposes of the meeting.

The thanks of the meeting were moved by [Mr.] J. P. Gassiott to Professor Graham for his kindness in taking the chair.

It is important to note that William Thomas Brande (1788-1866) was a founding member.

Brande deserves the honor for the first elucidation - in his 1819 Manual of Chemistry - of the principle of the balanced aquarium, and Warington for reintroducing it to a much wider audience. Warington later said that it was Brande's book that had incited him to set up his experimental tank with goldfish and *Vallisneria.*

The formal foundation took place on March 30, 1841. Warington was elected honorary secretary, and retained the post till March 1851. In acknowledgment of his services he was presented with a service of plate by the fellows of the society in December 1851.

THE SOCIETY OF APOTHECARIES

Henry Hennel was the chemical operator at Apothecaries' Hall. The Society of Apothecaries was both a City livery company and an examining authority for the medical profession. Founded in 1617 by the royal apothecary Gideon de Laune leading a breakaway group from the Grocers' Company, the Society was instrumental in raising the status of apothecaries as general practitioners. A year after the formation of the Chemical Society of London, Hennel was killed in an explosion. The following is from *Notes & Queries, A Medium of Intercommunication for Literary Men, General Readers, Etc.*, June 7, 1842:

Henry Hennell, 1842: Henry Hennel, F.R.S., the talented and much respected chemical operator at Apothecaries' Hall, had been literally blown to pieces that morning by an explosion of fulminating mercury. He was mixing in a china bowl several portions of the powder, so as to render the whole, which was required for a large military order, of a uniform colour, when the contents of the basin exploded, and he was instantly killed. At the inquest, which was held on the 6th of June, it was stated that all the upper part of Mr. Hennell's body was shattered, and the fragments cast to a distance. One arm was found on the roof of the Apothecaries' Hall, and a finger was picked up in Union Street, more than a hundred yards distant.

It has recently come to my knowledge that in the year 1859, that is, seventeen years after this sad accident, when some repairs were made to the roof of No. 3, Crescent, Block friars - which was then in the occupation of the Engle Insurance Company, and was shortly afterwards swept away to make room for the London, Chatham, and Dover Railway - there was found in one of the leaden gutters a human arm, or rather the bones of one, which had evidently been there many years. From the few facts which I have been able to gather, I think it very probable that these bones were part of the remains of the lamented Mr. Hennell; and if this were so, we have a yet further evidence of the terrific force of the explosion which killed him, as the place where the bones were found was about 130 yards distant from, and nearly forty feet above the level of, the site of the explosion. *Edward Solly.*

In the 1840s it appeared that written accounts were not quite as squeamish as they are today! On the death of Hennell, Warington was appointed chemical operator to the Society of Apothecaries, a position which he held to within a year of his death and where he was responsible for dispensing operations, managing at the same time to do some research on organic chemistry.

CHEMISTRY UNDER THE AEGIS OF PHARMICISTS?

Warington had been disillusioned with the state of chemistry at the time. Improving chemistry professionally, by bringing science and practice into closer communication, was certainly one of his aims in promoting the establishment of the Chemical Society in 1841. Warington, however, viewed the rising professional aspirations of chemists and druggists as likely to subsume the practice of chemistry under pharmacy. Disapproving of the training then available, Warington undertook the education of his sons himself, introducing them to the laboratory at a very early age. It may also have been in deference to his views that the Chemical Society's original plans included the establishment of a research laboratory. Warington even advised the young Frederick Augustus Abel, subsequently one of the Royal College of Chemistry's most illustrious alumni (one of the most important of his investigations had to do with the manufacture of guncotton, and he developed a process, consisting essentially of reducing the nitrated cotton to fine pulp, which enabled it to be safely manufactured and at the same time yielded the product in a form that increased its usefulness; this work to an important extent prepared the way for the "smokeless powders" which came into general use towards the end of the 19th century), not to study chemistry because the professional prospects were so poor.

WARINGTON'S CAREER MARCHES ON

In 1846 he took part in the formation of the Cavendish Society - a chemical printing society named after Henry Cavendish, the outstanding British scientist after Newton - of which he was secretary for three years - and from this time onwards he had many engagements as a chemical expert in legal cases.

In the year 1844 he began a series of investigations into the adulteration of tea and gave evidence at the parliamentary inquiry on adulteration in 1855. In 1851 he revised the Translation of the Pharmacopœia of the Royal College of Physicians into English, left unfinished by Richard Phillips; he was also engaged in the construction of the British Pharmacopœia in 1864, and was joint editor of the second edition in 1867. In 1854 Warington was appointed chemical referee by four of the metropolitan gas companies, and held this post for seven years. In 1864 he was elected a fellow of the Royal Society. The Royal Society's catalogue contains a list of forty-seven papers written by Warington alone, and one written in conjunction with William Francis.

WARINGTON AND THE AQUARIUM

In 1849 he began his investigation on aquaria and the means necessary to prevent the water therein from becoming stagnant. He wrote several papers, and in 1857 delivered a lecture at the Royal Institution on this subject, his work being the origin of our modern aquaria. In my 2012 essay "Who Invented the Aquarium?" I have provided

the details of Warington's work and will not repeat this information here.

Some have asserted (correctly) that Warington was not a biologist, but he definitely knew enough about aquarium biology to afford him some distinction in this area. The following two articles are examples. The first is from the *Annals and Magazine of Natural History*, Vol. XVI, Second Series, pp. 313-315, Taylor and Francis, London, 1885:

XXVII -On the Injurious Effects of an excess or want of Heat and Light on the Aquarium. By Robert Warington, Esq.

Temperature is a point requiring great attention in carrying out successfully the principles of a permanent aquarium. The mean temperature of the ocean is estimated to be about 56° Fahr., and this, under ordinary circumstances, does not vary more than about 12° throughout the different seasons of the year. The causes of this equilibrium will be readily understood when we take into consideration the effects that must be produced by the continued flux and reflux of the tides, and by the enormous streams of water which must be flowing from the Arctic regions from year's end to year's end in one constant current, and which, by their movement, must necessarily cause other currents to flow in and take their place, thus forcing, as it were, the heated surface-water of the tropical seas towards the colder regions of the globe. Again, the whole surface of the earth, submersed below the ocean, is protected by this fluid coating from the effects of the cooling influences of radiation on the one hand, and from contact with the currents of the atmosphere on the other; and hence we perceive an always existent cause for the maintenance of a steady, equable temperature by the waters of the ocean throughout the year.

Many of the inhabitants of the sea are very sensitive to changes of temperature, and we find that a few degrees of variation will cause them rapidly to move their position and seek some cooler or warmer spot as the case may be. In the ocean it will be evident that the creatures have the power readily to effect this under ordinary circumstances, by seeking deeper water not liable to be affected by atmospheric influences, by partially or entirely burying themselves in the sand or shingle, or by shielding their bodies under the protecting shadow of the rocks or growing vegetation. In arranging the rock-work in the interior of the aquarium, therefore, great care should be taken to keep these points in view, and to afford as much protection as possible to the creatures from the cooling influences of radiation on the one hand, and from the heat of the sun's rays on the other.

From my own experience I find that the range of temperature should not be below 50° Fahr., nor above 70°; within these limits all appears to progress healthily, but beyond these points many of the creatures are rapid-

ly affected. During the last long-continued and severe winter, it was found very difficult, in an ordinary sitting-room having a south aspect and a good fire maintained throughout the day—the tanks being also screened at night by a blind,—to prevent the powerful cooling effects from radiation on a clear frosty night; and on three several occasions, marking exactly the three severest frosts that we experienced during the winter, the thermometer, immersed in an aquarium containing about thirty gallons of water, fell as low as 45° Fahr. The Shrimp and Crab tribes, and the Crustaceans generally, are especially affected by these changes, and on each of the three occasions alluded to, one or two individuals perished; the larger-sized Prawns, as *Palaemon serratus*, appeared to suffer more readily than the *P. squilla*, although this might arise from the smaller ones being able to find a shelter from the radiation by concealing themselves more completely among the rock-work or vegetation. *Anthea cersus* is also very sensitive to considerable variations of temperature, falling from its foot-hold to the bottom of the tank apparently dead.

Excess of heat and also strong sunlight are likewise to be as carefully guarded against, and I may state as an evidence of this, that on a particularly hot day during the summer of 1854, being absent from home, the servant omitted to screen a small case from the sun's rays during the hottest period of the day, and on my return I found every creature dead. It contained an *Anthea cereus, Actinia dianthus*, two specimens of *Athanas nitescens*, and several others.

Too much light has also the effect of rapidly propagating several of the minute animalcules of a green colour, as the *Euglena* and its congeners, which under this influence multiply so rapidly as to render the whole water of a grass-green hue; this will at times subside to the lower part of the tank as evening approaches and disappear in the shingle bottom, but immediately the morning light shines strong upon the aquarium . it will rise like a thin green cloud and diffuse itself throughout the whole of the water. Although this animalcular growth is not unhealthy, yet it causes the aquarium to present a very unsightly appearance, and prevents all observation on the habits •of the inmates. The want of light, I need hardly observe, causes the rapid decay of the vegetation, and the products arising from this change are highly poisonous to animal life, the whole contents of the aquarium becoming of a black colour, and very soon of an offensive odour.
Apothecaries' Hall, Sept. 11, 1855.

The second is from the *Annals and Magazine of Natural History*, Vol. XVI, Second Series, pp. 330 -332, Taylor and Francis, London, 1885:

XXXI.— Observations on the Habits of the Stickleback (being a continuation of a previous paper). By Robert Warington, Esq.

During the early part of the last summer I had the good fortune to observe the whole progress of the various stages in the breeding of the Three-spined Stickleback, *Gasterosteus leiurus*, which will therefore enable me to complete the notice already published on this subject in the 'Annals and Magazine of Natural History' for October 1852.

In the account there given, the observations extended |to the completion of the nest by the male fish, and it is my intention in the present communication to carry on the details of the progress from that point, premising that the water was the same which had been employed for the original experiments of 1849, and that the fish contained in the aquarium consisted of three Stickleback, one male and two females, two Tench, and a Goldfish.

The position selected by the male fish for the construction of the nest was between two plants of *Vallisneria spiralis*, at the point where the leaves spring from the root, and directly in front of a fragment of limestone which rose behind the plants and acted as a protecting background to the position. The nest being all prepared, exactly as before described, although by another individual, the eggs were deposited, I presume, during the night of May 8th: this was judged of, not from observance of the act of spawning, but from the altered appearance of the female fish evidencing that she had shed her spawn, from the immediate change made by the male fish in the arrangement of the materials forming the nest, and, likewise, the violent repulsion of the female from the neighbourhood of its position, to which previously he had been as assiduous in driving her.

From this period the nest was opened more to the action of the water, and the vibratory motion of the body of the male fish while hovering over its surface, caused, as before described, a current of water to be propelled across the surface of the ova; this action was repeated almost continuously. The apparent luminosity of the body, if I may so term it, also decreased, and in this state all continued without change until the 18th of May, making a period of ten days. After this date the whole nest was destroyed, and the materials of which it had been composed thrown aside, with the exception of a few wiry stems of a decayed water moss, and a space cleared around the spot of about 3 inches in diameter; the mud or sand at the bottom being carefully removed with its mouth and carried in this manner to some distance, leaving the rounded stones of the gravel clean and free from any obstruction around them.

Watching carefully for a short time, to understand what all this busy alteration indicated, I at last had the pleasure of observing, by the aid of a long-focused pocket-lens, some of the young fry,—of course most minute creatures, fluttering upwards here and there, by a movement half swimming, half leaping, and then falling rapidly again upon or between

the clean pebbles of the shingle bottom. This arose from their having the remainder of the yolk still attached to their body, which, acting as a weight, caused them to sink the moment the swimming effort had ceased.

Around all this space above mentioned, and across it in every direction, the male fish, as the guardian, continually moved. And now his labours became still more arduous than they had been before, and his vigilance was taxed to the utmost extreme, for the other fish, three of them some twenty times larger than himself, as soon as they perceived that the young fry were in motion, used their utmost endeavours, continuously, to pounce upon the nest and snap them up. The courage of this little creature was certainly now put to its severest test, but nothing daunted he drove them all off, seizing their fins, and striking with all his strength at their heads and at their eyes most furiously. All the assistance that could possibly be afforded him was of course rendered, short of actual interference, by keeping them pretty well fed, in order to allay, if possible, their voracity. Another circumstance, which appeared to add greatly to the excitement that he was constantly subjected to, arose from the second female fish, being in spawn, endeavouring most pertinaciously to deposit her ova in the same locality, and hence rushing frequently down towards the spot; but the male fish was ever on the alert, and although he did not strike at her in the furious way he attacked the larger ones, yet, he kept continually under her, with the formidable back spines all raised erect, so that it was impossible for her to effect her apparent object.

The care of the young brood, while encumbered with the yolk, was very extraordinary, and as this was gradually absorbed and they gained strength, their attempts to swim carried them to a greater distance from the parent fish; his vigilance, however, seemed everywhere, and if they rose by the action of their fins above a certain height from the shingle bottom, or flitted beyond a certain distance from the nest, they were immediately seized in his mouth, brought back, and gently puffed or jetted into their place again. This was constantly occurring, the other fish being continually on the watch to devour these stragglers, and make a savoury morsel of these Lilliputian truants. Indeed, the greater number of the whole brood must have fallen a prey to their voracity, as it was only some three or four that reached a size to place them beyond the power of these destroyers.

As soon as the young fry could swim strongly the parent fish gradually relinquished his duties, although a constant watch appeared to be still quietly maintained on their motions as they swam about near the surface of the water and among the floating leaves of the *Vallisneria* and *Lemna*. It is a curious circumstance, that, very soon after these young Stickleback were left unmolested by their companions, both the parent fish disappeared, and I presume have died in some hid-

ing-place among the rock-work; as though, their allotted functions, namely the propagation of their species, having been completed, their period of existence must terminate.
Apothecaries' Hall, Sept. 11, 1855.

In his "The Aquavivarium, Fresh and Marine being an account of the principles and objects involved in domestic culture of water plants and animals," published in 1856, Edwin Lankester wrote:

If there has been no open controversy, there has been a good deal of latent feeling on the subject of the invention of collections of plants and animals in water.

Lankester might well have been referring to the disputes between Warington and Philip Henry Gosse that I mentioned in my 2012 essay, "Who Invented the Aquarium?" This, however, is a complicated and long story so I have added it as a complementary essay that follows this one, titled "The Warington-Gosse Aquarium Controversy Revisted."

Finally, the following is an excerpt from *Notices of the Proceedings at the Meetings of the Members of the Royal Institution of Great Britain*, Vol. II, pp. 403-408, 1857.

WEEKLY EVENING MEETING,
Friday, March 27.
THE DUKE OP NORTHUMBERLAND, K.G. F.R.S. President, in the Chair.
ROBERT WARINGTON, ESQ., On the Aquarium.
The speaker opened the evening's demonstration, by stating that he had immediately responded to the invitation of the Managers of the Royal Institution to deliver this discourse, on what they had been pleased to call his "own subject," from the feeling, that as the originator of the aquarium, he was in duty bound to afford, to all those who had taken up this "new pleasure," every assistance, from the results of his own experience, that lay in his power, in order to render the undertaking more easy and pleasurable; and for this purpose, he proposed to lay before his audience, as far as was practicable, a demonstration of the principles on which it was founded, particularly as very erroneous ideas had been promulgated on the subject, and instructions given in several most engaging publications, which might tend materially to mislead and disappoint those inclined to recreate themselves with this interesting subject.

With regard to the last part of this excerpt, when Warington was pressed to give to the world a little manual of instructions for amateurs, he always stated as a reason for non-compliance with the request, that the book market was overcrowded already with the worthless compilations of many scribblers on the subject. He was a really scientific man, and he did not wish to be associated with authors who wrote about things which they had never seen or done.

ADDENDUM: WARINGTON'S SON

Warington died at Budleigh Salterton, Devonshire in 1867. He left three children, of whom his eldest son - also named Robert (1838-1907) - was to outdo the fame of his father. As a boy he learned chemistry from his father and from the lectures of Faraday, Brande and Hofmann. When twenty years of age, he worked at Rothamsted, located at Harpenden in the English county of

Robert Warington Junior (1838-1907).

Hertfordshire. It is one of the oldest agricultural research institutions in the world, having been founded in 1843. Later he returned to London and went to the Royal Agricultural College in Cirencester - a market town 93 miles from London. It was here that he commenced lecturing on the Rothamsted experiments. Between 1843 and 1856, nine field experiments were started at Rothamsted Research to study the nutrient requirements of the principle arable crops and a hay meadow. These experiments have continued, with appropriate modifications, until today and are the oldest, continuous agronomic experiments in the world.

In Harpenden, where he remained until 1891, he published many memoirs on the nitrification of the soil. Leaving the Rothamsted laboratory, he lectured in America, and after his return home was an examiner in agriculture to the Science and Art Department and Sibthorpian professor of rural economy at Oxford, a post he held for three years. But he was most widely known and his name will be longest remembered for his admirable text books on agricultural chemistry, and most especially for that standard work, “Chemistry of the Farm,” which was translated into several foreign languages and reached its nineteenth edition while he was still alive.

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The WARINGTON-GOSSE CONTROVERSY REVISITED

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, May 21, 2016)

In *The Toy Fish* (Klee, 2003), I described the falling out between Robert Warington and Philip Gosse over a matter involving the preparation of artificial sea water. The material was based on William H. Brock's article, "The Warington-Gosse aquarium controversy: two unrecorded letters" (Brock 1991). However, I was never satisfied with Brock's description of the sequence of events that led up to the controversy nor was I with his views of who was at fault. Indeed, with regard to the latter, I disagreed so strongly that I did not include them in *The Toy Fish*, leaving this to my essay titled, "Who Invented the Aquarium?" (Klee, 2012), in which I went into the controversy in greater detail. Recently, however, I re-examined all the evidence and also gathered new information; this essay is intended to examine why and how they fell out, and who was at fault.

At first glance the controversy boiled down to the matter of which gentleman was to be believed, and in such matters opinion and/or emotions usually decide the outcome. However, Utilizing Ockham's Razor, I decided to take an entirely different tack. Both Warington and Gosse were honorable men, so could the controversy between them be explained by assuming that both were telling the truth? Once I did this, everything became clear.

GOSSE'S SEAWATER ARTICLE

In Gosse's article, "On keeping Marine Animals and Plants alive in unchanged Sea-water" (Gosse, 1852), in the following he refers to an article - no author was named - that appeared in *Chamber's Edinburgh Journal* (Anon., 1852):

In a recent Number of 'Chambers' Edinburgh Journal' (July 1852) a paper has just been pointed out to me, on maintaining the balance between animal and vegetable life in an aquarium. Mr. Warington, whose experiments are there alluded to, has succeeded in keeping living plants and animals together in fresh water, and announces that he is "attempting a similar arrangement with a confined portion of sea-water, employing some of the green sea-weeds as the vegetable members of the circle, and the common winkle or whelk to represent the Limneæ," which in the former case he had found useful in consuming the slime produced by the decay of the vegetable matter.

Priority of publication is universally acknowledged to give a title to whatever honour attaches to a new discovery, and this I shall not dispute with Mr. Warington.' I may be permitted to state, however, that I have for some considerable time been pursuing experiments on the same subject.

At another point he states:

The possibility of similar results being obtained with sea-water had suggested itself to my own mind, as it has to that of Mr. Waring-

ton; and the subject of growing the marine Algæ had become a favourite musing, though my residence in London precluded any opportunity of carrying out my project.

And lastly:

Mr. Warington's suggestion of employing the phytophagous Mollusca to get rid of the accumulating vegetable matter, had not occurred to me; it is ingenious, and might perhaps obviate this inconvenience.

I cite the second and third quotes to show that it must have disappointed Gosse to always come in last behind Warington. It was Warington who got the credit for the proof of principle for both the freshwater and marine aquarium, and it was Warington who got the credit for introducing the term "aquarium" as it pertains to the keeping of fish in containers. I cite the fourth quote to show that Gosse was an honorable man and gave credit where credit was due. But then, so was Warington. In 1819, William Thomas Brande first elucidated the principle of the balanced aquarium, and then some 31 years later, Warington demonstrated the principle and, in the process, popularized it. Warington later said that it was Brande's statement that had incited him to set up his experimental tank with goldfish and *Vallisneria.*

Before leaving Gosse's 1852 article, I should mention Brock's interpretation of its significance on Warington. In his paper Brock writes:

As Warington's surviving jottings demonstrate, he became obsessed with the demonstration of his own priority. Gosse's claim in July 1854 to have "invented" an artificial seawater at a time when the newly-published The Aquarium was receiving adulatory reviews, only seemed to confirm what Thompson had suggested the year before.

As we shall see shortly, Gosse claimed no such thing, but for now it is necessary to explain the reference to Thompson. The first of the two unrecorded letters in the title of Brock's article was from Gosse to Warington (October 1, 1852), in which he stated,

Far as be any thoughts of jealousy on the subject of common interest; I rejoice to see that your success has far exceeded mine, as you have kept sea-water pure for six months.

In the remainder of the letter Gosse offers to provide the red algae of several species, as well as many species of zoophytes. It is clear that at this time, Gosse and Warington were on very friendly terms.

The other letter was from William Thompson (1822-1879), a Weymouth naturalist who carried out what many consider the first recorded attempt to use a photographic camera underwater. Although a friend of Philip Gosse, he wrote to Warington on May 9, 1853 informing him that, in his view, Gosse's work was unoriginal and that Warington was undoubtedly the real creator of the marine vivarium, i.e., the term used at that time for the saltwater aquarium:

I need not apologise for sending this as I consider you the first projector and originator of the Marine Vivarium. After reading the Chemistry of Creation by Robert Ellis 1850 in reference to the Chemistry of the Oceans and your papers in the *Gardeners Chronicle, Chambers Journal* and the *Annals*, I hesitate very much as to the propriety of according to Mr. Gosse any honour for the originality of his paper in the *Annals* for October 1852.

In short, Thompson praised Warington's work and derogated Gosse's. For some reason, Brock chose this to mean that Gosse's article would increase Warington's resentment of him. However, this was directly opposite to what Warington really thought. The following is from Warington's tour de force paper on the marine aquarium, "On Preserving the Balance Between the Animal and Vegetable Organisms in Sea-water" (Warington, 1853):

For a considerable period, after commencing these experiments, I was much troubled to obtain living subjects in a healthy condition, but having alluded to this, and the success of my investigations, in a short notice appended to a paper published in the '*Annals of Natural History*' for October 1852, my friend Mr. P. H. Gosse, who was then sojourning at Ilfracombe for his health, offered in the kindest manner possible to supply me with materials, and from that period he **has always most heartily responded to my wants.**

How Block could have missed this is puzzling, since the reference in listed in his bibliography.

GOSSE'S ARTIFICAL SEAWATER ARTICLE

Sometime during 1854 Gosse became interested in artificial seawater and to this end, familiarized himself with Edward Schweitzer's paper, "Analysis of Seawater as it exists in the English Channel near Brighton" (Schweitzer, 1839). In April of 1854 he conducted experiments using a modification of Schweitzer's formula, using both marine plants and animals (anemones and snails, but not fishes) as test animals. After six weeks they had survived and he wrote a paper about his research titled, "On Manufactured Sea-water for

the Aquarium." The paper was submitted to the *Annals* on June 9, 1854. In it he did not state that he had "invented" an artificial seawater. The credit was given to Schweitzer although August Laurent's analysis of the seawater of the Mediterranean was mentioned as well.

Gosse visited Warington in 1854 on two occasions at Apothecaries Hall, on January 16th and again on January 21st. Among other things, the feasibility of using artificial seawater was discussed. *Gosse, however, did not tell Warington that he already knew about Edward Schweitzer's analysis of the water of the English Channel taken off Brighton.* He did, however, learn that Warington had experimented with artificial seawater the previous year. Perhaps he feared that Warington would write a paper and get it published first, or perhaps he was just interested in what Warington thought about the matter, but whatever the reason, it turned out to be a monumental mistake, compounded by what Gosse said in his article that was published later in the July 1854 issue of the *Annals*. The following is an excerpt (Gosse,1854):

Several scientific friends to whom I mentioned my thoughts, expressed their doubts of the possi-bility of the manufacture; and one or two went so far as to say that it had been tried, but that it had been found not to answer; that though it looked like sea-water, tasted, smelt, like the right thing, yet it would not support animal life. Still, I could not help saying, with the lawyers, " If not, why not ?" - *Experientia docet*. I determined to try the matter for myself.

This was probably the most colossal blunder in the history of the aquarium hobby, since Warington was one of his "scientific friends" and he recalled Gosse discussing the matter with him in face-to-face meetings six months earlier. Warington responded in the *Annals* in December (Warington, 1854):

In the 'Annals and Magazine of Natural History' for July last, you published a short communication from Mr. Gosse, on the artificial formation of sea water, and having lately had my attention especially directed to this paper by a friend who wished to put the formula given into practice, I was surprised at the difference in the proportions of the ingredients as compared with what I had myself employed in the course of 1853, more particularly from the circumstance, that when Mr. Gosse called upon me in January last, and consulted me on the feasibility of the plan, I told him that there could be no difficulty in the matter, as I had made and had then in use several small quan-tities artificially produced, and that all that was required was that a good analysis should be taken as the basis for deducing the proportions, and at the same time referred him to the source from which I myself had worked, namely Dr. E. Schweitzer's analysis of the water of the English Channel taken off Brighton.

Warington then began the process of correcting Gosse's errors. Block, by the way, referred to Warington's comments as a "bitter note," clearly showing his bias against Warington since, as readers can see, Warington's reply was reasonable, gentlemanly and temperate. In fact, the strongest language he used was, "I was surprised." In any event, the editor speeded matters up and Gosse responded in the January 1855 issue of the *Annals* (Gosse, 1855):

If Mr. Warington supposes that I obtained from him one atom of information previously unknown to me, on the subject of making sea -water from its constituent salts, he is most thoroughly mistaken. He is no less wrong in saying that I "consulted" him; since I merely mentioned what was on my mind in familiar conversation.

I believe that Gosse knew about Schweitzer's seawater formulation and perhaps even had an idea about writing an article about it before he and Warington met in January of 1854. *However, a damning question is, if Gosse had previously known this information, why didn't he stop Warington and tell him so?* Not doing so could be considered as unethical behavior; certainly it is something one does not do to a friend. The result was that after Warington mentioned his meeting with Gosse in January and provided the correct details for the formula for seawater, Warington was the one more frequently believed. The following is from *The Leisure Hour* (Anon., 1855):

It is now some months ago that Mr. Gosse, the gentleman on whom the care of the marine vivarium belonging to the Zoological Society devolves, and to whom the public are indebted for some most interesting works on natural philosophy, pub-lished a formula for the generation of sea-water artificially, and having supplied some marine pets with the liquid, found that they thrived in it well. The analysis of sea-water chosen by Mr. Gosse was that made by Dr. Schweitzer, the formula of which it appears was suggested to that gentleman by Mr. Warington of Apothecaries Hall.

The article then goes on to present Warington's correct formula and also his recommendation to obtain the dried extract of seawater and regenerate it by the addition of water. A source for the extract was also provided in this article.

ADDITIONAL ARGUMENTS BY BROCK

Brock presented the following three points in his attempt to show that it Warington who was at fault:

It was Gosse, whose livelihood depended upon literary, activities, who had the time and the literary ability to write the best-selling A Naturalist's Rambles on the Devonshire Coast (1853) and The Aquarium (1854a); it was Gosse, not Warington, whom D. W. Mitchell contracted to supply the Zoological Gardens with an aquarium in 1853; and it was Gosse, not Warington, whose work formed the focus of Charles Kingsley's *Glaucus* in 1855.

With regard to Gosse's literary ability to write best -sellers, Warington was never in competition with Gosse. As Brock himself points out, Warington was a busy chemist with heavy day-to-day responsibilities for the standardization and prevention of adulteration of drugs; his aquarium research was only a leisure time activity.

With regard to the Zoological Gardens at Regent's Park, the aquariums - based upon Warington's new concept of the aquarium (Anon., 1852A) - were ordered from Sanders & Woolcott by David W. Mitchell, Secretary of the Zoological Society of London. Warington was associated with the freshwater exhibits and Gosse with the marine tanks. The freshwater tanks were a success but because of the design of the marine system, the seawater had to be replenished often and at appreciable expense.

Unfortunately, Gosse ceased his association with the Zoological Gardens somewhat under a cloud. Gosse's main contribution to the aquarium at the zoo was to provide marine plants and animals, including fish, for which he was to be paid. When he submitted his bill, Mitchell presented it to the Society's Council who directed him to try and persuade Gosse to reduce it. Gosse, replied, however, that if he wasn't paid then all collections would stop. Ironically, William Thompson offered to supply the animals.

Gosse requested that the matter go to independent arbitration with Thomas bell, a friend and fellow of the Zoological Society, representing his interests. The Council agreed and appointed James Scott Bowerbank - the man who inspired Mitchell to install a "vivarium" at the Zoological Gardens at Regent's Park - to represent the Society. However, the arbiters soon found that the reason the Council had disputed the payment was that the Council had discovered that Gosse had also collected and sent specimens to the Surrey Zoological Gardens during his time in Weymouth but charged the Zoological Society for this time. Understandably, the Council were only willing to remunerate Gosse for the animals he sent to the Zoo. The arbitrators found in favor of the Society, awarding Gosse only £150, which he quietly accepted. In view of all of the above, when comparing Warington's and Gosse's associations with the Zoological Gardens at Regent's Park, Warington's looks much the better.

Finally, Kingsley's *Glaucus* had little or nothing to do with the aquarium hobby. Kingsley, uncommon among clerics battling with the religious and moral problems introduced by Darwinian theories, saw no conflict between the teachings of science and the teachings of religion. Indeed, like Gosse, he consistently emphasized that by studying science one was in effect studying the work of God and getting to know him better. How much he knew about natural history, however, is in doubt. The following is a review of the book (Anon., 1856)

It is a very difficult thing to write a good review, more especially on subjects of a scientific nature: the review must not be too learned, or it will have too few readers; it must not betray ignorance of the subject by the writer, or it is simply useless. "Glaucus," if considered as a review, shares both these faults; it is much too learned, and at the same time reveals to us an alarming extent of ignorance in the writer on the subject of natural history.

Yet, few works published during the past year have been more read than "Glaucus"; go where you will, talk to whom you will, every one has seen "Glaucus," and speaks approvingly of it; some, indeed, suggest, that it would have been better "if so and so had been omitted," or object to a passage in this page or a sentence in that; but, taken as a whole, it is very seldom that a work receives so cordial a welcome.

Now, what is the secret of this success? Mr. Kingsley had acquired fame as a writer on other topics before he touched upon natural history; and though apparently very ignorant of this latter subject, still he brought all the trained skill of the author, and all the weight of a pen of no mean calibre, to bear upon the topic he chose to advocate. Imagine the excitement that would be caused if Macaulay or Dickens were to bring out a book on natural history; all the world would read it, to see what they could have to say on the subject; and we presume it has been with much the same motive that all the world has read Kingsley's "Glaucus."

GOSSE'S SEAWATER FORMULA

In Brock's article he writes:

In fact, the differences between Warington's and Gosse's formulae for artificial sea-water were not all that significant; Warington used slightly greater amounts of sodium, potassium and magnesium chlorides and magnesium sulphate, and also included the magnesium bromide and calcium carbonate and sulphate which Gosse had considered too insignificant to include. Because the major factors in the preparation of sea-water for aquaria are the total salinity and hence specific gravity, it is scarcely surprising that Gosse's much simpler recipe worked. He was writing for "practical people, to whom minute accuracy was impossible", Gosse (1855) informed readers of the Annals in reply to Warington's challenge. The fact that Gosse's formula was scientifically incorrect did not convict him of being a poor scientist. On the contrary, he declared, he had proved his hypothesis before publishing it, for the sea-water he had prepared on 21 April 1854, and written about in June, was still supporting life.

Actually, the differences were significant, ranging from 24 to 47 percent (see table). Furthermore, Gosse did not eliminate the calcium sulphate because he considered it was too small to be of significance, *but because he had difficulty in dissolving it and because Laurens found it in "excessively minute quantity."* However, Laurens found the potassium chloride in his Mediterranean seawater analysis to be even lower than his calcium sulphate - 0.001 versus 0.045 - so why didn't Gosse eliminate the potassium chloride also? Indeed, why did Gosse even bother with Laurens' analyses, since the Mediterranean sea is far from the English Channel where the most of the readers of his sea-water article lived and where Schweitzer's samples were taken?

Gosse was criticized for his decisions made when he modified Schweitzer's formula. The following was written by George Wilson (1818-1859), a Scottish chemist and physician, succes-

sively appointed chemical lecturer in the School of Arts, director of the Industrial Museum of Scotland and regius professor of technology in the university of his native city (Wilson, 1854):

The paper was a criticism on a communication made by Mr. Gosse, and contained in the 'Annals of Natural History.' Guiding himself by Schweitzer's analysis, Gosse employed chloride of sodium, sulphate of magnesia, chloride of magnesium and chloride of potassium. Into a mixed aqueous solution of these salts, Gosse introduced various species of marine plants and animals; and for six weeks they throve and flourished. Dr. Wilson considers, however, that the less abundant, but still essential, constituents of sea-water—such as carbonate of lime, sulphate of lime, phosphate of lime, fluoride of calcium, silica, iodine, and bromine—should not be absent, as these latter sub-stances are found in marine plants and animals; and it is therefore plainly evident that the medium in which they live ought to contain the same substances.

As for the early glowing recommendations for Gosse's formulation, none of them, including Gosse's own experiments and those of William Alford Lloyd involved keeping fish; the highest invertebrates studied were marine snails and anemones. In any event, Gosse's seawater formulation was not a success. From Hibberd, 1856: **"But artificial water is quite unsuited for animal life of any kind, until it has been brought into condition by means of growing weeds for eight or ten days, and for Crustaceans, Starfishes, and Fishes proper, it is not suitable till it has been in use for many months, and even then some species lose their health in it, and at last perish…"** and from Hughes, 1874: **"Much has been said about artificial seawater, but my experience is not very favourable to it - I found it crude and harsh in its effects on the anemones, they refused to expand, and shrank up and died."**

EPILOGUE

In his desire to be the first to write about artificial seawater - and especially in his desire to beat Warington to it - things turned out badly for Gosse. He admitted discussing the subject in his meeting with Warington in January 1854, but he did not explain why he failed to tell Warington about what he knew about the subject during these discussions. Added to this, Warington's rejoinder (Warington, 1854) clearly showed that Gosse's grasp of chemistry was woefully inade-

TABLE I
THE SCHWEITZER, GOSSE AND LAURENS FORMULAS COMPARED
The numbers are lbs./ 100 lbs. of water (= 10 Imperial gallons).

COMPONENT	(1) SCHWEITZER	(2) GOSSE	% INCREASE (1) OVER (2)	(3) LAURENS
Sodium chloride	2.7060	2.1875	24%	2.722
Potassium chloride	0.0766	0.0563	36%	0.001
Magnesium chloride	0.3666	0.2813	30%	0.614
Magnesium bromide	0.0029	-	-	-
Calcium sulphate	0.1407	-	-	0.015
Magnesium sulphate	0.2296	0.1563	47%	0.702
Calcium carbonate	0.0030	-	-	0.009
Magnesium carbonate	-	-	-	0.011

quate in this matter and so the scientific community regarded him as the one who should be credited with the idea, not Gosse.

It is a shame that these two friends parted ways over what should have never happened in the first place. Ironically, Warington was never seriously interested in seawater formulae; he much preferred to obtain the dried extract of seawater and regenerate it by the simple addition of water.

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William Thomas Brande and the Balanced Aquarium Principle

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, October 10, 2015)

William Thomas Brande (1788–1866) was born in 1788 at Arlington Street in southwest London, the youngest of the six children of Augustus Everard Brande (1746–1834), an apothecary (an apothecary was a medical professional who formulated and dispensed materia medica to physicians, surgeons and patients; the modern pharmacist in American English - or chemist in British English - has taken over this role). Brande was a scion of a wealthy family of apothecaries with appointments to the Hanoverian and London courts stretching back to near the beginning of the eighteenth century. Brande's father, born in Hanover (naturalized 1784), was apothecary to Queen Charlotte between 1783 and 1801.

FAMILY PROBLEMS

From about 1794 until 1797 Brande received a rudimentary classical education at a private school in Kensington. Between 1797 and 1801 he attended Westminster School, where he made fair progress in classical and general knowledge. In the latter year Brande's father retired from the court and moved to Chiswick, a district of West London. As a consequence Brande met the chemist Charles Hatchett, who had a small chemical manufacturing business there and who was to exercise an immense influence over Brande's choice of career and its course. Hatchett had a private laboratory in Roehampton, southwest London, where he allowed Brande both to assist him and to undertake his own chemical experiments. This inculcated in Brande a taste for chemistry which never left him. Although his father wished him to enter the church, Brande decided to study medicine - then the only route to a career in chemistry. His decision may explain the rather strained relationship which Brande had with his family; his father's will made much less provision for him than for his siblings.

CAUGHT UP IN THE WAR

From 1802 until 1810, Brande was indentured to his elder brother, Everard Brande (1776–1868), who was then running the family business in Arlington Street. During his apprenticeship he visited Hanover where he pursued scientific and linguistic studies at Göttingen and Brunswick following the Treaty of Amiens in 1802 that temporarily ended hostilities between the French Republic and Great Britain during the French Revolutionary Wars. When the war recommenced in April 1803, Brande had difficulty returning to London but he finally escaped via Hamburg on a Dutch ship. By 1804 he had resumed working with his brother and in the same year he also commenced studying at the Great Windmill Street School of Medicine and at St. George”s Hospital, where he studied chemistry. According to Brande, at this time his brother “threw every

William Thomas Brande (1788-1866).

obstacle in the way of my chemical progress that was decently in his power." Nevertheless, he "found time … to read and often to experiment in my bedroom late in the evening."

BRANDE MEETS HUMPHRY DAVY

In 1801 Brande, still at Westminster School, was introduced to Humphry Davy who had then just been appointed professor of chemistry at the newly founded *Royal Institution*. Davy (1778–1829), the son of an impoverished Cornish woodcarver, rose meteorically to become a leader in the reformed chemistry movement initiated by Antoine -Laurent Lavoisier - albeit a critic of some of its basic premises - and a pioneer in the new field of electrochemistry.

On his return from Hanover, Brande renewed his acquaintance and "as a result, his zeal in the pursuit of chemistry was greatly augmented." From 1805 he started to attend Davy's lectures at the Royal Institution and occasionally absented himself from Arlington Street or Great Windmill Street in order to do so. In 1808 Brande and Davy were among the founders of the Animal Chemistry Club.

Despite his youth and family opposition Brande was able to conduct original chemical research, some of which was published in the *Philosophical Transactions of the Royal Society*. Such was his ability that in 1808, four years after he started studying there, Brande was lecturing at Great Windmill Street. This gave him membership of the London lecturing circle and in the next few years he delivered lectures on pharmaceutical chemistry at the medical school in Cork Street and on materia medica. In 1809, at the age of twenty-one, he was elected a fellow of the *Royal Society*.

In 1812 Davy resigned his professorship of chemistry at the *Royal Institution*. Brande moved into the Royal Institution and later in the year was also appointed superintendent of the house. Brande also replaced Davy in giving lectures on agricultural chemistry to the board of agriculture, but gave only one series before the board was dissolved the following year. In 1813 he was also appointed professor of chemistry to the *Society of Apothecaries*.

Brande's appointment to the *Royal Institution* marked an important change in his career. Unlike most other lecturers in the period, who earned their living by giving itinerant lectures, Brande was now permanently in an institution made famous by Davy and possessing the best-equipped laboratory in Britain. This did not mean, however, that he ceased giving lectures elsewhere. For instance, in 1819 he delivered the first lecture and course at the newly built London Institution, which had been founded in imitation of the *Royal Institution*, and he gave other courses there in later years.

BRANDE'S REPUTATION SPREADS

Brande's meteoric rise within the London scientific community was confirmed during 1813 by

Humphrey Davy (1778–1829)

his election to membership of the *Royal Society Club* and by the award of the society's Copley medal for a paper on experiments dealing with the alcoholic content of wine and other drinks. In 1816 he succeeded W. H. Wollaston, at the latter's suggestion, as one of the two secretaries of the society, a position he held for the following ten years. By 1818 he was sufficiently financially secure to marry the younger daughter of his patron, Anna Frederica Hatchett (1797–1881). His marriage on July 4th entailed his moving out of the *Royal Institution*. They had two sons and three daughters.

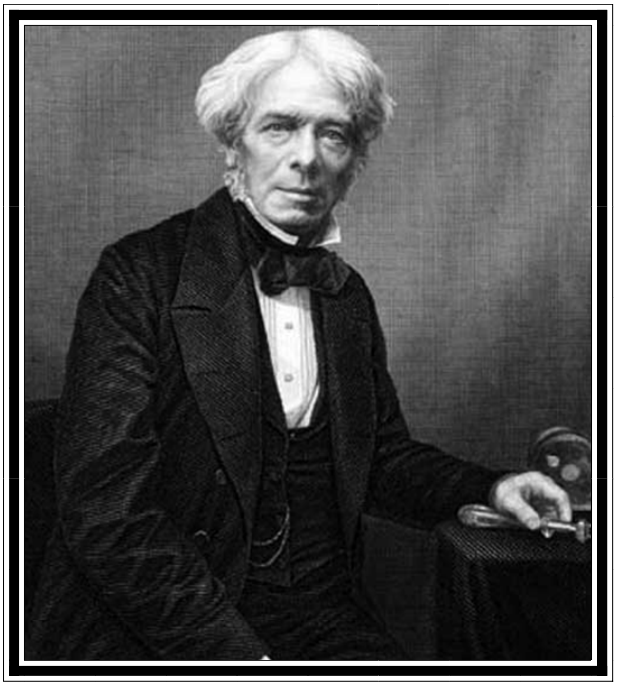
According to Brande's later recollection:

From 1815 to 1848, I also delivered a series of lectures and demonstrations on theoretical and practical chemistry in the Laboratory below [the main lecture theatre of the Royal Institution]. They were intended for all denominations of students, and were given thrice weekly, from October to May. They were the first lectures in London in which so extended a view of chemistry, and of its applications, including technical, mineralogical, geological and medical chemistry, was attempted.

These lectures were mainly attended by students from Great Windmill Street and, from 1828, from St George's Hospital. Initially he delivered these courses alone with the help of Michael Faraday, who as the assistant chemist at the Royal Institution was responsible, until 1825, for preparing and executing lecture demonstrations for Brande. Michael Faraday (1791-1867), who like Davy came from a very poor family, became one of the greatest scientists in history. His achievement was remarkable in a time when science was the preserve of people born into privileged families. The unit of electrical capacitance is named the farad in his honor. In 1824 Faraday gave some of the lectures and from the following year the course was given jointly. In 1846 Brande tried to drop them but was persuaded to continue, though at a reduced level. Brande also gave many courses of Saturday lectures on specific topics at the *Royal Institution*, delivered twenty-eight Friday Evening discourses between 1826 and 1852, and gave seven series of Christmas lectures between 1834 and 1851.

BRANDE'S PUBLISHING CAREER

Brande's lectures at the *Royal Institution* served, at least initially, as the basis for his major publications. In 1817 he published "Outlines of Geology" (2nd edition, 1829) while in 1819 his "Manual of Chemistry" appeared; both were based on his lectures. The "Manual of Chemistry" became a hugely successful and influential textbook and formed the model for many subsequent chemical textbooks by other authors. It went through six English editions by 1848 and was translated into several languages. He repeated the formula with his "Manual of Pharmacy," which, published in 1825, had reached its third edition by 1833. Then followed his "Dictionary of Materia medica" (1839) and the highly successful "Dictionary of Science, Literature, and Art," published in 1842. This latter went through many



Michael Faraday (1791-1867

editions and was still being published posthumously in 1875.

His last major publication, "Organic Chemistry" (1854), was based on his last course of lectures at the *Royal Institution*, in 1852. The link between Brande's publications and the institution also extended to his editing, between 1816 and 1830, of the *Quarterly Journal of Science* which, although not an official publication of the *Royal Institution*, was nevertheless closely connected with it. It contained original papers, details of lectures given at the institution, summaries of papers published in overseas journals, and book reviews, and provided a quick route to publication for those associated with the *Royal Institution*. Faraday helped Brande with the work, preparing summaries of papers, and when Brande was away was completely in charge. The *Quarterly Journal* was a valuable general science journal at a time when there were very few such.

BRANDE AND THE ROYAL MINT

Brande was active in promoting the study of chemistry. In 1836 he was one of the original members of the senate of the University of London and in 1846 was appointed an examiner in chemistry, a post he retained until 1858. He was one of the founders of the *Chemical Society* in 1841 and was among its first vice-presidents, a post he held from 1841 to 1846. He was president from 1847 to 1849, during which period he oversaw the incorporation of the society and commencement of publication of its *Quarterly Journal*.

In 1823 the government consulted Brande on the manufacture of iron and steel to be used as dies for coins at the Royal Mint. This was the start of his long association with the mint in which, once again, Hatchett played some initiating role. Two years later Brande was appointed clerk of the irons and superintendent of machines. Though these posts involved much administrative work they provided an annual income of £700 and accommodation at the mint which the Brande occupied after leaving Grafton Street. Following the royal commission of 1848, the organization of the mint was reformed and in early 1852 Brande was appointed at an annual salary of £900 to the newly created post of Superintendent of the Coining and Die department, a post he held until death. One of the requirements of the reformed mint was that employees must have no other paid employment so Brande had to resign his professorships at the *Society of Apothecaries* (of which he was master for the year 1851–2) and the *Royal Institution*, though he was made an honorary professor there. He also had to cease consultancy work for the various London water companies. He had undertaken this kind of work for many years and in the preceding three had played a major role in the extremely controversial issue of how to provide a new water supply for London.

"It's murder during these power cuts."

A DISAPPOINTING CAREER

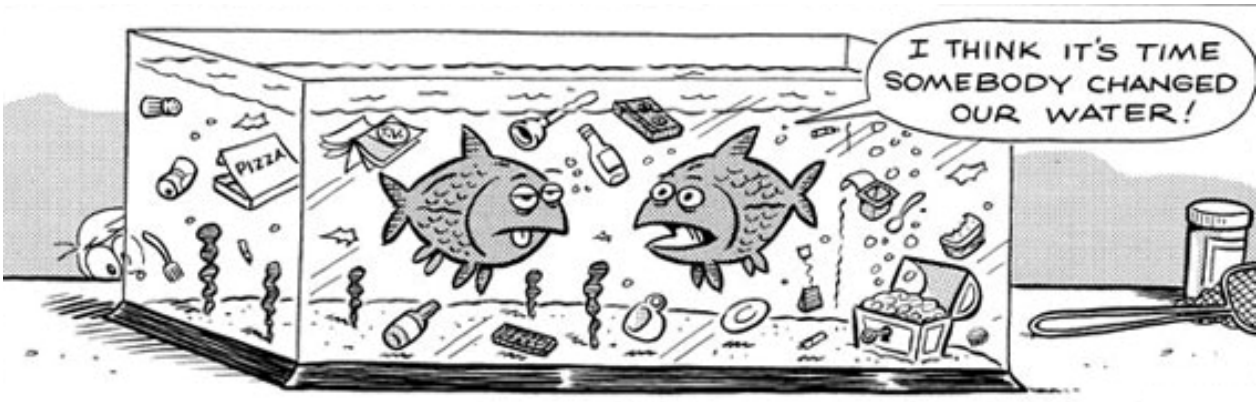
Brande's contribution to science and its practical application was recognized by the award of a Doctor of Civil Law by the University of Oxford in 1853. Nevertheless, most of his contemporaries believed that he had not fulfilled his early promise. According to John Davy, Davy became "very much disappointed" with Brande, whom he believed to be "mercenary and had no lofty views." Brande was not a brilliant lecturer when compared with his predecessor at the Royal Institution, Davy, or with his successor, Faraday, but these are hardly fair comparisons and the fact that he was able to sustain his lectures to medical students and others for more than thirty years certainly helped keep the institution in a reasonable financial state. A contemporary noted that Brande was "distinguished for the clearness of his [lecturing] style, for the methodical arrangement of his matter, as well as for the admirable selection and performance of his experimental illustrations." Nor, unlike Davy and Faraday, did Brande make any scientific discovery of major importance. Yet in the application of science to medicine, to water analysis, and to coining, Brande made a significant contribution to bringing science and technology together in the nineteenth century. He died on his seventy-eighth birthday at his country house in
Tunbridge Wells in 1866 and was survived by his wife and children.

THE BALANCED AQUARIUM PRINCIPLE

The first edition of Brande's "Manual of Chemistry" appeared in 1819 and was in one volume containing 699 pages. Subsequent editions tripled this. Although Brande's book had chapters, Brande numbered sections with each chapter consecutively over all chapters. This has caused some confusion since a section in the first edition numbered 1000 might be numbered 2000 in another edition even though the material is identical.

The Manual contains a chapter "Of vegetal substances" and another "Of animal substances." The following appeared in the vegetal chapter:

As the plant advances to perfection, it becomes dependent upon the air and soil for its nutriment: the roots absorb moisture and other materials; and the leaves, while they exhale moisture, frequently absorb carbon from the carbonic acid present in the atmosphere, and evolve oxygen. This evolution of oxygen takes place while plauta are exposed to the solar rays, and appears one of the most efficient causes hitherto suggested of the purification and renovation of the air. In the night-time, the leaves of plants always exhale carbonic acid, and at all times if the leaves be dying or unhealthy. There are also certain plants which appear under all circumstances rather to deteriorate than renovate the air; to the whole, however, the balance is in favour of amelioration (Davy's *Agricultural Chem. 4to.* p. 195) though the disappearance of the enormous quantities of carbonic acid gas continually pouring into our atmosphere,



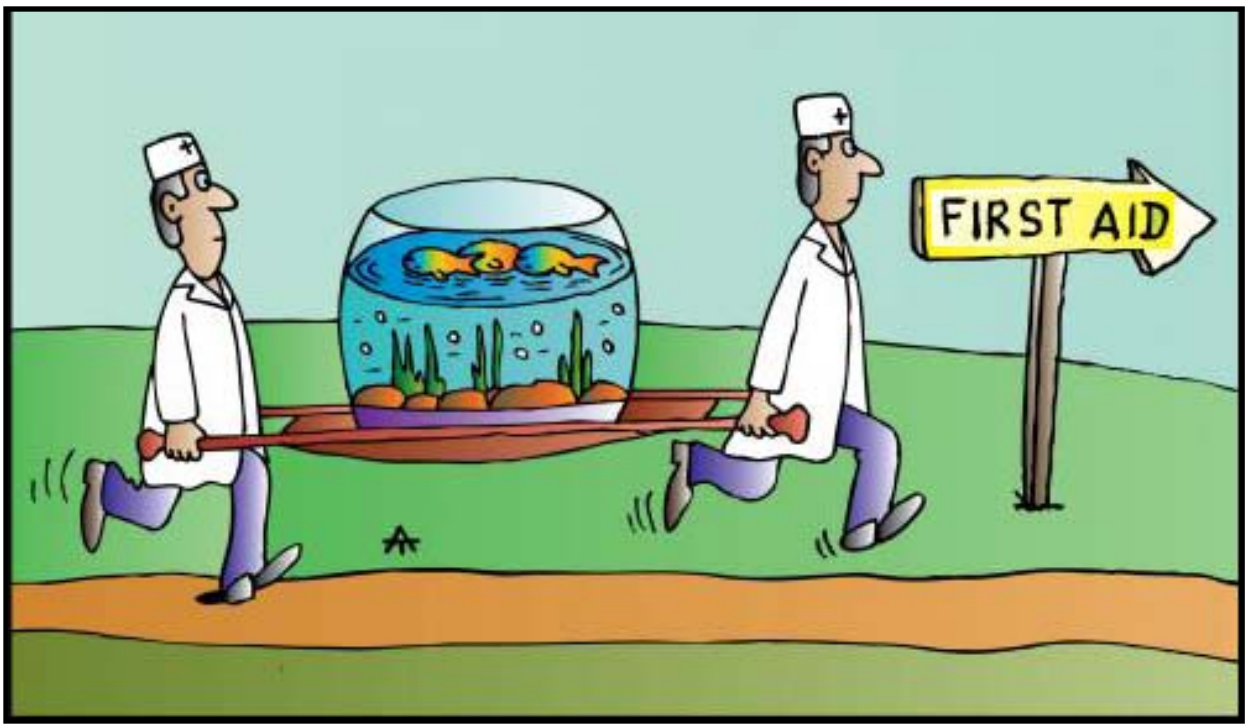
can, I think, scarcely be referred to the purifying action of vegetables alone.

Under certain circumstances, the leaves of plants also absorb a considerable portion of aqueous vapour and water, as is shown by the resuscitation of a drooping plant, on sprinkling it with water, or exposing it to a humid atmosphere. It is probable that, in healthy vegetation, the absorption of water by the leaves takes place in the night season chiefly, and that their principal function in the day is that of transpiration. Upon these subjects the reader may consult Saussure's *Richerches Chimiques sur la Végétation.*

The following appeared in the animal chapter:

Different animals require very different quantities of oxygen for the purposes of respiration. Man, and warm-blooded animals, consume the largest quantity; the amphibious tribes not only require less, but can breathe in an atmosphere which will not support the life of the former; and many insects take such small quantity, as sometimes to have been supposed capable of living without air, which is not the case. In the production of carbonic acid all animals agree, and consequently the nature of the deterioration suffered by the air is similar throughout the animal creation.

Fishes breathe the air which is dissolved in water; they therefore soon deprive it of its oxygen, the place of which is supplied by carbonic acid; this is in many instances decomposed by aquatic vegetables, which restore oxygen, and absorb the carbon [here Brande refers to the section in the vegetal chapter quoted above**]; hence the advantage of cultivating growing vegetables in artificial fish-ponds. It has been ascertained by Biot, and verified by others, that the air- bladders of fish that live in very deep water are filled with a mixture of oxygen and nitrogen, in which the former greatly preponderates: but in fish that are taken near the surface, the nitrogen is most abundant. In the *trygla lyra* [**actually *Trigla lyra*, the Piper gurnard**], always caught in very deep water, the air bladder contained 87 *per cent,* of oxygen: in the carp and roach, according to Fourcroy and Priestley, the air-bladder con-**



tains little else than nitrogen.—BIOT, *Memoires d' Arcueil,* i. & ii.

It is in the foregoing paragraph that Brande made the first elucidation of the principle of the balanced aquarium to appear in print. In other words, Brande first elucidated the principle, and then some 31 years later, Warington demonstrated the principle and, in the process, popularized it. Warington later said that it was Brande's statement that had incited him to set up his experimental tank with goldfish and *Vallisneria.*

Note: Antoine François, comte de Fourcroy (1755-1809) was a French chemist and a contemporary of Antoine Lavoisier. Fourcroy collaborated with Lavoisier, Guyton de Morveau, and Claude Berthollet on the *Méthode de nomenclature chimique*, a work that helped standardize chemical nomenclature.

With regard to Biot, the *Society of Arcueil* was a circle of French scientists who met regularly on summer weekends between 1806 and 1822 at the country houses of Claude Louis Berthollet and Pierre Simon Laplace at Arcueil, then a village 3 miles south of Paris. Other famous members of the group included Alexander von Humboldt and Jean-Baptiste Biot. Biot (1774-1862) was a French physicist, astronomer and mathematician who made many contributions to the scientific community in his lifetime – most notably in optics, magnetism and astronomy. He established the reality of meteorites, made an early balloon flight (he reached a height of 23,000 feet, quite dangerous without supplementary oxygen) and studied the polarization of light. Biot also discovered the mineral biotite, a name used for a large group of black mica minerals that are commonly found in igneous and metamorphic rocks.

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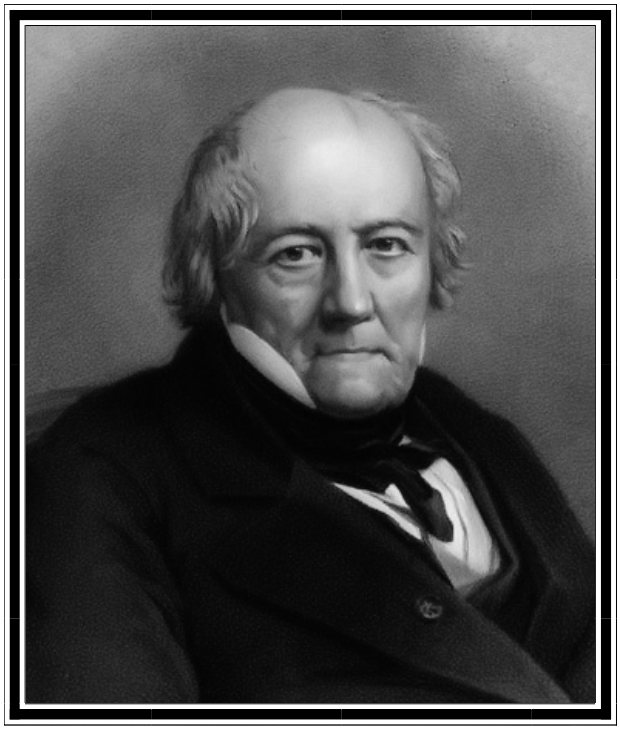


Jean-Baptiste Biot (1774-1862)

A HISTORY OF THE AQUARIUM HOBBY IN THE NETHERLANDS

By Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society of America,
Facebook Files, November 28, 2015)

WHAT'S IN A NAME?

Holland? Or the Netherlands? And what's the difference between the two? The Netherlands is often referred to as Holland, nevertheless, the official name of the country is the (Kingdom of the) Netherlands. The Netherlands consists of twelve provinces. Two of them, North and South Holland, are the two provinces that together make up "Holland." Due to the maritime and economic power of these provinces in the 17th century, the Netherlands became known worldwide as "Holland." To make matters even more confusing, the inhabitants of the Netherlands are called Dutch, except in the two provinces of North Holland and South Holland where they are called Hollanders! You pays yer money and takes yer choice!

THE FIRST INTRODUCTION OF THE GOLDFISH INTO EUROPE

In their 1968 book, *The Goldfish*, by George F. Hervey and Jack Hems, the authors state:

Bloch [i.e., Marcus Elieser Bloch (1723-1799), a German medical doctor and naturalist generally considered one of the most important ichthyologists of the 18th century], in his *Oeconomische Naturgeschichte der Fische Deutschlands* (1784), records that goldfish were introduced into England in 1611, and he cites Pennant's *British Zoology* as his authority. But, as Pennant gives the year as 1691 it is clear the Bloch's 1611 is a misprint, even if we did not know that misprints were very common in eighteenth-century books.

It is too much of a coincidence in the date to suspect otherwise than that this error in Bloch's book might also be the source of a claim regarding Portugal. It is widely asserted that goldfish were introduced to Portugal in 1611 and from there introduced to other parts of Europe. The wording of these assertions follows each other so closely that it is obvious that they have been copied over and over from a single source. Zhang Zhong-ge (1984) suggested that the goldfish may have arrived in Portugal in 1611, were introduced into England about 1705, in Scandinavia before 1740, in France about 1750 and in Holland between 1753 and 1754.

In the zoological literature, the goldfish is first referred to Portugal by Vandelli (1797) under the scientific name *Cyprinus auratus* and the common name "Peixe da China" (this suggests a probable introduction into Portugal from China). However, the goldfish is not mentioned in Baptista's account in 1789, suggesting that the introduction of the goldfish to Portugal occurred sometime between 1789 and 1797, not 1611. That Zhang Zhong-ge's dates are either not credible or else suspect is shown by the following.

SO WHO GOT THE GOLDFISH FIRST?

Towards the end of the Ming Dynasty (1644 A.D.) every Chinese household had a small (or large) goldfish basin. This was the centerpiece of the dwelling and brought people much pleasure, acting as a source of interest and entertainment, and already the first cultivated forms were appearing, such as the bubble-eye, the celestial and the twin-tailed Lionhead. In 1643 the Jesuits arrived in Hangzhou where they proceeded to construct their churches. Some of the priests, however, became interested in a local farm where goldfish were being bred. From these ponds the Jesuit, Martinus Martini, brought 10 goldfish to Holland in 1643 and thus this date is the first documented introduction of goldfish into Europe (Martini, 1663).

A bronze statue of Dr. Job Baster (1711-1775) in the town of Zierikzee. The statue represents Baster in 18th century costume with a goldfish in his right hand.

JOB BASTER

Job Baster, sometimes written Hiob Baster (1711-1775) was a Dutch physician and naturalist who devoted himself almost entirely to the study of medicine and natural history. He studied and took his degree of doctor of medicine at Leiden in 1731. Albrecht von Haller (1708-1777), a Swiss anatomist, physiologist, naturalist and poet, often referred to as "the father of modern physiology, thought his thesis, *De Osteogenia* [the study of the formation of bones], worthy of a place in his collection. Professors like Herman Boerhaave, a Dutch botanist and physician of European fame (1668-1738), regarded as the founder of clinical teaching and of the modern academic hospital and sometimes referred to along with his pupil von Haller as "the father of physiology." trained him in scientific methods and how to study natural phenomena. After his studies he visited the hospitals and botanical gardens in Paris and London where he became friends with Philip Miller (an English botanist) and Hans Sloane (an Irish physician and collector of natural history objects). Afterwards he settled as a physician in his native town of Zierikzee, a small city located in the Dutch province of Zeeland.

In 1738 he became a Fellow of the Royal Society in London on recommendation of Boerhaave and Willem Jacob's Gravesande (1688-1742), the latter a Dutch mathematician and natural philosopher, chiefly remembered for developing experimental demonstrations of the laws of classical mechanics. Baster was a versatile scientist; in addition to his work as a physician he contributed papers about medicine, horticulture and marine biology to the *Philosophical Transactions* and the V*erhandelingen der Hollandsche Maatschappij der Wetenschappen*. He was well-known for his translation of Philip Miller's work on horticulture and also maintained a vast correspondence with the leading biologists of his time.

In 1758 he came into possession of some farmland in Zierikzee called Zonnehof that had trees and two ponds. Baster used it to grow plants for his research and in the ponds he managed to cultivate Chinese goldfish. That was unique in the eighteenth century in the Netherlands. Thanks to his (corresponding) memberships in many learned societies, through a contact in England he came into possession of twelve gold fish. The following is translated from his book, "Physical Amusements, with the purport of some observations about some sea plants and sea insects, and in addition, seed houses and egg nests" (Baster, 1762-1765):

A shipment of young goldfish were sent by the British from China in 1728 via St. Helena Island on the East Indian ship, *The Houghton*, captained by Philip Worth, a man held in high regard by the famous Merchant, Sir Mathew Dekker. From that moment on they

came over on several ships to England, put in ponds and bred. From there they were sent along into Europe where they have become well-known.

In the month of November 1758, I received the first twelve of these fingerlings from England. I put eight in one pond and four in another of my garden. Except for about four, which I saw floating on the water after they died, I never saw any of them again. I have heard that this accident has happened to many other people who have put these fingerlings in their ponds. Perhaps this happens when the fish are poured into the water from a bucket and, becoming fearful, quickly shoot to the bottom and are so deeply embedded there that they cannot get out of the mud and thus smother. Therefore I have found it advisable using cords to suspend a net under the water and to keep the fish there until they are at ease and swimming.

In the month of October in 1759, I again received another twelve and put them all in the pond I had put the first four in. During that winter which was quite severe I had, because the water was unusually clear, sometimes seen the fish amusing themselves in the bright sunshine, even though deep under the ice. In February of 1790 I received six more, two of which died within a few days. Sixteen now remained and from them I obtained all of my offspring.

In the last of April and during the month of May 1790, they could be seen playing, and sometimes six or eight males chased a female, swimming behind her. When she had chosen one of her suitors, they swam pairwise for a while. They took special positions in the water and, lying on her side, she rubbed her belly on him and expelled her roe. They made no distinction regarding color, some sporting gold, silver and black, all one with one another, and treated as one kind of fish.

During the month of June, and therefore four or five weeks after spawning, one began to see the small fish, in which then only three or four lines had any length, and the grayish green of their coloration. Six weeks after they started to fatten up there were some shimmering silver or white patches between the dorsal fin and tail that, as the fish grew older, developed into one run and a stripe of half a line width. The fish now are grown up to an inch and a half long, and started eating little crumbs of bread, having up to this time been feeding on the water-insects that travel in the vegetation and along the lining and edges of the pond.

In Holland he became famous for this introduction of this common goldfish (Kin-Yu or Chin-yu) to the Netherlands and breeding it on Dutch soil. From his ponds in Zierikzee he handed them out to many acquaintances and thus began the march of goldfish across the country and beyond. In a letter (in Latin) to Carl Linnaeus in 1763,

A pair of Kin-Yu by the French artist, Edme Billardon-Sauvigne.

Jac. P. Thijsse (1865-1945). Interest in aquatic animals in Holland was first aroused by Heimans and Thijsse with the publication in their book, "In Pond and Stream," 1895.

Baster mentioned that he had a lot of goldfish in his ponds, and that they had withstood the winter cold. He even offered to send some to Linnaeus if some means could be found to send them quickly and safely.

HEIMANS AND THIJSSE

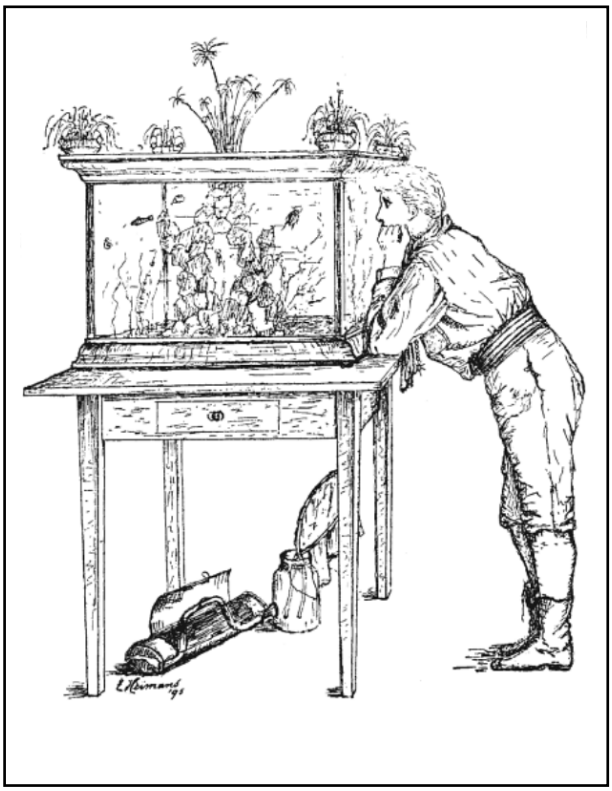
In the Netherlands, interest in aquatic animals was first aroused by Heimans and Thijsse with the publication in their book, "In Pond and Stream" (Heimans and Thijsse, 1895).

Jacobus Pieter Thijsse (1865-1945) was born in Maastricht, a town in the southeast of the Netherlands, his father serving as a sergeant in the second infantry regiment. Three years later the family moved to the small fortified town of Grave, and in 1873 his father left the service and found work in the larger town of Woerden. In those years both towns were enclaves in a vast, agricultural and sparsely populated landscape, which was hardly affected by industry and major infrastructure projects.

Both in Grave and in Woerden, Thijsse lived on the edge of town and he loved to go out into the fields and hang out along the waterfront. With friends from Woerden he liked mucking about in nature, where "We would eat huge meals of potatoes roasted under the ashes, wild strawberries, prepared eel which we caught and also a lot of 'Goats Beard,' a kind of chicory." But nature was not only a great place to play or get out of mischief. The young Thijsse wandered around alone to marvel at all that lived and grew there. He found it endlessly delightful to walk and revel in nature. He would call himself later by the Afrikaans word, "alleenloper" because loner in Dutch sounded too negative.

On these trips he tried to learn as much as possible about plants and animals and to study their characteristics. In plants it was easier than in birds, because how could you see what a tree-creeper looked like exactly? Thirty years later he wrote how he did it in his youth: "In the old days

Jac. P. Thijsse (far left) and other members of the Association for the Preservation of Nature (which he founded) during an excursion on the island of Textel (1908).



Boy with aquarium and vasculum, in *In sloot en plas* (Pond and Stream). A vasculum was a container, usually made of tin, used by botanists to transport plants without crushing them and by maintaining a cool, humid environment.

you took a rifle or a blowpipe or a catapult and shot the bird dead; then you could see everything at your leisure." This patriarch of Dutch nature conservation had a long way to go!

Of course the young Thijsse could not always study nature. As a clerk at a notary's office, Thijsse's father earned a reasonable salary so at age twelve he did not have to go to work. On his fourteenth year he enrolled in the Municipal Training College where his favorite subject was the History of Nature.

In 1883, at the age of eighteen, Thijsse obtained his teacher's certificate and after a few unsuccessful applications he received an appointment at the end of the year at a Second Class C school. (A Class C school was intended for school children of "limited means" and the school was poor. The poorest children went to a free "grade" school.)

Like most of his colleagues, Thijsse wanted to move higher up in the hierarchy of comprehensive education and therefore looked to the achievement awards. He took them in French, English and German, plus the main one by which he could teach in a primary school. In 1887 he was rewarded for these efforts with a promotion to teacher "second class."

Two years later he was hired at the teacher training college called Leerschool. However, his ambitions went far beyond that and in this period he applied to several better paying institutions, including even a position at the Eglise Hollandaise in St. Petersburg, a Dutch school for children of the elite who lived there. But before he received an answer from Russia, he had already found a job on the island of Textel, a municipality and an island in the province of North Holland.

In the so-called "French School" of Texel, Thijsse carried on all kinds of educational reforms. He took his students out of the classroom and he also became the first lifeguard in the Texel pool. He also introduced them to the then elite game of soccer. Thijsse took a deep interest in birds. Before that he was mainly occupied with plants and landscapes, but here he became fascinated by the many birds that he had never seen in Amsterdam, such as silver plovers, ducks and Stone Mountain runners. Here he first wrote about nature. After he had come into contact with English birders who had discovered Texel as particularly rich bird island, he wrote for the British popular science magazine, *Science Gossip*, his first article being about the breeding birds of the island.

Thijsse married in 1891 and the couple returned a year later returned to the capital. He was appointed head of a primary school on the outskirts of the Jordan area and as he no longer had his own classes was reasonably free to experiment on his

own time. He introduced the "walking school" where students left the classroom for an object lesson. The goal here was that students become familiar with nature, but history and cultural subjects were also given plenty of attention.

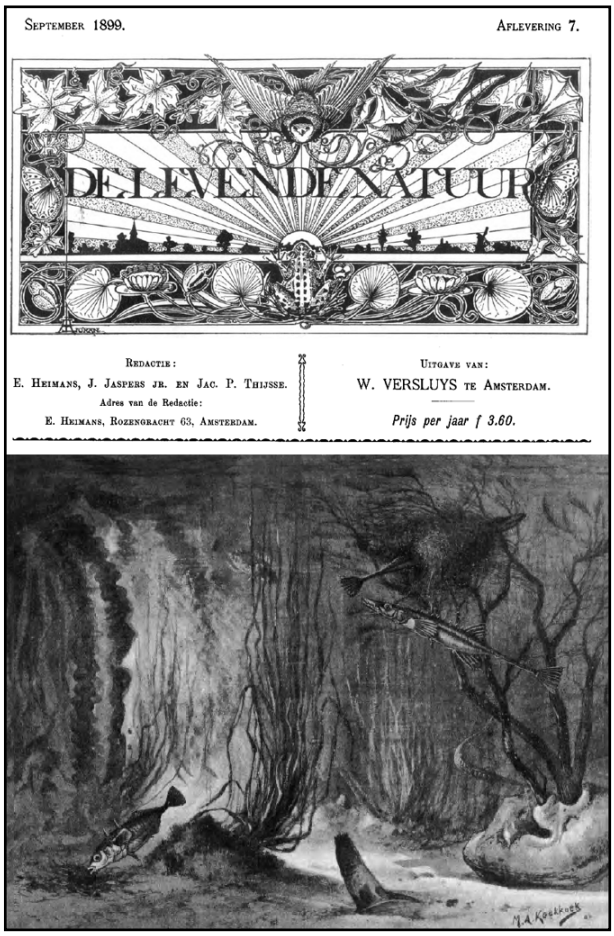
Numerous educational reformers also propagated the phenomenon of a school walk. They felt that the old education techniques where only dry book knowledge was taught were insufficiently suited to the interests and experiences of children. One of the innovation-minded teachers of the time, Eli Heimans, published a book in in 1893 called, "The Living Nature." This textbook was not, as was usual at the time, written by a professional biologist, but the material - based upon the flora and fauna of the Amsterdam Sarphatipark - was described in an attractive and lively way. (The park is named after the Jewish doctor and philanthropist, Samuel Sarphati (1813-1866). This small - it stretches for only two blocks - rectangle of green in the middle of the trendy De Pijp area is one of the nicest in Amsterdam. Shortly thereafter Thijsse and Heimans met, they quickly hit it off well and planned to write books together.

Eli Heimans (1861-1914) grew up with four brothers and two sisters in an Orthodox Jewish family in Zwolle, the capital city of the province of Overijssel, where his father had a silk-dying factory. When the company ran into financial difficulties, Eli had to leave the fourth class of the State higher secondary school to help his father. As a 'traveler' he had to pick up paint on the farm as well. During these hikes, his love of nature - instilled in him by his mother - grew stronger and he made his first sketches. Heimans went to the evening secondary school and there he revealed himself as a great writer. One of his essays resulted in a school prize in the form of Willem Frederik Reiner Suringars 1876 book, "Zakflora," a manual for identifying the plants growing wild in the Netherlands, which henceforth he would always carry with him on his trips. Along with his developing knowledge of the indigenous flora he had a chance encounter with "Herbal-Marie." Through this woman, who collected herbs for local pharmacists, the young Heimans came to know many wild plants.

Besides a great interest in living nature, Heimans developed an equally strong interest in the geology and genesis of the earth. The germ for this was already awakened in his early childhood. At home, he had to hear about the biblical creation story many times. "It was like God created the world over and over again in my presence," he wrote later. Doubt began to grow and he was carried by the waves of a movement that Darwin put in motion and in the years 1860 to 1880 brought the scientific world into great turmoil. Fossils, which bore the title of monstrosities before Darwin's time, taught him and many others that the earth must be much older than that assumed in the Bible.

In 1879 Heimans won the achievement award for mathematics, followed a year later by the award

Eli Heimans (1861-1914).



De Levende Natuur **(Living Nature), with the subtitle** ***Tijdschrift voor de Natuursport*** **(*Magazine of Nature Sport),* published by Thijsse, Heimans [and Jaspers, Jr.] in 1896.**

of assistant teacher. In 1882 he was appointed as the third teacher at a public elementary school in a poor inner city of Amsterdam. After obtaining the certificate of headmaster one year later, Heimans was appointed second teacher at a newly erected school that soon gained a reputation for its talented teachers. This privileged position certainly helped the teacher in Heimans to develop fully, because he was a dedicated educator at heart.

In Amsterdam Heimans was member of the *Netherlands Teachers Association of the Pedagogical Study Club*. Later, in 1897 with other members of the Association, he started the educational journal *New Year*, which thousands of teachers counted as subscribers. Heimans also wrote children's books, and in 1889 he published the popular boy's book, *Willem Roda.* As an author, he had a gift of writing for "ordinary people"; an elitist position was alien to him. Heimans' business sense was not strong, however; an Amsterdam publisher offered him one-hundred guilders for the rights to the book and, after some hesitation, he accepted and waived all rights to future publication. The book, to Heimans' dismay, was reprinted many times.

The innovations in education at the end of the 19th century were based on learning how to understand one's own familiar environment. The education in natural history in those years was barren and dry; a book reading or a look at a wall-chart was typical. No living material was present or used in the classroom. Heimans made a difference by taking animals and plants to school. He also went as far as possible with his pupils to Amsterdam's Sarphatipark, his favorite excursion site. He restrained during these lessons and the school walks from mentioning the names of plants and animals, and mostly tried to teach his students to see the connection between life and form. Heimans' ideas about a new form of science education were brought together in his book, *De levende natuur. Handleiding bij het onderwijs in de kennis van planten en dieren op de lagere school, in het bijzonder voor groote steden* (Living nature, a manual of education in the knowledge of plants and animals in elementary schools, especially for large cities) which appeared in 1893.

In 1894 Heimans and Thijsse published *Langs dijken en wegen* (Along dikes and roads) the first of a series on butterflies, flowers and birds. The booklet, designed for schools, was initially received lukewarmly, and the reviewer of an education magazine suggested that boys preferred to read about "…Indians and dark murder novels and girls were mostly interested in romance: What are butterflies and beetles and birds to our

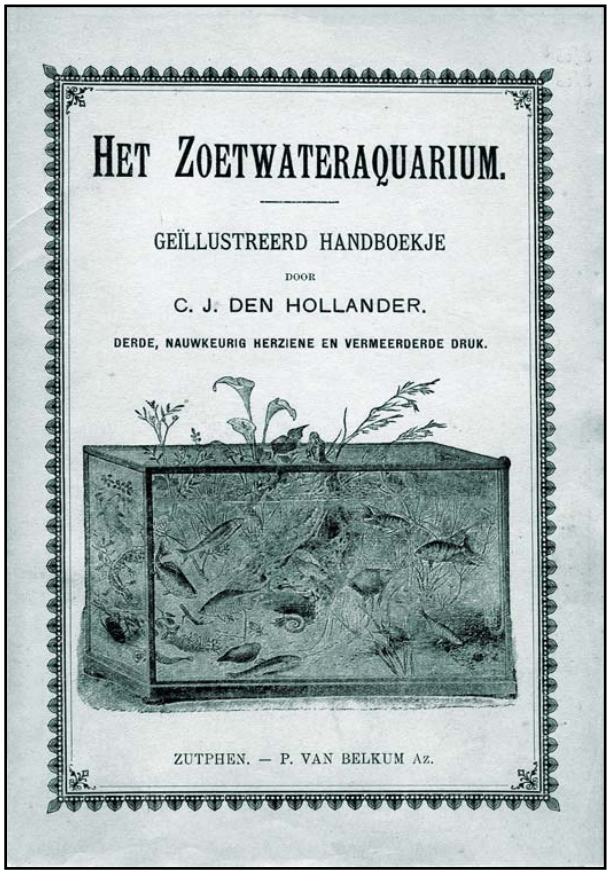
12-13 year-old youngsters?" In spite of this, the book and the others that followed were commercially successful.

The next to be published was *In sloot en plas* (In pond and stream, 1895). This was significant since in the Netherlands interest in aquatic animals was first aroused by this book. The accompanying figure shows a drawing from the book made by Heimans of a young boy observing the catch in a freshwater aquarium. Below the tank are a net and a vasculum. A vasculum or botanical box was a stiff container in the form of a cylinder and typically made from tinned and sometime lacquered iron, used by botanists to keep field samples viable for transportation. The main purpose of the vasculum was to transport plants without crushing them and to keep them in a cool, humid environment.

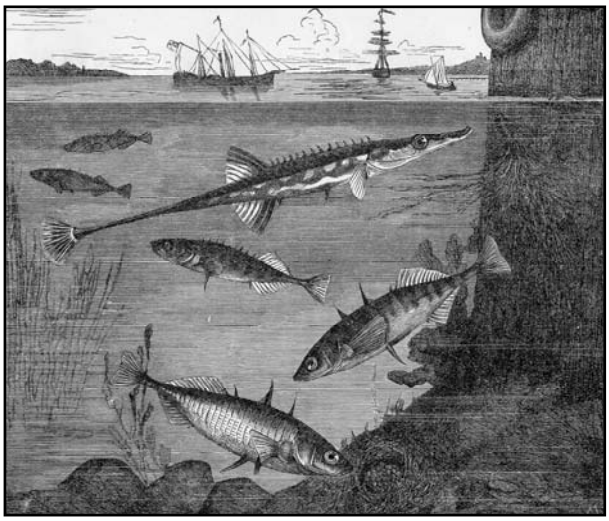
This book was followed by Door *het rietland* (By the reeds, 1896), *Hei en dennen* (Heath and pine, 1897), *In de duinen* (In the Dunes, 1899) and *In het bosch* (In the Forest, 1901). These publications had a pleasant and popular writing style and featured colorful illustrations drawn by the authors. Their readily understandable and catchy way of writing about nature was new and spoke to a wide audience. The authors took the reader, as it were, on their walks to a park or a ditch. The booklets challenged the reader to follow the authors, to go and see for themselves, and thus encouraged the study of nature as a hobby, sometimes called a "natural sport."

The response to this series of books was enormous, and in 1896 the idea was conceived to publish a magazine for amateur naturalists. For this venture they co-opted another teacher, J. Jaspers, Jr., and their magazine was christened *De Levende Natuur* (Living Nature) with the subtitle, *Tijdschrift voor de Natuursport* (Magazine of Nature Sport), implying that the study of nature was not just for gathering and spreading knowledge, but was also fun and exciting.

The success of the magazine in gaining a substantial readership was immediate, and the editors made it one of their aims to engage readers in different projects, encouraging them to submit articles and questions that would be answered by the editors or other specialists. From an early period, assistance from readers was requested on research on the distribution of plant species, and when this became a success the Governmental Herbarium in Leiden used the same method in preparing distribution maps for Dutch flora. Within a relatively short period, *De Levende Natuur* became well established and a source of encouragement and inspiration from which new initiatives were being taken, such as the foundation of several natural history societies, with Heimans and Thijsse elected to their boards.



***Het Zoetwateraquarium*, the first aquarium book written in the Dutch language (1900).**



Various types of sticklebacks pictured in *Het Zoetwateraquarium.*

THE FIRST DUTCH AQUARIUM BOOK

The first aquarium book written in the Dutch language was *Het Zoetwateraquarium* (The Freshwater Aquarium) written by C. J. den Hollander (i.e., Carol Jacob den Hollander) in 1900. Hollander lived in Nieuwaal, a village on the De Waal River in the Dutch province of Gelderland - part of the municipality of Zaltbommel - located about 46 miles west of Rotterdam. The school was in existence from 1886 to 1953 and Hollander was its headmaster from its inception to 1917.

Hollander was a keen student of nature and took his students on field trips to the surrounding area. He was especially interested in keeping fishes in aquariums (in those days it was primarily native fishes) and he contributed to various journals, including *De Levende Natuur.* As a result, he was constantly receiving letters from other interested parties asking for advice and information on keeping fishes. Hollander responded as best he could but was limited in his replies as he had to be succinct in letters. He observed that there were numerous books on the subject, both small and large, but none in Dutch. After years of observation, searching in ponds and streams and examining freshwater fishes and plants up close, he decided to write this book. In doing so he sought and found help from others, as well as consulting well-known works such as Alfred Edmund Brehem's *Tierleben* and Anton Kerner Ritter von Marilaun's *Pflanzenleben*. It was highly thought of and praised, and went through many editions over the years with the last edition being published in 1928.

Hollander had planned to write a second book dealing with amphibians, crustaceans, mollusks, worms, infusoria and the like. This, however, did not come to fruition. *Het Zoetwateraquarium* described the establishment and maintenance of an aquarium, aquatic plants and fishes. He liked to refer to aquariums as "water palaces" and maintained that a glass container with some duckweed and some midge-larvae is as good an aquarium as under that name as the famous grand public establishments in Naples, Amsterdam, Paris or London.

FURNISHING AND MAINTENANCE

He was not as sanguine about the typical goldfish bowl, however, noting that they necked down to a circular opening at the top, restricting oxygenation of the water. He also remarked that they were difficult to clean and dangerous to move. When filled three quarters with water it was heavy and usually wet so it was slippery; if one lost one's grip the result would be disastrous. As Hollander remarked, "It is too bad that the gorgeous goldfish, so easy to keep clean and stay healthy, is given a most inefficient house." He recommended the larger cylindrical containers used for preserving food as a much better solution.

Hollander also experimented with the sulfuric acid bottles suggested by Rossmässler, which were of large size and thick glass (although the green color predominated, clear was also available). Hollander's aquarium supplier sent a bottle to a famous glass factory for the removal of the top of the jar but the bottle had burst under the operation. The procedure was to wrap a piece of knitted cotton soaked with turpentine around the bottle and set fire to it. If one was lucky, the bot-

tle would crack along this line. Hollander, of course, was skeptical.

Hollander provided a list of fourteen suppliers of aquariums in Holland and Germany, seven of which also provided fish and aquarium equipment. He also listed the sizes and prices for a variety of aquariums from one supplier including all-glass rectangular and round tanks, and framed tanks. Also included was a brand of German heatable aquariums called "Thermecon," fitted with a metal mantel cemented in the bottom where a heating lamp fueled by alcohol or kerosene could be placed underneath the mantel. For his own use, he had a zinc worker build a number of containers, 80x50x40 cm (32x20x16 inches) - about 42 gallons, glazed with a heavy plate glass.

In those days aquariums were not heated - especially those containing native fishes - and in those not drained for the winter and not kept in a heated room ice would form and the glass would break. The problem with drained tanks, however, was that the aquarium cement would dry and when next filled they would leak.

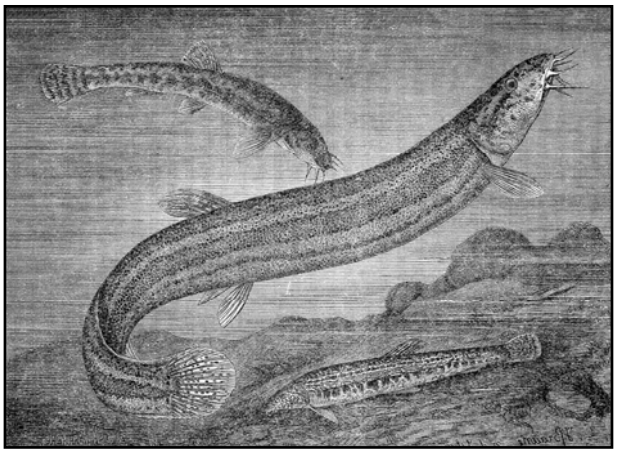
One of his aquariums was located in his living room but was relatively close to the stove and so was unevenly heated. During one winter an unexpected bang like a gunshot startled Hollander; the glass had cracked and he ran to the kitchen for some buckets to avoid the expected deluge in his living room. Wonder of wonders and to everyone's astonishment, the cracked glass did not leak, even over a span of 20 years when the tank was never filled less than half with water. Hollander finally replaced the glass and had the tank re-glazed. However, in the middle of summer the same glass side cracked again from top to bottom. Once again the tank did not leak and remained so for the next five years.

Hollander provided instructions for preparing aquarium cements. He recommended one devised by a French industrial chemical firm, Serbat, located in Saint-Saulve. Composed of a well-worked mixture of 72 parts annealed and rubbed lead sulfate, 24 parts magnesium peroxide and 13 parts linseed oil, it could be kept for a long time; one could knead easily with the hands and without any addition of oil.

He also had a very flat aquarium constructed, one meter square by 5.9 inches high (about 40 gallons), indispensable for the temporary observation of animals that required oxygen-rich water or lived at a shallow depth.

Hollander discussed the placing of aquariums with regard to light, aquarium stand requirements, cemented rockwork and cooling the water during hot days. He was not a fan of expensive systems so the one he devised was the gravity fountain aeration system. A water container was located above the aquarium, clamps controlling the water flow from it through a rubber hose that ended in a U-shaped lead tube capped by a brass cap provided with fine holes. The excess water was removed by an overflow.

Hollander warned about water that contained excess iron and groundwater with an excessive iron or calcium content as it was very detrimental to plant and animal life. He deemed the city water in Amsterdam and Haarlem ideally suited for the



Various loaches and weatherfish pictured in *Het Zoetwateraquarium.* From top to bottom: *Cobitis barbulata, Misgurnus fossilis* and *Cobitis taenia*.

aquarium. Rainwater that had been first boiled, then cooled and reaerated was also recommended.

Cleanliness was emphasized. Rotten leaves were to be cut with a pair of scissors and removed, and the detritus at the bottom was to be siphoned off. Hollander provided much practical advice, such as never cleaning the algae off the glass with sand as it would scratch and mar the surface. The only fault I found with this section on setting up and maintaining an aquarium was the lack of diagrams or illustrations. There is only a single engraving (i.e., his "Water Palace) in the whole chapter.

THE GREEN IN OUR GLASS PALACE

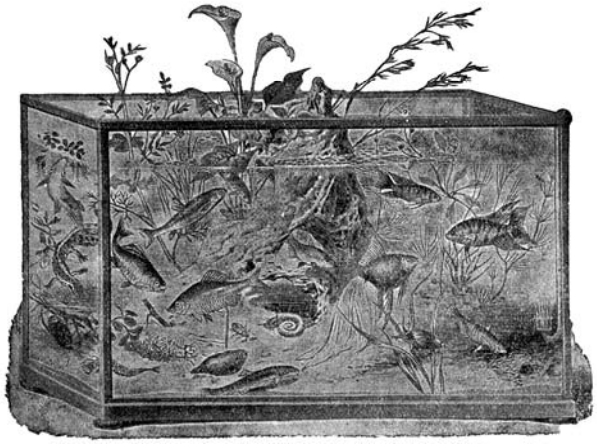
The section on plants - dubbed "The Green in Our Glass Palace" by Hollander - is profusely illustrated, the illustrations being taken from a number of different botanical texts. Most of them will be recognized by American aquarists, e.g., *Ceratophyllum, Hydrocharis, Elodea, Utricularia, Azolla, Lemna, Myriophyllum, Potamogeton, Sagittaria, Nuphar, Fontinalis, Chara* and *Vallisneria*. All of these plant descriptions are quite detailed. It is the introductory material that is of greater interest, however.

Hollander describes where aquatic plants are found and how to collect them. At one point he comments:

Since ditches, puddles, ponds, kills, ponds, streams, and even the rivers offer us a wealth of aquatic plants, we will not have much trouble in obtaining a puny amount of the needed green for the puddle in our room. Free-floating aquatic plants are easily scooped up; rooted plants on the other hand, are more difficult to come by. Thus we ask one of the farmers along the way if we can borrow a rake or ditch hook (a few cents handed out to the local preschoolers works miracles here!) Then it's possible for us to pull out the deepest rooting plants.

Hollander explains how different plants require different substrates for nourishment. Water Mint and the great Water Plantain are able to make do with a nutrient-poor soil layer: they grow and prosper against all odds. However, a vigorous growth and flowering of most aquatic plants can only be expected if the sand layer rests on a mixture of peat, sand and clayish soil, or finely divided earth into which peat is stirred.

He also advises on how to plant a tank, depending upon whether it is the plants, fish, aquatic insects or invertebrates that are to be featured. Cleaning and trimming of the plants, transportation, lighting considerations, algae and snails with relation to plants are also discussed. What I find interesting is that although - including Hollander's book - individual species of plants are described in detail in aquarium books published throughout the following one hundred and thirty years, none of them talk about many of the issues dwelt with in *Het Zoetwateraquarium*, especially in the collecting of plants and installing them for particular effects.



Hollander described how rockwork, using rocks, stones, brick and cement could be used to construct a fountain. However, here he shows an artificial rock containing niches for sand or soil that extends out of the water. In it are planted marsh plants that thrive with their roots in water and the bulk of their leaves out of water.

Hollander (arrow) with a group of his students in 1903.

THE SCALY FOLK

The section on fishes - dubbed "The Scaly Folk" by Hollander - is similar in that it is profusely illustrated, the illustrations being taken mainly from Alfred Edmund Brehem's *Tierleben*. As Hollander states:

In this chapter we want to investigate which of our native fishes fare best in captivity. Nothing will be said about ornamental fish from other countries and continents, which in many richly planted salon aquariums display an uncommon beauty, because it is our intention in this work of limited scope only to deal with our own fishes to the exclusion of everything alien. The only exception is the widely admired goldfish, since it is a completely naturalized foreigner and cannot be ignored.

Hollander points out that aquarists will have little trouble keeping native fishes from small ponds or ditches; however, with river or stream dwellers the transition from running to stagnant water will be more of a challenge. For sturgeons, flatfishes or lampreys one will want to wait for a few days or weeks and keep them under close observation in the special flat or low aquarium he devised since such fish need a spacious, well aerated home.

After explaining the oxygen/carbon dioxide relationship of plants to fishes and the necessity of providing rockwork where fish can get out of direct sunlight during hot summers, Hollander turns to the task of feeding. Here he favors earthworms. For smaller fish he boils them in hot water, minces them up in small pieces and adds some Piscidin - a commercial fish food of the time - resulting in a sort of paste. Bass, pike, eels and other predators were fed on small fish, easily obtained during the summer time. Carp and goldfish got stale bread crumbs but also occasionally lean meat cut up with a pair of scissors. Hollander lived near a butcher shop that supplied him with ground beef heart, calf brains and a variety of blutwurst.

The majority of the fishes that Hollander described are really large. The following are the only reasonable small species in his list: *Cobitis taenia* (Spined loach), *Misgurnus fossilis* (Weatherfish), *Gasterosteus aculeatus aculeatus* (Three-spined stickleback), *Rhodeus amarus* (Bitterling) and *Barbus barbus* (Barbel). For some reason, he overlooked describing two more of the smaller native fishes, i.e., *Leuciscus leuciscus* (Common dace) and *Phoxinus phoxinus* (Eurasian minnow).

Hollander also refers to his low or flat aquarium he described in his first chapter.

If we want a closer look for a few days or weeks at a sturgeon or a lamprey, then we use a flat aquarium (already described earlier) placed on our observation table. Said fish then have the spacious and well-aerated home that they need.

I can't see that a one meter square tank, 6 inches high is all that spacious for fish of this size but most likely Hollander was referring to juvenile specimens. He remarks that on occasion a lamprey will slither over the side and drop to the floor, but this fish can lie there for some time, reviving with unharmed since it can stand being out of the water better than it can take high water temperatures. Hollander used sand and soil on the bottom, small hills of gravel and stones (and he kept these far from the walls of this low tank to minimize the possibility of a fish crawling out). Floating water plants helped shield the tank from the sun, and aeration and cooling was provided by sending water from an elevated basin through a tube ending in fine nozzles. He also mentions that he placed crayfish and bullheads in this tank. This tank is an oddity I have not come across before in an aquarium book.

AN OVERGROWN ROCK

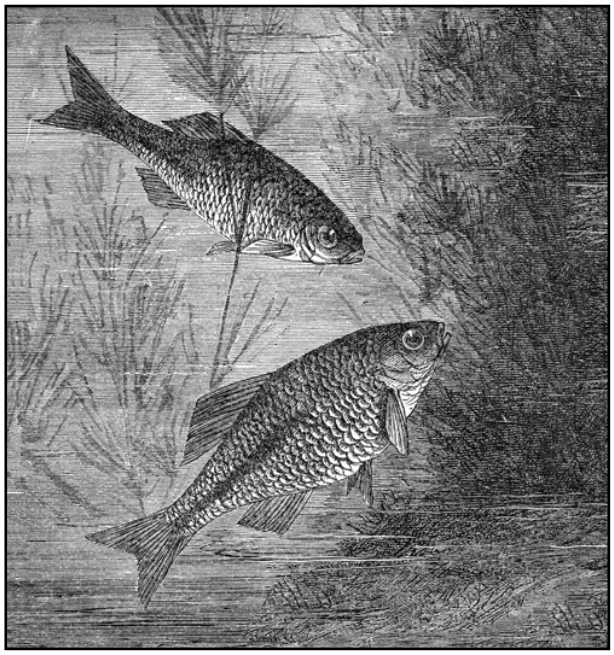
The last section - dubbed "An Overgrown Rock" by Hollander - deals with rockwork in the aquarium. In those days, display tanks were usually not covered with glass but were left open and not filled to the top with water. In the first chapter Hollander described how rockwork, using rocks, stones, brick and cement could be used to construct a fountain. Here he describes an artificial rock containing niches for sand or soil that extends out of the water. In it are planted marsh plants that thrive with their roots in the water and the bulk of their leaves out of water. (A good example is the one shown that is the only aquarium pictured in Hollander's book.) The sort of plants discussed in this section include: *Hydrocotyl, Viola, Samolus, Chrysosplendium, Oxalis, Drosera, Pinguicula* and *Veronica*.

All in all, the book is well-written and based upon the experiences of the author. It was thought well enough of that quite a few editions were published in the 29 years of its lifetime. By 1902, for example, it had been re-printed five times.

THE STIRRINGS OF THE HOBBY IN HOLLAND

The origin of the hobby in the Netherlands goes back to the early 19th century, although there certainly had been in the years before people who had been dealing with keeping fish and other aquatic animals. As we have seen, this mainly involved its native fishes, which served as an object for scientific study, education or enjoyment. The number of tropical or subtropical fish, which were not available in the Netherlands, could be counted on the fingers of two hands.

There were hardly any retailers who sold these fish, and if there were any, they were located mainly in the major port cities of Rotterdam and Amsterdam. Some fish were brought in by sailors who supplemented their modest wages in this way. The prices that each dealer charged for these exotic fish were astronomically high if one compares them with the then prevailing wages; a laborer's earnings usually did not exceed ƒ10 to ƒ15 per week (the florin, f, or guilder was worth about $15 today). Thus, for example, in 1911 a pair imported guppies was ƒ1.50, a few *Barbus*



European Bitterlings (*Rhodeus amarus*) from *Het Zoetwateraquarium*

conchonius ƒ2.25 and a few red fighting fish ƒ2.50. It is no wonder that in those time fish hobbyists regularly exchanged their home-bred fish with each other.

As far as other sources were concerned, fish were brought in directly from the east from Germany - where the aquarium hobby already had many followers - and were sold by local merchants. Famous commercial names at that time were Hanselman in Rotterdam, and Holgen and Voorwalt in Amsterdam.

Aquariums, often fully glazed containers (such as battery containers) but sometimes made of cement or wood, later of angle iron, and equipment such as thermometers, oil heaters, glass capture bells and nets, and siphons were included among the wares of the retailers. Those who could not pay the prices asked had to roll up their sleeves and make their own equipment. Some aquarists devised inexpensive solutions that were very inventive.

There were established aquarium clubs in the Netherlands before the First World War and that they were found in the two major ports of Rotterdam and Amsterdam is not surprising. In the year 1908 and almost simultaneously, the *Triton* was founded in Amsterdam and the *Anthony van Leeuwenhoek* in Rotterdam. In the heyday of its existence, the latter had 40 club members; not all lived in Rotterdam - others were spread across the country. One year after its establishment, the *Anthony van Leeuwenhoek* split up (this, by the way, was typical of Dutch aquarium societies). Under the leadership of F. Groeneveld, a number of its members formed a group under the name *De Exotische Club* (The Exotic Club). Smaller aquarium clubs, often with no more than a handful of members, were also established in Amersfootse, Tilburg, Sittard and in Vlaardingen.

A TONGUE-TWISTER FIRST UNION

Because the only magazines that were available to Dutch aquarists were the German *Blätter* and *Wochenschrift*, it was thought that the time was right to establish a bond among the existing aquarium societies scattered here and there and to establish a union (the name used by the Dutch; it is what we generally call a federation or an association) and to publish a Dutch magazine. Thus was founded in 1909 as a union with the tongue-twisting name A.A.B.B.C.C. for *Algemeene Aquarium Bezitters Bond Cyprinus Carpio* (Universal Aquarium Owners Union Cyprinus Carpio). It is amusing to note that in these early days, the Dutch referred to an aquarist as an "aquarium owner."

In 1910 the A.A.B.B.C.C. had 169 members and published a magazine called *Ons Eigen Blad* (Our Own Journal). It had about 200 subscribers and cost ƒ1.50 per year. Its Editor was J.H.M. Gadiot, who fulfilled this task in an extremely professional manner. Gadiot however, was in poor health and died in 1913. His death marked the end of *Ons Eigen Blad* and the A.A.B.B.C.C. One Dutch aquarist remarked that it was fortunate that this union disappeared from the scene since merely pronouncing its name would tie up the speaker for the rest of the day!

On the initiative of A. van Essen, president of *Natuurgenot* (Natural Pleasures) in Rotterdam, a

Comical or offensive Dutch surnames were a practical joke on their French occupiers during the Napoleonic wars.
Some quirky Dutch surnames: Gekkehuis (Madhouse), Naaktgeboren (Born naked), Uittenbroek (out of his pants) and Spring in 't Veld (Jump in the Field)

new union was established in 1916 with the name *Bond van Aquariumhouders in Nederland* (Federal Aquarium holders in the Netherlands) or B.A.N. However, it did not last long and after the end of World War I - in 1922 - it went bankrupt. Note that the term used by the B.A.N. for an aquarist was an "aquarium holder." The Dutch also referred to aquarium societies as associations, but I will use aquarium societies (and clubs) in this essay in order to avoid confusion.

A BEVY OF FIRST NAMES

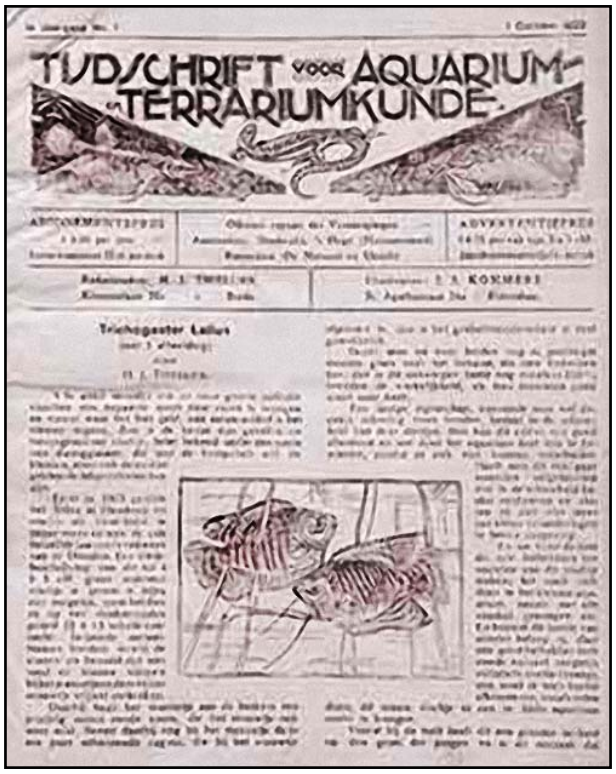
Note the name, "J.H.M. Gadiot" and later in this essay, "J.H.J.M. Oosterhuis." In early times the Dutch frequently had three, four or more first names and no middle names (nearly half of Dutch children today receive one name, over 30% are given two names, 17% have three names, 2.5% get four names and only very few children have five or more first names). This why initials are used in names; writing all the first names is a chore. In fact, the names recorded by banks in The Netherlands are usually written using initials for first names in order to simplify their records. Unfortunately, this makes research involving biographical data much more difficult.

Another oddity is that even with all these first names, a family may decide on an additional name used only by family and friends. For example, a Dutch politician was named Henricus Antonius Franciscus Maria Oliva van Mierlo (yep, five first names). The announcement of his birth (the one parents send to family and friends) probably said "We are glad to announce the birth of Henricus Antonius Franciscus Maria Oliva van Mierlo; we call him Hans." Until his death he was indeed known as "Hans van Mierlo." Note that Hans had no resemblance to any of his actual first names. Fortunately, Hans van Mierlo didn't have to write his full name very often since if "Hans" was not enough, his initials would usually be okay.

POST WORLD WAR I

The number of aquarium societies now increased. In 1919 there were *Danio rerio* in Delft, De *Natuurvriend* (The Nature Friend) in The Hague, *De Natuur* (The Nature) in Dordrecht, *Natuurgenot* (Natural Pleasures) in Utrecht, and in 1921 *Natura* in Arnhem followed. *Danio rerio* still exists and *Natuurvriend* also still exists, albeit merged with the related *Scalare* in The Hague.

The aquarium society *De Natuur*, now incorporated into *De Bijlzalm* (The Hatchetfish), organized a successful aquarium exhibition in Rotterdam in the first year of its existence, which produced a significant amount of money for the club. *De Natuur* elected not to join B.A.N. since it feared the that by joining the Union the club's board would be liable for its debts; it also disagreed with how its business was conducted (including its poorly executed magazine). In October 1922 *De Natuur* took a big step. With the money from the exhibition as seed, the club took


TIJDSCHRIFT voor AQUARIUM- en TERRARIUMKUNDE

The first issue of Tijdschrift voor Aquarium- en Terrariumkunde Flora en Fauna **(Flora and Fauna, the Journal of Aquarium and Terrarium Science), October 1, 1922. Its first editors were W.J.M. Deutz, M. den Outer and H.J. Thiellier.**

W.J.M. Deutz, an important figure in the history of the aquarium hobby in the Netherlands.

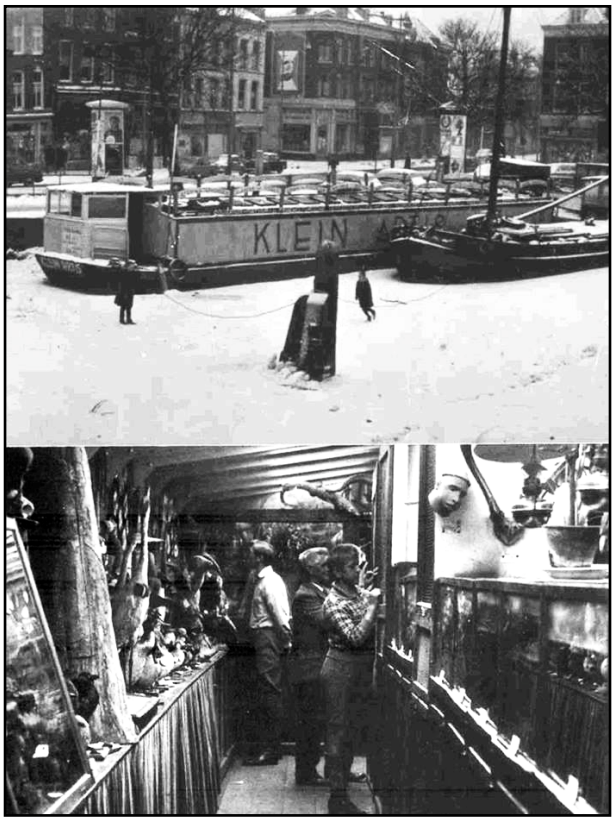
a risk and started publication of the *Tijdschrift voor Aquarium- en Terrariumkunde Flora en Fauna* (Flora and Fauna, the Journal of Aquarium and Terrarium Science). Its first editors were W.J.M. Deutz, M. den Outer and H.J. Thiellier. The subscription price amounted to ƒ3.50 per year. Quite soon afterwards a number of clubs used the journal as their own official newsletter and published information about their meetings and activities (sometimes in too detailed a manner!).

In 1924, saltwater aquarists were organized in The Hague under the name, *Zeeclub Biologia Maritima* (Maritime Biological Seaclub). The co-founder and board member of the club at the time was L. Athos who had joined *Flora and fauna* at the start of its second issue as an employee. Athos wrote countless articles about the aquarium which, slightly modified and adapted to the knowledge of that time, could just as well be published today.

A FLOATING AQUARIUM

Founded in 1838, the Artis Royal Zoo in Amsterdam (artis is short for *natura artis magistra*, Latin for "Nature is the teacher of art and science") is a haven for some 700 animal species and 200 tree varieties, many on the verge of extinction. Artis is also one of the few zoos in Europe to have as many listed buildings within its grounds, namely the Large Museum (1855), the unique Library building (1867) and the Aquarium (1882).

In June of 1924 Deutz started taking what he named the *Klein Artis* (Little Artis), a sort of floating zoo in a small river barge, all along the Dutch waterways and, when docked, asked for a few cents entrance fee. At this time Deutz was succeeded as editor of *Flora and fauna* by C. Cherries. The *Klein Artis* mostly traveled in the provinces of Friesland and Limburg, the people there showing much interest in nature. Rotterdam was the boat's winter mooring. The vessel was



Top: The Klein Artis anchored at its wintertime moorings. Bottom: The interior of the Klein Artis.

equipped with dozens of aquariums, iron-framed with puttied glass and heated by means of oil burners under the bottom tray.

As you can see from the accompanying photograph, strolling through the *Klein Artis* was a very tight squeeze. If you entered the boat during the winter you were covered in smoke from the burners. One Dutch aquarist remarked that when returning home from a visit to *Klein Artis* without him saying where he had been, his wife would welcome him home by saying, "How was the *Klein Artis*?" On his travels throughout the country, Deutz would target aquarium societies along his route and thus increased the interest in the aquarium hobby in the Netherlands. The business later passed on to his son, but after 32 years in existence the *Klein Artis* was no more.

On November 2, 1926, the *Klein Artis* was moored in the Kolk River in Assen, a city in the northeastern Netherlands. A.H. Mulder paid a visit to the boat and he and Deutz discussed the possibility of setting up an aquarium society in Assen. That conversation led to a meeting of six aquarists - along with Deutz and his son - on November 9th who decided to set up a club called *Antoni Leeuwenhoek*. The first executive board consisted of A.H. Mulder (chairman), Mr. Tjepkema (secretary), H. Heringa (treasurer) and Mr. Kwerreveld (general). The club stands as the oldest aquarium society of the Northern provinces and also one of the oldest aquarium societies in The Netherlands.

Deutz was a passionate man, had a tremendous work ethic and often had really good ideas. During the first year of the existence of *Aqua-Terra*, he gave dozens of talks and devised a number of principles for maintaining an aquarium; in addition, he still wrote many articles for his magazine. In the second and subsequent editions of *Aqua-Terra*, the first color images appeared, something that until then had not been featured in a Dutch aquarium magazine.

A CHOCOLATE FACTORY GETS INTO THE ACT

Koninklijke Verkade is a Dutch manufacturing company headquartered in Zaandam and at one time was one of the oldest existing family companies in the Netherlands. Originally founded in 1886 by Ericus Verkade to make mostly bread and rusk, it expanded to produce cookies, sweets and especially chocolates. Starting in 1906, the company began issuing cards (much like our baseball cards but also with writing) with pictures of its products, which could be collected in albums. It started with three Fairytale albums with illustrations purchased in Germany. This was a great success and Verkade decided to issue other

The Klein Artis.

books about various aspects of nature and landscapes in the Netherlands. The albums, most of them written by Jacobus P. Thijsse, were very popular. They generated a kind of collection mania among the Dutch population before World War II; about 30 albums and 360 million cards were made and distributed over a span of 30 years. A huge boost for the aquarium hobby occurred in 1925 when Verkade published an album edited and written by A.F.J. Portielje called *Mijn aquarium* (My Aquarium).

ANTON JOHAN FREDERIK PORTIELJE

Anton Johan Frederik (Frits) Portielje (1886-1965) spent 46 years in the service of the Artis Zoo in Amsterdam. Many thought he was the director of the zoo, but that was not the case. He was for all those years the figurehead of Artis and wrote many books. He was the son of Gerrit and Johanna Portielje Hassels who had a printing business. After his school years he worked at the Nieuwsblad where in addition to writing about court records for his job he also wrote a number of articles about animals. Because of his interest and love for animals he became an assistant in 1906 to the director of Artis who later appointed him later as Inspecteur van de Levende (Superintendent of Livestock).

Anton Johan Frederik (Frits) Portielje (1886-1965).

Portielje was the first specialist in the world to conducted behavioral experiments involving animal instincts. In 1939 he performed experiments on monkeys and the crowning achievement of his investigations into animal behavior was seeing his book, *Dieren* (Animals) published in 1938 and receiving widespread recognition in the academic world. For his contribution to the knowledge of the life and his passion in developing the instinct concept, he received an honorary doctorate in 1946 in mathematics and physics from the University of Amsterdam.

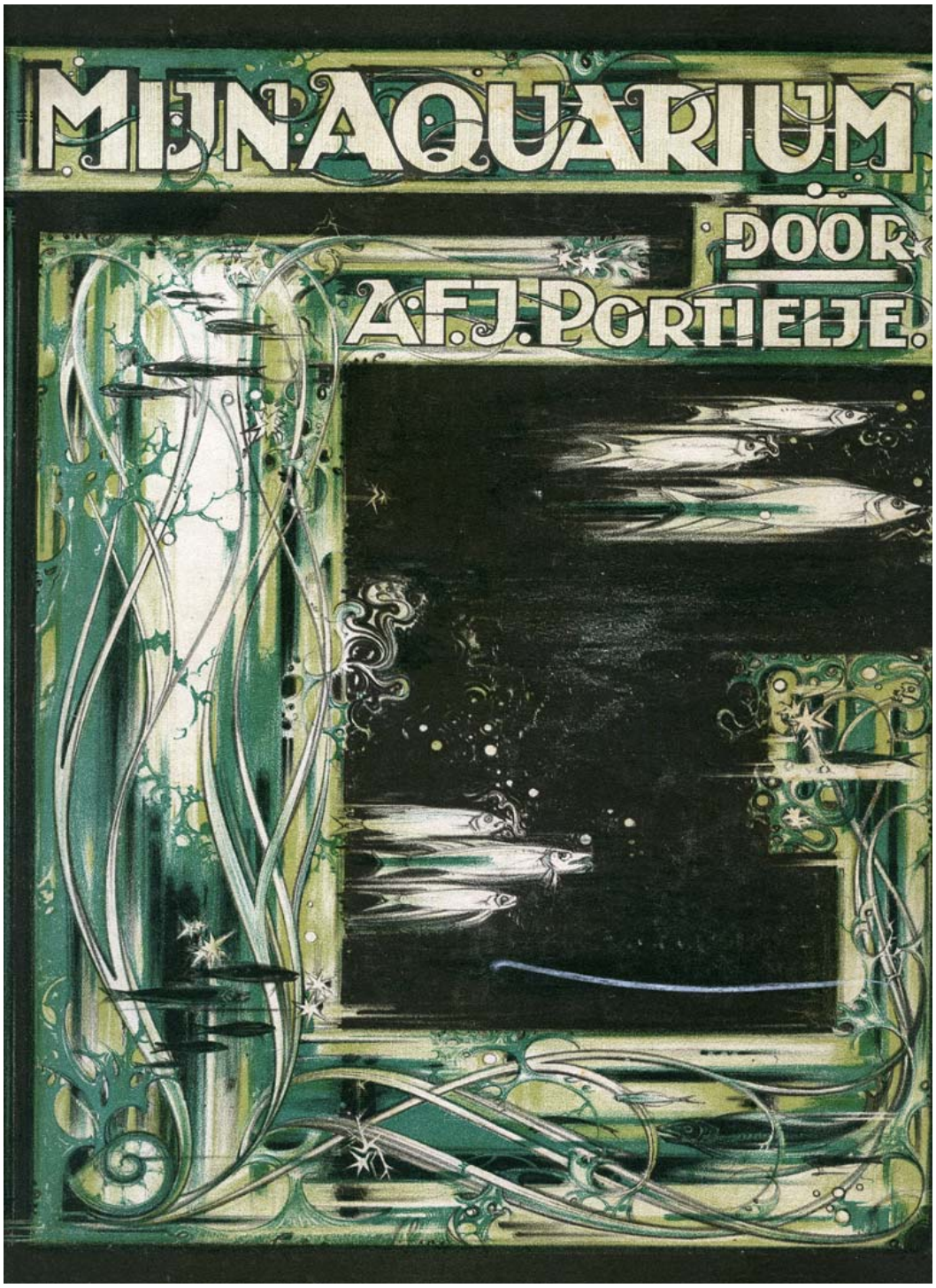
He made many presentations on animal behavior and for a number of years hosted a program on animals at the Dutch radio station, AVRO. His Verkade albums, which were illustrated with the pictures of packaged biscuits and other Verkade products, were very popular: *Wandelingen door Natura Artis Magistra* (Walks through Natura Artis Magistra) in 1922, Mijn *aquarium* (My Aquarium) in 1925, *Dierenleven in Artis* (Lives of animals in Artis) in 1939 and *Apen en hoefdieren* (Monkeys and ungulates) in 1940; they all were printed and distributed in large numbers.

In 1946 he was appointed head of the information department of Artis. In 1952 he retired, the big celebration in Dutch cinemas at that time being a documentary entitled "De dieren van Artis nemen afscheid van Dr. Portielje" (The Artis animal's farewell to Dr. Portielje). For his research, writings and lectures he was awarded the Visser-Neerlandia Prize in 1960.

MIJN AQUARIUM

Verkade's business model for their albums was simple. They sold each album for 50 cents, available from any dealer in

their goods. If desired, the album could also be delivered by mail upon receipt of 70 cents (Note: there were 100 cents in a guilder and the guilder was worth about $15 in today's money). The albums were very large - 12" high x 9-1/2" wide x 3/4" thick - and resembled the photo albums in use today except that the pictures were pasted in rather than using triangular corner holders. The covers were of a thick, hard material and well-bound.

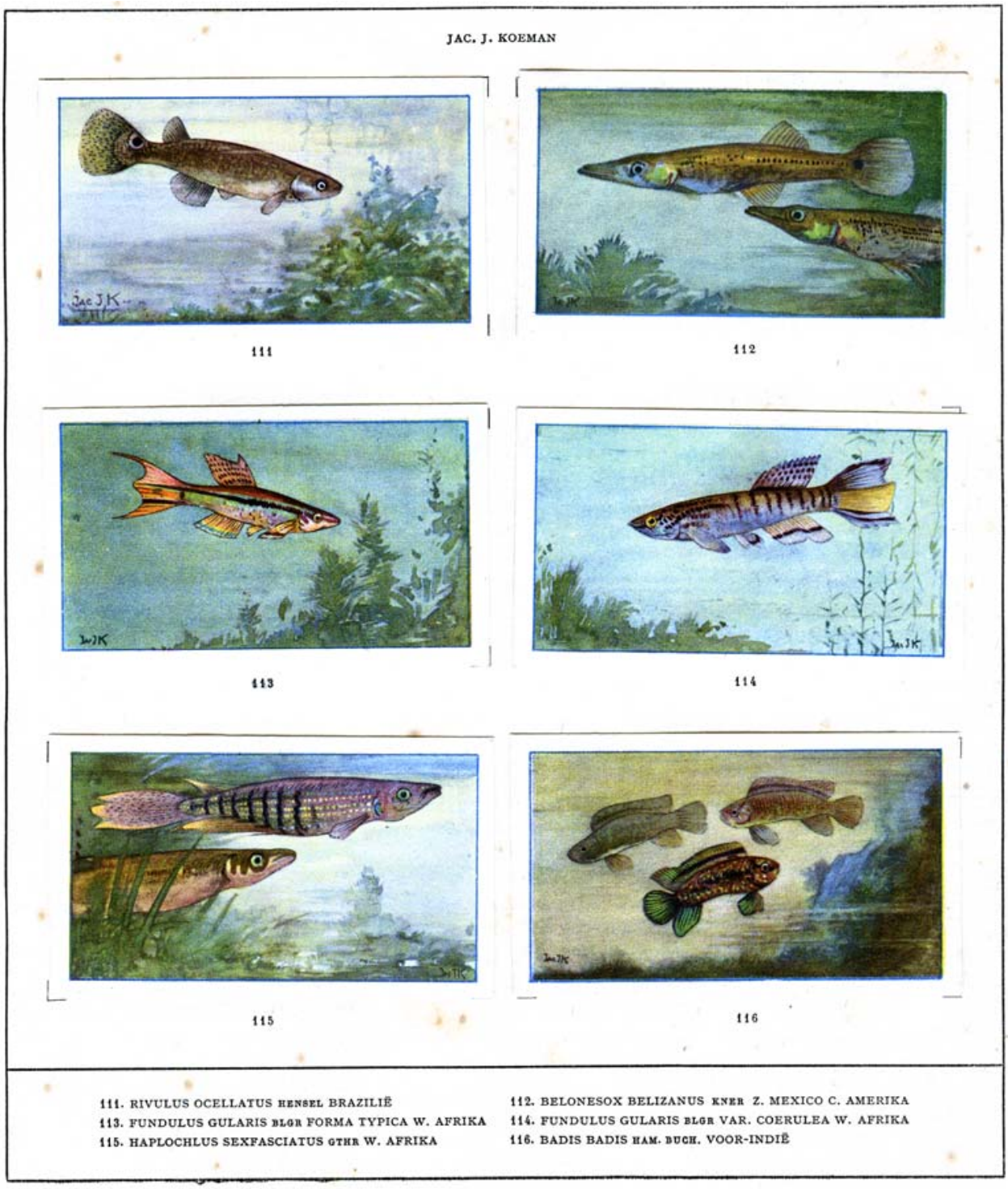


Cover of Mijn Aquarium.

The albums came with the text and the black and white images already on the bound pages; all that the owner had to do was to collect the colored paintings and paste them in. The *Mijn Aquarium* album contained 126 small paintings, each 3-1/2" x 2", printed on a light card stock. On the back of each card were the instructions as to where to paste the card. These cards were packed with Verkade's goods (bread, cookies, chocolates, etc.) and, of course, were free if you bought the

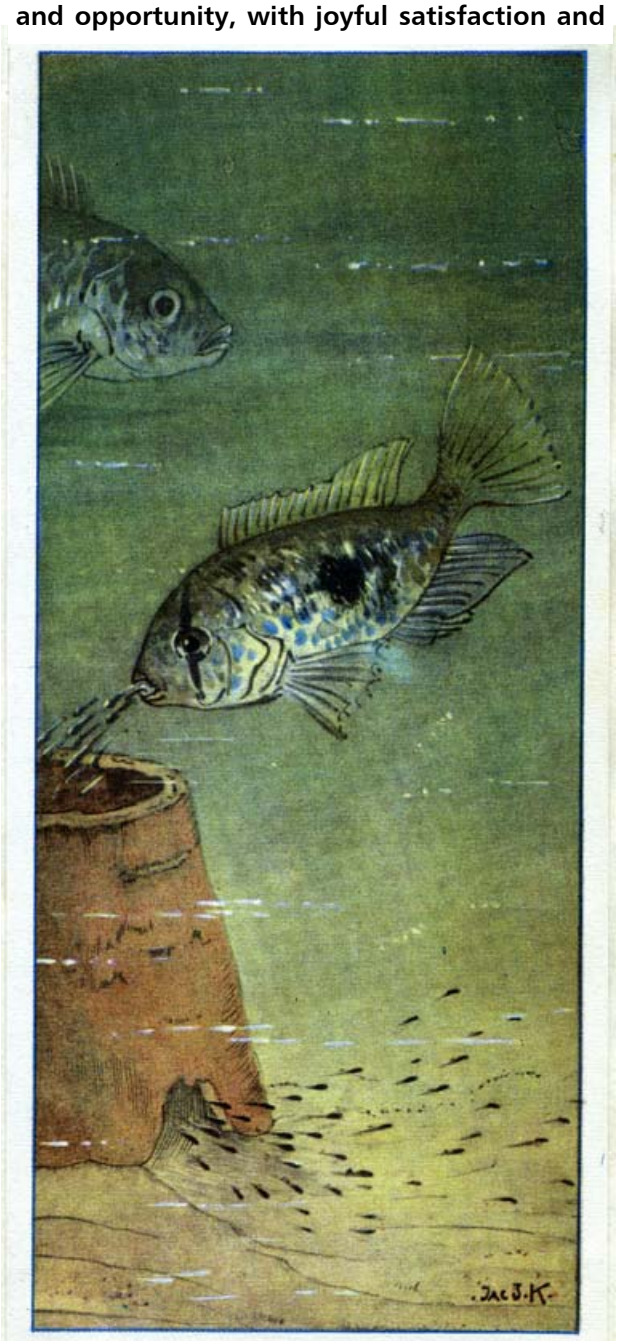
Frontispiece from Mijn Aquarium.

item. Verkade made sure that you would be able to complete the album and one could exchange duplicate cards or buy needed cards directly from the Verkade factory. In addition to the 126 small paintings, the *Mijn Aquarium* album contained about a dozen plates that ranged from a full size page (8-1/2" H x 7-1/2" wide - absolutely gorgeous!) to tall paintings 8" H x 2-1/4" W. These had to be obtained directly from the Verkade factory.



The black and white drawings - and there were many strewed throughout the album - were by J. Voerman Jr. but the colored painting were done by Jac. J. Koeman. The following is how Verkade explained how this all came about:

Having failed to take advantage of both time and opportunity, with joyful satisfaction and after a nearly ten-year period of dormancy we now resume the issue of our albums. Outsiders can hardly imagine how much time and how many headaches there are in the preparation of such an album. A happy coincidence brought us to this new edition. At an exhibition of the work of his pupils held here in Zaandam, we met the young painter, Jac. J.

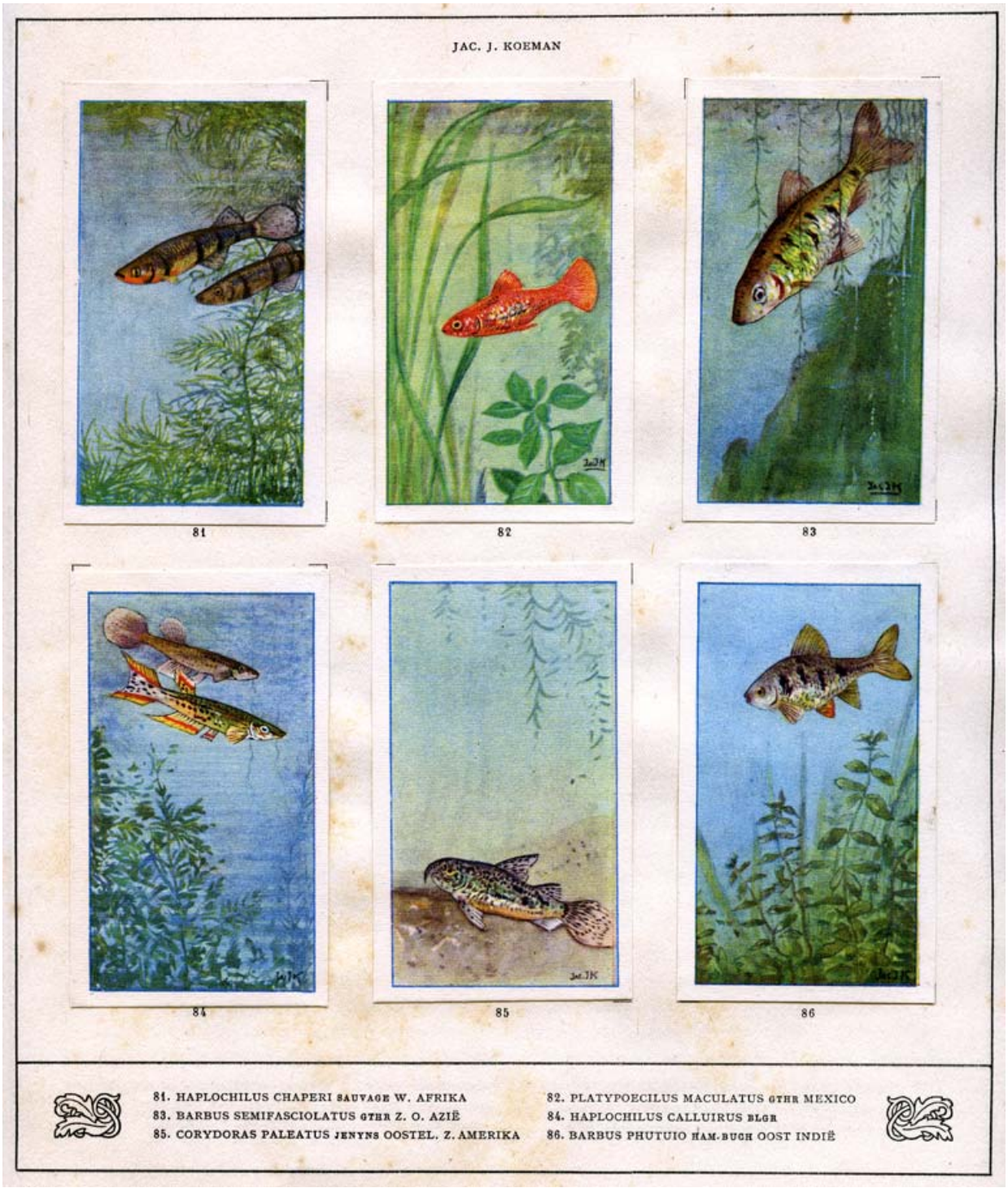


GEOPHAGUS GIJMNOGENYS HECKEL
MET LARVEN

(CARASSIUS LANGSDORFI CUV. ET VAL. VAR JAPONICUS BICAUDATUS.) (JAPANSCH KWEEKPRODUCT) MET CABOMBA CAROLINIANA A. GRAY UIT NOORD-AMERIKA

Koeman. From conversations we had with him it turned out that he was an enthusiastic admirer of our previous albums. He was able to allay our objections to an eventual new edition by being willing not only to take on the whole preparation itself, but also to co-operate in the design and implementation of the graphics and leaf embellishments. As a result, we provisionally commissioned him to create an album, possibly followed by others. What, however, would be the subject?

Firstly, we wanted to take into account our previous workers on the albums, Thijsse,



Carter and Wenckebach, with whom Koeman then held his first talks. That they offered their cooperation willingly is the reason for us to give here our expression of gratitude. The subject matter was resolved by Koeman himself. He wrote to us: "In a quiet corner of my studio is my home aquarium. The many hours that I have enjoyed this wonderful world, have convinced me that this would be a splendid subject for the new album." We were in complete agreement with his choice.

So we now here present this new album, *Mijn Aquarium*. We wanted it to be not only a feast for the eyes, but also a reliable guide for the owners of aquariums, so we asked Mr. A.F.J. Portielje, Superintendent of Livestock at Artis, to write the text. We have no doubt that in him we found "the right man in the right place."

The accompanying illustrations from the book show that Verkade was right! Finally, it is important to note that the publication of *Mijn Aquarium* was an important boost for the hobby in The Netherlands.

THE 1920s MARCH ON

In 1927 an aquarium society called *Vivarium* was established in the "City of Light, a name for the city of Eindhoven, having established a light bulb factory there some six months later. The president of the club, R.W. Dahmen von Buchholz, wrote an article in the April issue of *Flora and fauna* about illuminating aquariums with artificial light. Until then, the lighting of the aquarium consisted exclusively of daylight. Aquariums were either placed near or in front of a window. Daylight, however, is a variable and uncertain factor, so that plant growth during the dark winter seasons left much to be desired. Dahmen von Buchholz illuminated his 100 x 50 x 50 cm-sized aquarium (40x20x20 inches) with two parabolic reflectors, each with a 75-watt bulb (one silver and one semi-matte), burned for 7-2/3 hours each day. In this way he achieved remarkable results, and he described the growth of his plants in detail.

The NBA IS FORMED

By now the aquarium hobby had wind in its sails. New clubs were founded, some of which adopted *Flora and fauna* as its official organ. This increase meant that the demand in 1929 for this umbrella publication was great. It was *Natuurvriend* that took the initiative. It sent a letter to the clubs, asking for cooperation in the establishment of a union. Many clubs had absolutely no interest, the B.A.N. adventure being still fresh in their memory. However, a dozen clubs convened in The Hague to discuss the creation of a union. The majority were convinced of the value of such since together they could achieve more. The stumbling block, however, was the magazine. Should they go on with *Flora and fauna*, or publish their own magazine? Some clubs opted for *Flora en Fauna* further only if they were assured of greater participation and were given more information on its operating costs and revenue. *De Natuur*, which had published the magazine for years at its own risk and expense refused and withdrew.

On August 18, 1929 a commission was appointed and met to prepare for the establishment of a un-

"I lost my appetite!"

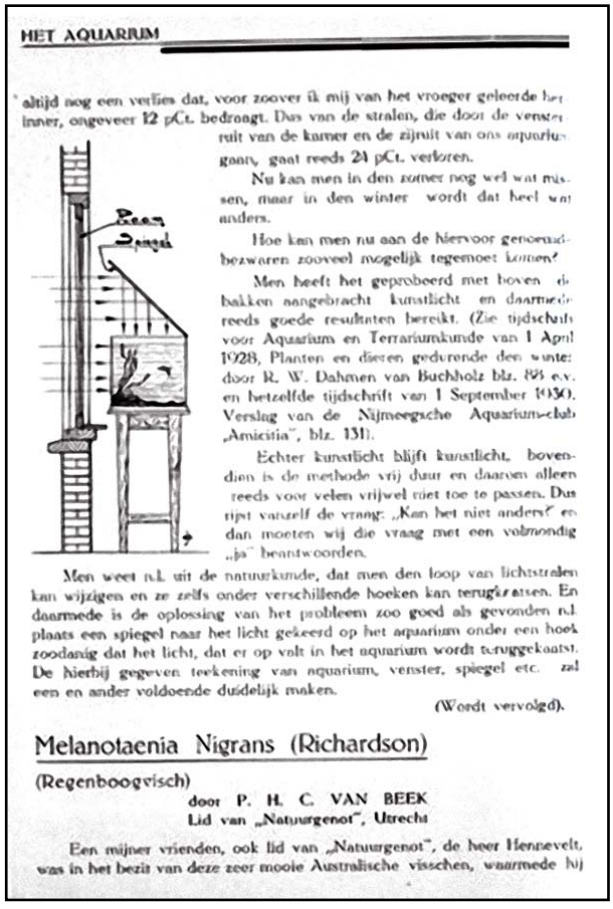
ion. This committee consisted of H. Gijswijt, C.G. Kwint, A. de Ruyter, F.J.C. Zaalberg and J.H.J.M. Oosterhuis. Considering his position in his club, the latter gentleman, although a member of *De Natuur*, was placed on the committee. On March 16, 1930 it finally happened. The inaugural meeting was held in Utrecht, and the *Nederlandsche Bond van Aquariumhouders* or NBA (the Dutch Union of Aquarium owners) was a fact. The core of this third union were the aquarium societies *De Natuurvriend* (Nature Friend) in The Hague, *De Natuur* (Nature) in Haarlem, Dordrecht and Zutphen, the *EUAC* in Utrecht, *Natuurgenot* (Nature Indulgence) in Utrecht, *Danio rerio* in Amsterdam, and *Vivarium* in Eindhoven; a total of eight clubs together consisting of 275 aquarists. The first Board members were: H. Gijswijt, chairman, F.J.C. Zaalberg, secretary, W. Schrameijer, treasurer, L. Prooijen, Commissioner and A. de Ruyter, librarian. Since the NBA had no funds, they issued shares in the amounts of ƒ1.00, f5.00 and ƒ 10.00 to establish an initial capital fund.

THE 1930's

In June 1930 the first issue of *Het Aquarium* (The Aquarium) appeared. It had 16 pages, the subscription price was ƒ3 per year and its first editor was J.R. van der Void of Eindhoven. Only 500 copies of the first edition were printed but after six months this had risen to 800. Yet not all was going well. A few months after the establishment of the NBA, *De Natuurvriend* went back to the *Flora and Fauna Group*. A number of members who disagreed with this decision split off and founded the *Vereniging van Aquariumhouders Scalare* (Association of Aquarium Owners Scalare). Afterwards *De Natuurvriend* and *Scalare* merged once again.

It is remarkable that a subject covered in the first issue of *Het Aquarium* is still topical, viz. how to combat blue-green algae. The second issue led off describing a remarkable novelty electric heater. Up to then heating was with oil lamps, and this would continue for years as the main fuel for heating the aquarium. Mr. Leeuwenberg, a member of *Amicitia* - Nijmegen, wrote an article in August 1931 about heating aquariums using a brine heater. Electric lighting of the aquarium again was described. The author of the article used a reflector with a 75 watt Philips Argalamp for an aquarium of 80 x 30 x 45 cm (32x12x18 inches) and had good results. C.G. Kwint, a staff member of *Het Aquarium*, responded. He opined that this kind of lighting amounted to nothing. Artificial light had no effect on plant growth, he wrote; an aquarium belonged by a window where it could receive daylight.

However, matters with the NBA generally went well and more and more clubs joined the union. In October 1931 there was a change in the editori-



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altijd nog een verlies dat, voor zoover ik mij van het vroeger geleerde her inner, ongeveer 12 pCt. bedraagt. Dus van de stralen, die door de venster ruit van de kamer en de zijruit van ons aquarium gaan, gaat reeds 24 pCt. verloren.

Nu kan men in den zomer nog wel wat missen, maar in den winter wordt dat heel wat anders.

Hoe kan men nu aan de hiervoor genoemde bezwaren zooveel mogelijk tegemoet komen?

Men heeft het geprobeerd met boven de bakken aangebracht kunstlicht en daarmede reeds goede resultaten bereikt. (Zie tijdschrift voor Aquarium en Terrariumkunde van 1 April 1928, Planten en dieren gedurende den winter door R. W. Dahmen van Buchholz blz. 895 e.v. en hetzelfde tijdschrift van 1 September 1930, Verslag van de Nijmeegsche Aquarium-club „Amicitia", blz. 1311.

Echter kunstlicht blijft kunstlicht, bovendien is de methode vrij duur en daarom alleen reeds voor velen vrijwel niet toe te passen. Dus rijst vanzelf de vraag: „Kan het niet anders?" en dan mooten wij die vraag met een volmondig „ja" beantwoorden.

Men weet n.l. uit de natuurkunde, dat men den loop van lichtstralen kan wijzigen en ze zelfs onder verschillende hoeken kan terugkaatsen. En daarmede is de oplossing van het probleem zoo goed als gevonden nl. plaats een spiegel naar het licht gekeerd op het aquarium onder een hoek zoodanig dat het licht, dat er op valt in het aquarium wordt teruggekaatst. De hierbij gegeven teekening van aquarium, venster, spiegel etc. zal een en ander voldoende duidelijk maken.

(Wordt vervolgd).

Melanotaenia Nigrans (Richardson)

(Regenboogvisch)

door P. H. C. VAN BEEK
Lid van „Natuurgenot", Utrecht

Een mijner vrienden, ook lid van „Natuurgenot", de heer Hennevelt, was in het bezit van deze zeer mooie Australische visschen, waarmede hij

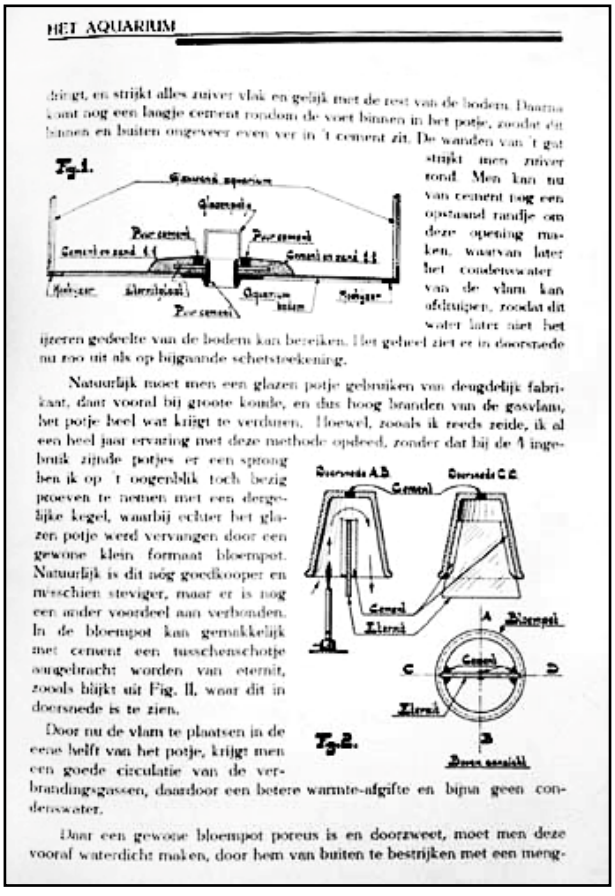
***Het Aquarium*, 1st year, No. 6, February 1930. This was an example of how one could get daylight for plants in an aquarium using a mirror.**

al staff. Van der Void dropped out and was replaced by J. Sybrandi who would perform this function until his death in 1940. During this period Sybrandi, who was an extremely able man and who wrote numerous articles for the magazine, made his mark on *Het Aquarium*. His death was an irreparable loss to the NBA, but even more so for *Het Aquarium*.

The third year began with pep talk from the Union president, H. Gijswijt. The circulation of the *Het Aquarium* had risen to 1,500 copies and the number of employees had increased, he noted, and it was enjoyable to work jointly towards a common goal. If the increase in readers kept up this way we may reach the second thousand at the end of the year. Grow, bloom, bear fruit - that is our watchword, as he ended his speech. Ironically, however, in 1933 Gijswijt got into trouble with his club and had to resign as chairman of *Scalare*. It also meant his end as president of the Union.

After a short interim period, during which Mr. Kranenburg acted as temporary President of the NBA, Dr. L. van der Perk was elected President. The economic crisis in the Netherlands (as in other countries in the world), accompanied by high unemployment, began to be felt in the thirties and the growth of the NBA came to a standstill. The Union now had 26 clubs with a total of 1200 members. Because of the poor financial state of the Union in September 1934, it was decided to issue a loan in the amount of ƒ1000.00. *Flora and Fauna* also suffered the effects of the crisis and the magazine had to reduce the number of its pages. Finally, in September 1934, De *Natuur* in Rotterdam, *De Natuurvriend* in The Hague, *Danio rerio* in Delft and *Natura* in Arnhem joined the NBA and unity was finally restored.

In 1935 the economic crisis reached its peak. Many people were forced to examine every penny twice before spending it. The Union dues amounted to ƒ0.30 per month, an amount which one now laughs at, but then it represented an insurmountable obstacle for many aquarists. For this reason, many newly established clubs decided not to join the Union. Meanwhile, after traveling for 10 years throughout the country with the museum ship *Klein Artis*, W.J.M. Deutz turned the helm over to his son H. Deutz and started living ashore. Soon afterwards old friends with whom he had worked with on *Flora and Fauna* urged him to start a new aquarium magazine. After some hesitation, Deutz agreed. In June 1935 the magazine *Aqua-Terra* appeared on the market with Deutz as its owner and editor. His fellow editors were L. Athos and E. Saathoff. The first issue of *Aqua-Terra* had only eight pages, but within a year the number had doubled to 16. The price of the magazine was only ƒ2 per year and for groups the price was



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dringt, en strijkt alles zuiver vlak en gelijk met de rest van de bodem. Daarna komt nog een langje cement rondom de voet binnen in het potje, zoodat dit binnen en buiten ongeveer even ver in 't cement zit. De wanden van 't gat strijkt men zuiver rond. Men kan nu van cement nog een opstaand randje om deze opening maken, waarvan later het condenswater van de vlam kan afdruipen, zoodat dit water later niet het ijzeren gedeelte van de bodem kan bereiken. Het geheel ziet er in doorsnede nu zoo uit als op bijgaande schetsteekening.

Fig. 1.

Natuurlijk moet men een glazen potje gebruiken van deugdelijk fabrikaat, dan vooral bij groote koude, en dus hoog branden van de gasvlam, het potje heel wat krijgt te verduren. Hoewel, zooals ik reeds zeide, ik al een heel jaar ervaring met deze methode opdeed, zonder dat bij de 4 ingebruik zijnde potjes er een sprong, ben ik op 't oogenblik toch bezig proeven te nemen met een dergelijke kegel, waarbij echter het glazen potje werd vervangen door een gewone klein formaat bloempot. Natuurlijk is dit nóg goedkooper en misschien steviger, maar er is nog een ander voordeel aan verbonden. In de bloempot kan gemakkelijk met cement een tusschenschotje aangebracht worden van eternit, zooals blijkt uit Fig. II, waar dit in doorsnede is te zien.

Door nu de vlam te plaatsen in de eene helft van het potje, krijgt men een goede circulatie van de verbrandingsgassen, daardoor een betere warmte-afgifte en bijna geen condenswater.

Fig. 2.

Daar een gewone bloempot poreus is en doorzweet, moet men deze vooraf waterdicht maken, door hem van buiten te bestrijken met een meng-

***Het Aquarium*, 2nd year, No. 8, January 1932. Not only was light but heat was a problem. This article concerned a discussion on using gas or oil to heat the aquarium.**

even lower. It is no wonder that in its first year of existence 16 clubs, some of which like *Natura* in Arnhem previously affiliated with the Union, chose *Aqua-Terra* as their official organ.

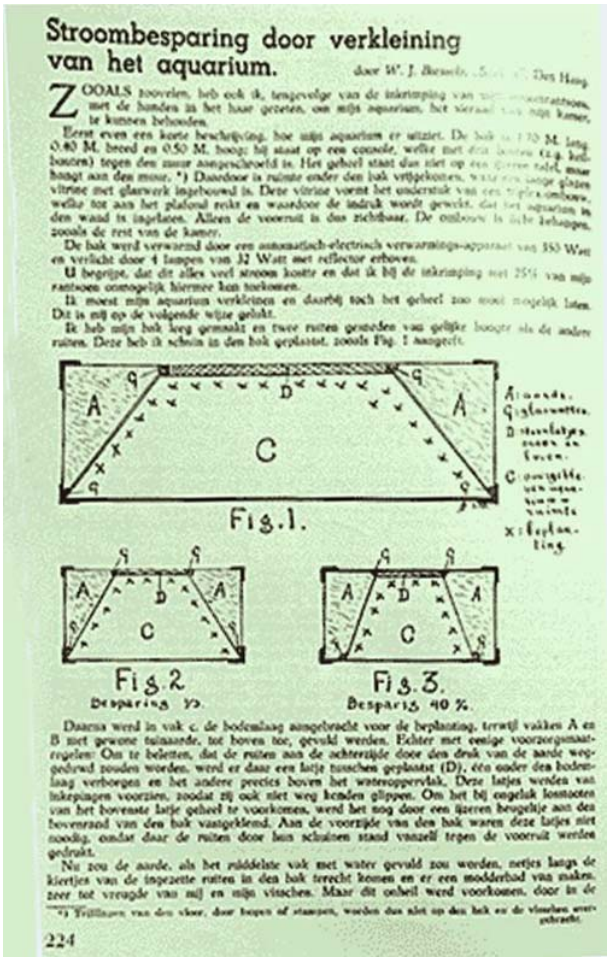
WORLD WAR II

Although in 1939 the Netherlands was not yet involved in the war, it did feel some consequences, especially in the distribution of petroleum products. It is true that petroleum as a fuel for heating the aquarium was already partially replaced by gas and electricity, but many aquariums were still heated with a kerosene burner. In January 1940 the Members Council of the NBA took an important step, one that would have far-reaching consequences. Due to the improved financial situation of the Union its dues, which amounted to over ƒ0.30, were reduced to ƒ 0.20 per month. Thus the main stumbling block for the recruitment of clubs was removed and the results exceeded all expectations. Existing clubs returned to the fold and newly established clubs joined. A few months after the decision, the Union's membership rose by a whopping 50%.

The war affected many cities. The following months demonstrated how important it was to have an umbrella body for aquarium societies. The NBA's board held talks with the National Office for Petroleum Products and achieved limited success. Homes not equipped with gas or electricity were given an allocation of 6 liters of petrol per month. Unfortunately, this joy was short-lived, for in July 1940 a message came from the National Bureau that there might be no further allocations. Also changed were the conditions to be able to petition the Board; clubs or private aquarists were not going to be heard by the authorities.

The heating of tanks and everything connected with it was difficult. It was striking how many aquarium owners trying to solve this urgent problem came up with inventive solutions. In the Volume 13, 1942-1943 issue of *Het Aquarium* there was an article showing how power requirements could be reduced by filling the corners of the aquarium with sand and so reducing the amount of water in the tank to be heated (see the accompany image). The magazine also, with tongue in cheek, advised the members of the NBA to *Slaap zelf met koude voeten en hang de warme kruik in Uw aquarium!* (Sleep with cold feet and hang the hot water bottle in your aquarium!).

The first years of the war had little influence on the paper quality and size of the *Het Aquarium* or *Aqua-Terra*. In late 1941, however, the paper



Stroombesparing door verkleining van het aquarium.

door W. J. Berends, ... Den Haag

ZOOALS toovelen, heb ook ik, tengevolge van de inkrimping van ... met de honden in het haar gezeten, om mijn aquarium, het ... te kunnen behouden.

Eerst even een korte beschrijving, hoe mijn aquarium er uitziet. De bak is 120 M. lang, 0.40 M. breed en 0.50 M. hoog; hij staat op een *console*, welke met ... (e.g. hoekbouten) tegen den muur aangeschroefd is. Het geheel staat dus niet op een ... tafel, maar hangt aan den muur. *) Daardoor is *ruimte onder* den bak vrijgekomen, ... een soort glazen vitrine met glazenwerk ingebouwd is. Deze vitrine vormt het onderstuk van een ... welke tot aan het plafond reikt en waardoor de indruk wordt gewekt, dat het aquarium in den wand is ingelaten. Alleen de voorruit is dus zichtbaar. De ... zoowels de rest van de kamer.

De bak werd verwarmd door een automatisch-electrisch verwarmings-apparaat van 180 Watt en verlicht door 4 lampen van 32 Watt met reflector erboven.

U begrijpt, dat dit alles veel stroom kostte en dat ik bij de inkrimping met 25% van mijn rantsoen onmogelijk hiermee kan toekomen.

Ik moest mijn aquarium verkleinen en daarbij toch het geheel zoo mooi mogelijk laten. Dit is mij op de volgende wijze gelukt.

Ik heb mijn bak lang gemaakt en twee ruiten gemeden van gelijke hoogte als de andere ruiten. Deze heb ik schuin in den bak geplaatst, zooals Fig. 1 aangeeft.

Fig. 1.

Fig. 2
Besparing 33.

Fig. 3.
Besparing 40 %.

Daarna werd in vak c. de bodemlaag aangebracht voor de beplanting, terwijl vakken A en B met gewone tuinaarde, tot boven toe, gevuld werden. Echter met enige voorzorgsmaatregelen! Om te beletten, dat de ruiten aan de achterzijde door den druk van de aarde weggedrukt zouden worden, werd er daar een latje tusschen geplaatst (D), één onder den bodemlaag verborgen en het andere precies boven het wateroppervlak. Deze latjes werden van inkepingen voorzien, zoodat zij ook niet weg konden glippen. Om het bij ongeluk loostoten van het bovenste latje geheel te voorkomen, werd het nog door een ijzeren beugeltje aan den bovenrand van den bak vastgeklemd. Aan de voorzijde van den bak waren deze latjes niet noodig, omdat daar de ruiten door hun schuinen stand vanzelf tegen de voorruit werden gedrukt.

Nu zou de aarde, als het middelste vak met water gevuld zou worden, netjes langs de kiertjes van de ingezette ruiten in den bak terecht komen en er een modderbad van maken, zeer tot vreugde van mij en mijn vischjes. Maar dit onheil werd voorkomen, door in de

*) Trillingen van den vloer, door loopen of stampen, worden dus niet op den bak en de vischjes overgebracht.

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This article in Volume 13, 1942-1943 issue of *Het Aquarium* showed how power requirements could be reduced by filling the corners of the aquarium with sand and so reducing the amount of water in the tank to be heated. At this point Dutch aquarists were grasping at straws.

shortage was exacerbated; the number of pages of the magazines was reduced and the quality of the paper deteriorated.

August 1943 spelled curtains for *Het Aquarium* and *Aqua-Terra*; both journals were closed by orders from on high. The months that followed were extremely difficult for the Dutch population, especially in the west of the country, which included The Hague, Amsterdam and Utrecht. Hunger, cold and war ravaged the people. Who could think at that time about aquariums? Aquarists had only one goal: to survive! Although the end of the war brought true freedom, there was no immediate improvement in the economic situation. There was an enormous shortage in every field and this included paper, which was available only on allocation. It would be late in 1945 before *Het Aquarium* and *Aqua-Terra* would reappear.

UNION IS FINALLY ACHIEVED, SORT OF

The personal feuds that for many years stood in the way of cooperation between the NBA and Aqua-Terra, started to fade with the idea of unity that prevailed after the war. Although in the 10th edition of *Aqua-Terra* Deutz still fiercely disagreed with the government of the NBA, there was already in another area talk of reconciliation. Shortly after the end of the war, NBA's management managed to get an extra petroleum allocation for the members of the clubs affiliated with the Union. When shortly thereafter Aqua-Terra also made a similar attempt, it was told by the National Agency for Petroleum that they wanted to deal with only one central body since one phone call between the secretary of the Petroleum Contact Committee and the Secretary of the NBA was sufficient to resolve any issue. The Union presented the application of the Aqua-Terra Group to the Contact Committee and obtained for it the requested extra allocation.

Unity finally came on May 12, 1946. With tempers sometimes running high, after preliminary discussions the merger agreement was signed in Utrecht by the NBA and the Aqua-Terra Group. All 62 clubs with a total of 3140 members were now united in a single union, which from that time bore the name Nederlandse Bond Aqua Terra (NBAT). Publication of *Aqua-Terra* was suspended and two of its editors joined the editorial staff of the *Het Aquarium*. The first executive committee of the NBAT consisted of J.M. Lodewijks, Chairman; Mr. Bot, Secretary; and J.A. de Rot, treasurer. W.J.M. Deutz also was elected to the Board and assumed the role of Publicity Chairman. The years that followed were dominated by the reconstruction period in the Netherlands but slowly, economic stagnation came to an end and the aquarium hobby crawled out of the mire.

In the cold winter of 1944/45, when fuel was mostly unattainable, not many aquarium fish had survived. The fish population was now severely depleted, and the prices of aquarium fish soared. Glass also was scarce and only available upon allocation. Despite all these handicaps, the hobby flourished. New clubs were established and within a short time the membership of the Union rose to more than 5000 in 1949; later it would even exceed 10,000. The work associated with this increased membership was too large for a single

"You can't blame it on the dog, Hans; I can see the bubbles."

board member to do in his spare time. Therefore, in September 1948 Mr. P. de Bruijn was appointed as administrator and NBAT finally had a Union office.

After four years of peace and progress in the Union, the first cracks became visible in the hitherto closely united NBAT. Deutz became more and more in conflict with his fellow members of the Board and the arguments came to a head in 1950. Deutz threatened to leave the NBAT, remarking, "Torn as it [the NBAT] is, I'll tear it with me."

From October 21-29, 1950 eight clubs held a large aquarium exhibition in the Rivièrahal building of the Blijdorp Zoo in Rotterdam that attracted a record number of over 40,000 visitors. Despite this success, the tension remained, especially since it was known that Deutz had many followers in Rotterdam. During the exhibition, the bomb burst. Together with a few former loyalists he founded the *Unie van Aquariumverenignen* or UvA (Union of Aquarium Associations). Three of the Rotterdam clubs and some in other parts of the country rallied behind Deutz and joined the new Union. As if nothing had happened in the past four years, the first issue of the 11th volume of *Aqua-Terra* was published in January 1951. The NBAT responded almost immediately. With the merger in 1946, Deutz had ceded all rights to the name so the NBAT filed a lawsuit against Deutz, demanding that he stop using it. The NBAT won the case and Deutz was forced to change the name of his magazine to *Waterweelde* (Water Riches).

Not only did the NBAT prosper by the economic boom in the aquarium hobby, UvA also benefited, albeit to a lesser extent. In June 1951 the Union had 25 member clubs; in March of 1952 there were 50. In subsequent years, however, the growth of UvA stagnated and the first of its problems came in 1955. UvA wanted to take over the management of *Waterweelde*, hitherto owned by Deutz and his co-editor Jeremy Lever. Liver agreed and reluctantly Deutz abided by the decision taken by the Council of Members of the UvA. Defeat, however, was unacceptable for Deutz. In September 1956 he left the UvA and reported back to the NBAT, some clubs following him and also joining the NBAT. It was the beginning of a veritable exodus of UvA clubs. In 1962 it threw in the sponge and disbanded. Meanwhile, television posed a much greater competitor to the NBAT. In many households aquarium viewing gave way to the tube and, as a result, membership in the Union dropped for the first time in 10 years.

EPILOGUE

De Nederlandse Bond Aquaterra or NBAT today is the umbrella organization for nearly 90 aquarium clubs. *Het Aquarium* is still its official organ and the magazine is published - in full color - eight times a year for aquarium, terrarium and pond lovers. I have subscribed to this magazine for many years and consider it one of the finest aquarium magazines ever published. Publication in a digital format is planned for next year.

In 1943, 31 clubs with 1,357 members were affiliated with the NBAT. By 1946 this had grown to

"Don't tap on the glass dear; those are fish, not apps."

Okay, here's the glass cutter you asked for. Now don't go doing anything stupid!

62 clubs with 6,140 members and by 1955 to 232 clubs with 16,112 members. In 1972 nearly 35,000 members were associated with the NBAT although this had decreased to around 9000 by 1992. The latter figure probably represented something less than 10% of the total number of people in the Netherlands with one or more aquaria, a number believed to be between 100,000 and 150,000 and having stayed fairly stable over the last few years. According to a recent estimate, in the Netherlands there are as many as 220 fish clubs and (including people with a pond) 450,000 fish hobbyists in the country.

As the hobby developed in the Netherlands, competitive aspects became of increasing importance with local and national competitions arising in which aquaria are judged in situ. Originally fish only played a minor role in these aquaria, with aquatic plants being of major importance. However, as more and more specialist aquarist associations arose, themed aquaria - for example, those for East African cichlids with rocky habitats, or marine aquaria - were also allowed to enter the competitions. Fish and other animals were of much greater importance in these more specialized aquaria. Nowadays the competition is further extended with the participation of riparia (i.e. shoreline aquaria) and aqua-terraria.

Finally, two major aquascaping styles dominate the world of freshwater aquariums today: the Nature style and the Dutch style. Of these two, the Dutch aquascape style is the oldest. The Dutch aquarium employs a lush arrangement in which multiple types of plants having diverse leaf colors, sizes and textures are displayed much as terrestrial plants are shown in a flower garden. This style was developed in the Netherlands starting in the 1930s as freshwater aquarium equipment became more commercially available. It emphasizes

Example #1 of the Dutch Aquarium.

plants located on terraces of different heights and frequently omits rocks and driftwood. More than 80% of the aquarium floor is covered with plants, and little or no substrate is left visible. Tall growing plants that cover the back glass originally served the purpose of hiding bulky equipment behind the tank.

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Example #2 of the Dutch Aquarium.

A CASE of AQUARIUM PIRACY and PLAGIARISM

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, December 5, 2015)

In my essay, "Emil Adolf Rossmässler, Father of the Aquarium Hobby in Germany," I described a book, *Aquarium. Belehrung und Anleitung, solche anzulegen und zu unterhalten* (Aquarium. Instruction and Guidance for its Creation and Maintenance) written by a "Dr. L. Müller" in 1856 and published in Leipzig by Ernst Schäfer. The author was somewhat of a mystery since he could not be identified with any certainty. However, some bibliographic references identified him as Dr. Ludwig Müller, a subrector (i.e., an assistant to a rector, the highest academic official of a school) at a school in Kiel. Müller was born in 1801 and studied theology at the University of Kiel. His doctorate was an Honorary Doctor of Philosophy, given to him in 1847 by the University of Kiel for his 25 years of outstanding service to his school. In 1864 he died of cancer. However, I was unwilling to naming him as the author since the book was not mentioned in his obituary.

After I published my Rossmässler essay I came into possession of the book, *Plain instructions for the Management of the Aquarium, or, tank for Gold and Other Fish, Water Plants, Insects, etc.*, written by F.S. Leach, a "manufacturer and fitter up aquariums." The editor was James Bishop and the illustrations were done by R.C. West. It was a small book, 46 pages, published in London by Dean & Son ("three doors west of Old Bailey').

Figure 1 shows the covers of the Leach and Müller books and Figures 2 and 3 each show a similar

PLAIN INSTRUCTIONS FOR THE MANAGEMENT OF THE

AQUARIUM,

OR, TANK FOR

GOLD AND OTHER FISH,

WATER PLANTS, INSECTS, &c.

BY F. S. LEACH,

MANUFACTURER AND FITTER UP OF AQUARIUMS,

BEDFORD CONSERVATORY, COVENT GARDEN.

LONDON:

DEAN & SON, 31, LUDGATE HILL,

THREE DOORS WEST OF OLD BAILEY.

Aquarium.

Belehrung und Anleitung,

solche anzulegen und zu unterhalten.

Leipzig,

Verlag von Ernst Schäfer.

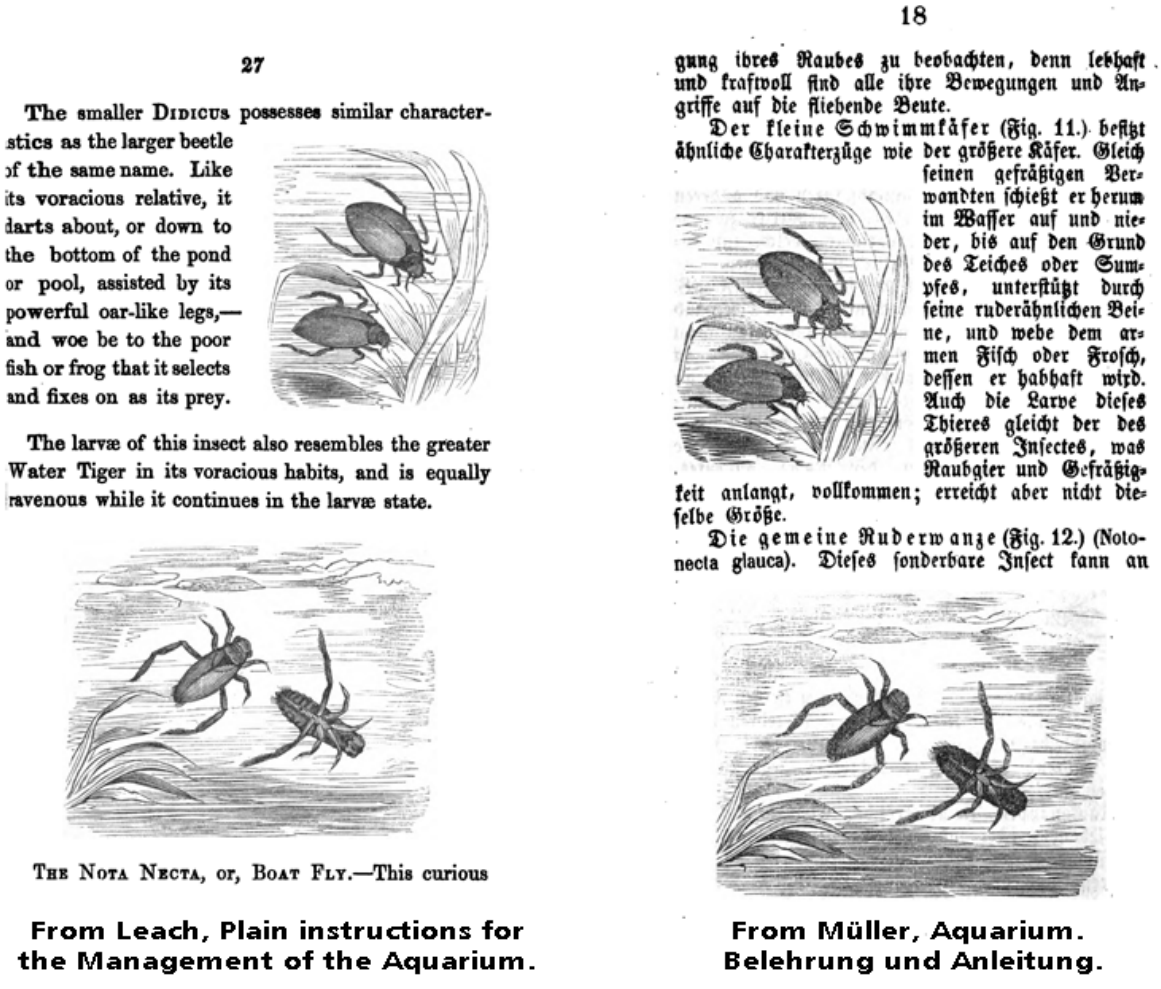
1856.

FIGURE 1

page from each book. Incidentally, in describing the "*Didicus"* beetle in both books, the name of the beetle is misspelled as it should be "*Dyticus*" if you accept Etienne Geoffrey Saint-Hilaire's name for the genus or "*Dytiscus*" is you accept Linneaus' name. Linneaus first wrote *Dyliscus* in 1735, and he never altered it. The word *Dyticus* first appeared in Geoffroy's "Histoire Abrégée des Insectes" which was published anonymously twenty-seven years later. Therefore, in accordance with the law of priority, the spelling must be *Dytiscus*. In any event, the point is that Müller's book is a word-for-word translation of the Leach book. There parts of the latter that were not translated, of course, since they were relevant to the British hobby or to Leach himself; for example, pages 42-43 where Leach talks about a young friend's experiences. Of the 46 pages of the Leach book, 32 pages were identical to that of the German translation.

The publisher did not include a date for the Leach book. However, the *Publisher's Circular* included the book in its edition of June 2, 1856 and the *American Publisher's Circular and Literary Gazette* included it in its edition of June 28, 1856. Finally, although the British Museum Library Catalogue notes the date as 1856, my copy has a library date stamp that reads "21 MY 56" so I am accepting May 1856 as the latest publication date.

The modern concept of copyright originated in England in the year 1710 with the Statute of Anne, with the copyright term lasting for 14 years plus an optional renewal of 14 additional years. Under the



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The smaller DIDICUS possesses similar characterstics as the larger beetle of the same name. Like its voracious relative, it darts about, or down to the bottom of the pond or pool, assisted by its powerful oar-like legs,—and woe be to the poor fish or frog that it selects and fixes on as its prey.

The larvæ of this insect also resembles the greater Water Tiger in its voracious habits, and is equally ravenous while it continues in the larvæ state.

THE NOTA NECTA, OR, BOAT FLY.—This curious

From Leach, Plain instructions for the Management of the Aquarium.

18

gung ihres Raubes zu beobachten, denn lebhaft und kraftvoll ſind alle ihre Bewegungen und Angriffe auf die fliehende Beute.

Der kleine Schwimmkäfer (Fig. 11.) beſitzt ähnliche Charakterzüge wie der größere Käfer. Gleich ſeinen gefräßigen Verwandten ſchießt er herum im Waſſer auf und nieder, bis auf den Grund des Teiches oder Sumpfes, unterſtützt durch ſeine ruderähnlichen Beine, und wehe dem armen Fiſch oder Froſch, deſſen er habhaft wird. Auch die Larve dieſes Thieres gleicht der des größeren Inſectes, was Raubgier und Gefräßigkeit anlangt, vollkommen; erreicht aber nicht dieſelbe Größe.

Die gemeine Ruderwanze (Fig. 12.) (Notonecta glauca). Dieſes ſonderbare Inſect kann an

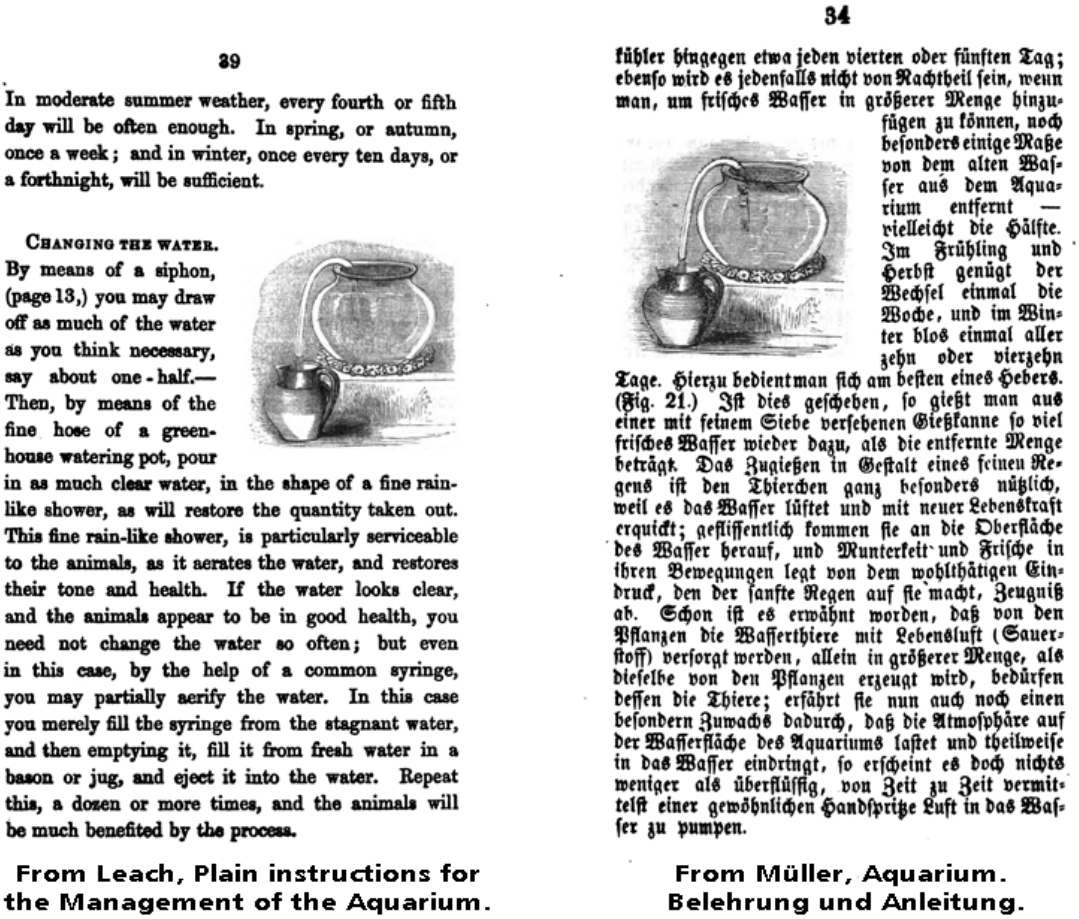
From Müller, Aquarium. Belehrung und Anleitung.

FIGURE 2

Copyright Act of 1842 - covering the period in which I am comparing these two books - the copyright period lasted for the lifetime of the author plus 7 years, or for 42 years from first publication, whichever was longer. However, the Act only applied to the copying of books and nothing was said in the Act about translations. It was only until the Convention of Berne in 1886 when authors were specifically protected against unauthorized translations. The fact that the British law had no provision for translations, explains why the publisher of the Leach book, Dean & Son of London, did not do anything about it.

Germany, on the other hand, didn't bother with the concept of copyright for a long time. Prussia, then by far Germany's biggest state, introduced a copyright law in 1837, but the division into small states meant that it was hardly possible to enforce the law throughout the empire since authors and publishers just had to go to another German state to circumvent its ruling. In Germany, therefore, publishers had plagiarizers who could reprint each new publication and sell it cheaply without fear of punishment breathing down their necks. Copyright laws in German were not enforceable until the unification of Germany in 1871. Thus the publisher of the Müller book, Ernst Schäfer of Leipzig (which was not a part of Prussia at the time), could easily get away with plagiarism.

There is no mystery as to who published first and who pirated from whom, however. The artist's signature appears on the cover art of the Leach book as well as the "Fresh-water Wilk" on page 16, the "Diving Water Spider" on page 17, the "Hydris"



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In moderate summer weather, every fourth or fifth day will be often enough. In spring, or autumn, once a week; and in winter, once every ten days, or a forthnight, will be sufficient.

CHANGING THE WATER.

By means of a siphon, (page 13,) you may draw off as much of the water as you think necessary, say about one-half.—Then, by means of the fine hose of a green-house watering pot, pour in as much clear water, in the shape of a fine rain-like shower, as will restore the quantity taken out. This fine rain-like shower, is particularly serviceable to the animals, as it aerates the water, and restores their tone and health. If the water looks clear, and the animals appear to be in good health, you need not change the water so often; but even in this case, by the help of a common syringe, you may partially aerify the water. In this case you merely fill the syringe from the stagnant water, and then emptying it, fill it from fresh water in a bason or jug, and eject it into the water. Repeat this, a dozen or more times, and the animals will be much benefited by the process.

From Leach, Plain instructions for the Management of the Aquarium.

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kühler hingegen etwa jeden vierten oder fünften Tag; ebenso wird es jedenfalls nicht von Nachtheil sein, wenn man, um frisches Wasser in größerer Menge hinzufügen zu können, noch besonders einige Maße von dem alten Wasser aus dem Aquarium entfernt — vielleicht die Hälfte. Im Frühling und Herbst genügt der Wechsel einmal die Woche, und im Winter blos einmal aller zehn oder vierzehn Tage. Hierzu bedient man sich am besten eines Hebers. (Fig. 21.) Ist dies geschehen, so gießt man aus einer mit feinem Siebe versehenen Gießkanne so viel frisches Wasser wieder dazu, als die entfernte Menge beträgt. Das Zugießen in Gestalt eines feinen Regens ist den Thierchen ganz besonders nützlich, weil es das Wasser lüftet und mit neuer Lebenskraft erquickt; gestissentlich kommen sie an die Oberfläche des Wasser herauf, und Munterkeit und Frische in ihren Bewegungen legt von dem wohlthätigen Eindruck, den der sanfte Regen auf sie macht, Zeugniß ab. Schon ist es erwähnt worden, daß von den Pflanzen die Wasserthiere mit Lebensluft (Sauerstoff) versorgt werden, allein in größerer Menge, als dieselbe von den Pflanzen erzeugt wird, bedürfen dessen die Thiere; erfährt sie nun auch noch einen besondern Zuwachs dadurch, daß die Atmosphäre auf der Wasserfläche des Aquariums lastet und theilweise in das Wasser eindringt, so erscheint es doch nichts weniger als überflüssig, von Zeit zu Zeit vermittelst einer gewöhnlichen Handspritze Luft in das Wasser zu pumpen.

From Müller, Aquarium. Belehrung und Anleitung.

FIGURE 3

on page 21, the Triton on page 23, the "Didicus" on page 25, "The Anachrus" on page 33 and "The Valisneria Spiralis" on page 34. Although a good magnifying glass is a help in determining the signature, on the rather large Valisneria on page 34 the artist's name is quite easily seen without squinting. The artist is R.C. West and this name has been deliberately erased in all of these instances in the Müller book!

This, and the fact that the British law had no provision for translations, explains why the publisher of the Müller book, Ernst Schäfer of Leipzig (which was not a part of Prussia at the time), was able to get away with this piracy (for the copying) and plagiarism. And, purely and simply, it was plagiarism since no one has the right to claim authorship when all one has done is to simply translate a work like Müller did. In this, both Müller (whoever he was) and the firm of Ernst Schäfer are to be condemned.

In any event, it is not true that Müller's book was the first German book, as it is nothing more than a translated British book. The first German book was Rossmässler's *Das Süsswasser-Aquarium*, published in 1857.

Lastly, it should be noted that the Leach book was, to say the least, held in some contempt. In an anonymous article titled "The Literature of the Aquarium" that appeared in the *National Magazine*, Vol. III, pp. 46-48, 1858, the author states:

We have before us eight of the many works that have been published on the aquarium; and strange to say, with but one exception, each has merits of its own, and no two come into actual competition. We give the titles of these below, and shall glean from them a few particulars which may prove both interesting and useful to our readers.

The following is the list of the books the author consulted:

(1) **Shirley Hibberd**: *Rustic Adornments far Homes of Taste, and Recreations for Town-folk in the Study and Imitation of Nature*.

(2) **Shirley Hibberd**: *The Book of the Aquarium and Water-Cabinet; or Instructions on the Formation and Management of Collections of Freshwater and Marine Life.*

(3) **H. Noel Humphreys**: *Ocean and River Gardens: a History of the Marine and Fresh-water Aquaria*.

(4) **G. B. Sowerby**: *Popular History of the Aquarium*.

(5) **E. Lancaster**: *The Aquavivarium, Fresh and Marine*.

(6) **Rev. J. G. Wood**: *The Common Objects of the Seashore, including Hints for an Aquarium.*

(7) **H. G. Adams**: *The Seaside Lesson-Book: designed to convey to the youthful Mind a Knowledge of the Common Things of the Seacoast*.

(8) **F. S. Leach**: *Plain Instructions for the Management of the Aquarium*.

The commentaries for each of these books were in my opinion well-done, but the omission of any of Gosse's books is strange. In any event, the following is the last paragraph of the article:

We have only one word for the last book on our list, and it is this: How Messrs. Dean could attach their respectable name to it we cannot imagine. It is by attempting to follow such a work as this that we hear of so many "aquarians in difficulties."

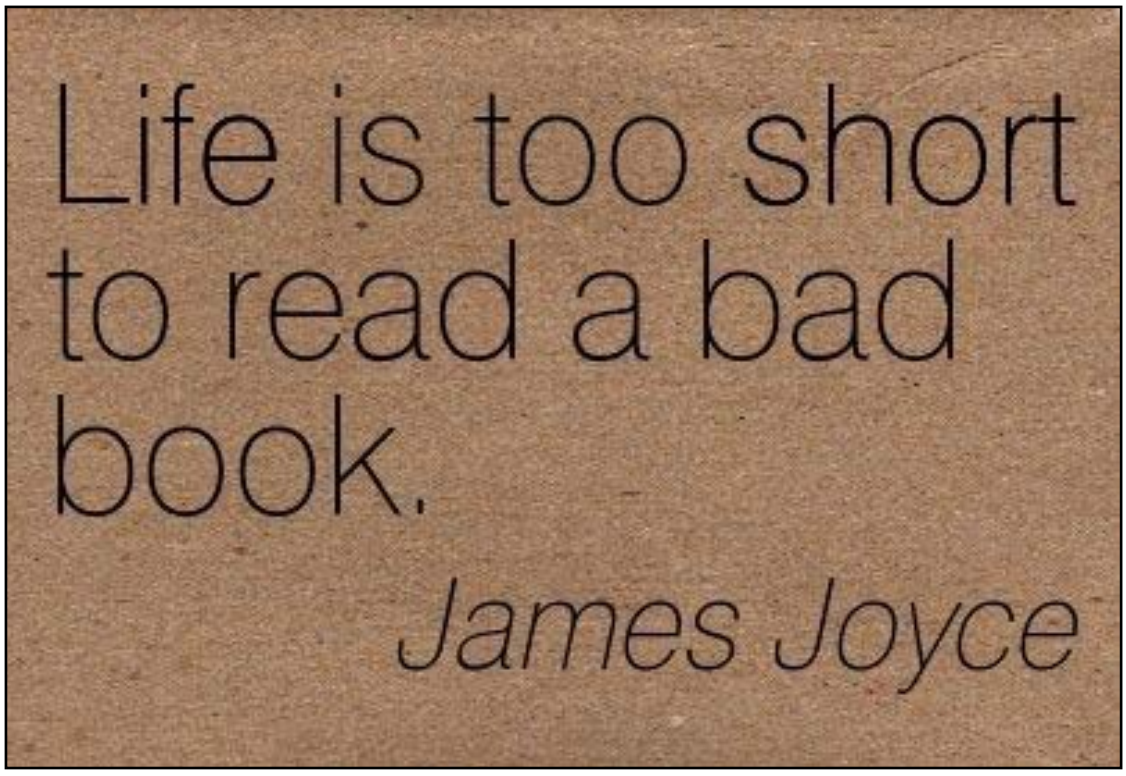
If I have ever read a more severe condemnation of a book, I cannot recall one. However, I cannot disagree with the reviewer. There were much better books for the "Management of the Aquarium."

However, the anonymous reviewer did not provide any details of what he found wrong with it. The following review, however, provides the missing details (Reference: **Anon.**, "Instructions for the Management of the Aquarium, by F. S. Leach. Edited by J. Bishop," *The Governess: A Repertory of Female Education*, Vol II, pp. 283, Darton & Co, Holborn Hill, London, June 1856.):

When a shilling pamphlet occupies the pens of two persons in its production, we have a right to expect something good for our money; but this work would be unacceptable, even as a gift. Instead of teaching us how to stock and maintain an aquarium, the book is replete with small twaddle about spiders, beetles, flies, and worms; two or three pages only being devoted to the fishes. When we find that the few remarks respecting the latter are worse than commonplace—in fact, miserably erroneous, we can do no more than pronounce the work as worthless. It is a most illiterate production; the names of animals and plants are in nearly every case incorrectly spelt, and the diction throughout is of the lowest class. Do our scientific readers know anything of the *Anachrus* or the *Diditcus*, or, above all, the plant to which the author, in ignorance of its true name, designates the Anna Comfry. We know what the plants are that he refers to, and we could tell him how to spell their names; but that may not be the case with the young people for whom the book professes to be written.

The whole thing is an evidence of how little knowledge it requires now-a-days to produce books. If this is intended by Mr. Leach as a mere trade advertisement, we should advise him and his editor to go to school, or the literary partnership may cause the breaking up of what little trade Mr. Leach may have already acquired in this very new and to him strange employment, of dealing in aquarian stock. A good book on the subject is still wanting.

This review, by the way, is evidence of a real contribution to the aquarium world by women in the nineteenth century, namely in the world of education. *The Governess* reviewed all sort of books but without exception they all had something to do with education. Ergo, these female educators believed that the aquarium had a place in the classroom as an educational tool and used it as such. Chalk up another first for women in the aquarium hobby!



The FISHES and FISHPONDS of ANCIENT EGYPT

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, January 9, 2016)

In the 4th edition of THE TOY FISH, I wrote:

"Although it might seem that the Romans should be given credit for being the first Stage I aquarists to construct vertical-walled tanks, (the figure) shows an ornamental fish pond at the Temple of Amon in Luxor, constructed about 1350 B.C. Since the amphorae embedded in the walls show that the Egyptians not only knew how to build fishponds but also were knowledgeable about the requirements for keeping fish, the credit, therefore clearly goes to the Egyptians."

Fish were enjoyed by all classes of Egyptian society, both the poor and the wealthy, and were part of most Egyptians' daily diet. Like in Rome much later, Mullet were particularly favored, and the roe was considered to be a delicacy. The Israelites, who had become accustomed to the standard Egyptian diet of bread, fish and vegetables, complained when they were wandering in the desert: "We remember the fish, which we did eat freely in Egypt…"

Certain species of fish were associated with various deities and therefore considered to be sacred. The symbol of the patron goddess of fishermen, Hat-Mehit, was the Lepidotus Fish (*Barbus bynni*). The goddess Neith was associated with the Nile Perch (*Lates niloticus*; the Greeks named the city of Esna "Latopolis" for the prominence that the Nile perch held in the city's religious practices), the Nile Carp (*Labeo niloticus*) was associated with Osiris, and the gods Ra and Atum with the eel. The Nile Mormyrid was a symbol of the evil god Set, and therefore reviled (in some instances, however, it was held as sacred because it was thought to carry some of Osiris' own flesh). The Chromis (*Chromis niloticus*) acted as a pilot for Ra's solar bark and warned him of the approach of the serpent Apophis as the bark traveled through the Duat, the realm of the dead in Egyptian mythology.

Khabekhnet lived during the 19th dynasty when Ramesses II (1279-1212 BC) was on the throne. He worked in the royal tombs at the Valley of the Kings in Deir el-Medina, his title being "Servant in the Place of Truth." In his tomb there is a wall painting of a mummy depicted as a fish (Figure 1). The fish has been identified as the Nile perch (*Lates niloticus*) and was explained as a symbol of the deceased awaiting rebirth. The precise meaning of this fish mummy is uncertain, but it probably represents the deceased, who associated himself with the god Osiris. The Nile perch has been interpreted as symbolizing the turbulent stage of the journey of the deceased; the Nile tilapia the calmer. Why Khabekhnet chose the Nile perch in this case and not the usual tilapia, we probably will never know.

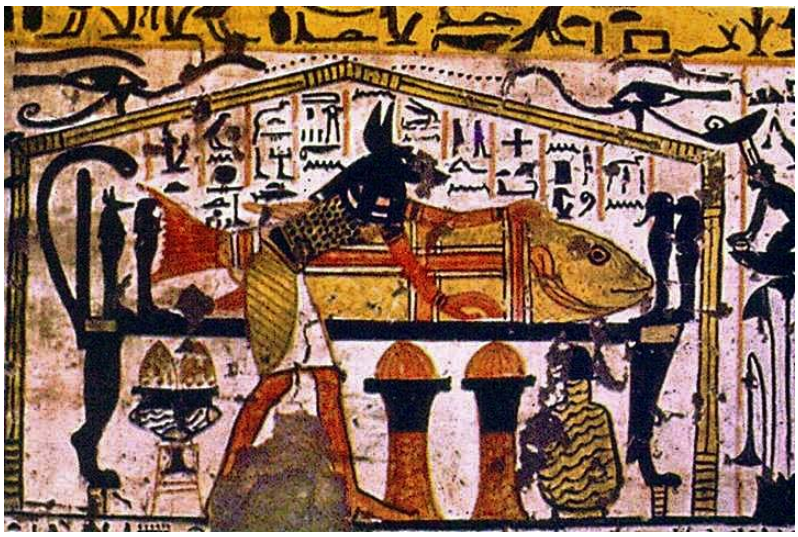


Figure 1: The fish mummy in the tomb of Khabekhnet, 19th Dynasty.

Tilapias - *Tilapia nilotica* or *galilaea* (see my essay, "Our First Aquarium Cichlid") - were regarded as a symbol of rebirth because it carries its eggs in its mouth. They were believed to have multiple lives, and to be self-created. The image of a Tilapia with lotus flowers issuing from its mouth was a symbol of resurrection. Amulets of both were buried with the dead. The heart was likened to a "red fish swimming in a pond." During the harrowing journey through the Duat, the deceased at one point changed into a fish and the possession of a fish amulet was believed to help with this transformation. Sometimes an actual mummified fish (often a *Lates*) was included in the mummy wrappings.

Figure 2 Shows a painting of fish offerings (tilapia) from the Tomb of Benia, supervisor of construction work at the foot of the south-eastern hills of Sheikh Abd el-Qurna in Thebes. The offering of fish is rarely seen, probably because it was not considered prestigious enough. A representation of a tilapia is noteworthy, however, since as I have mentioned previously this fish is also a symbol of rebirth. Dating the tomb precisely is a difficult task and is still debated, because there are no names of rulers mentioned anywhere in the tomb.

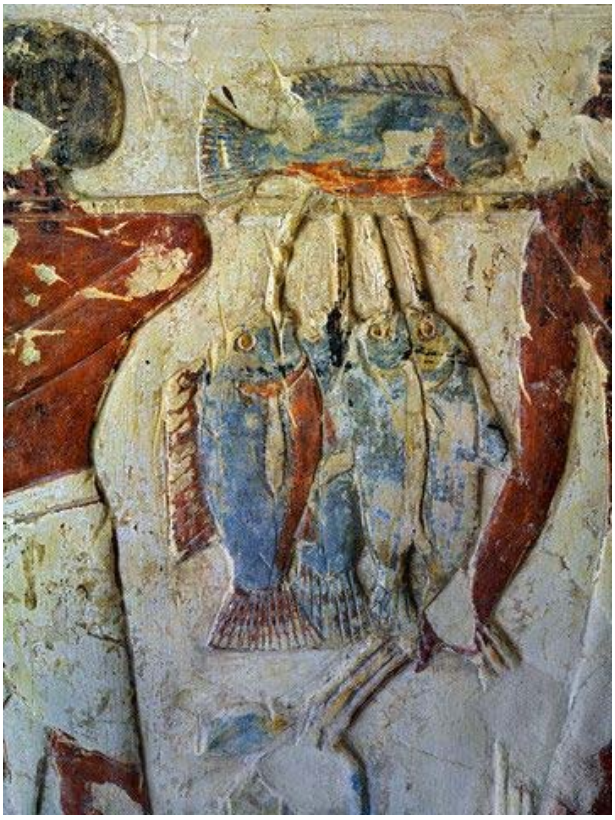


Figure 2: Fish offerings (tilapia) from the Tomb of Benia,

My interest in this essay, however, is not with the culinary or religious aspects of ancient Egyptian society, but with its ornamental ponds and its fishes. A notable example is that found at the end of the Avenue of Ram-headed Sphinxes at the Temple of Amun in Luxor (Figure 3) where ceramic vessels were incorporated into the walls to protect the fish from predacious neighbors and to provide shade under the hot Egyptian sun. Although it has been suggested that ponds like these equipped with such ceramic niches were probably deigned for the raising of eels - since some of the vessels are close below the surface of the water and eels are not

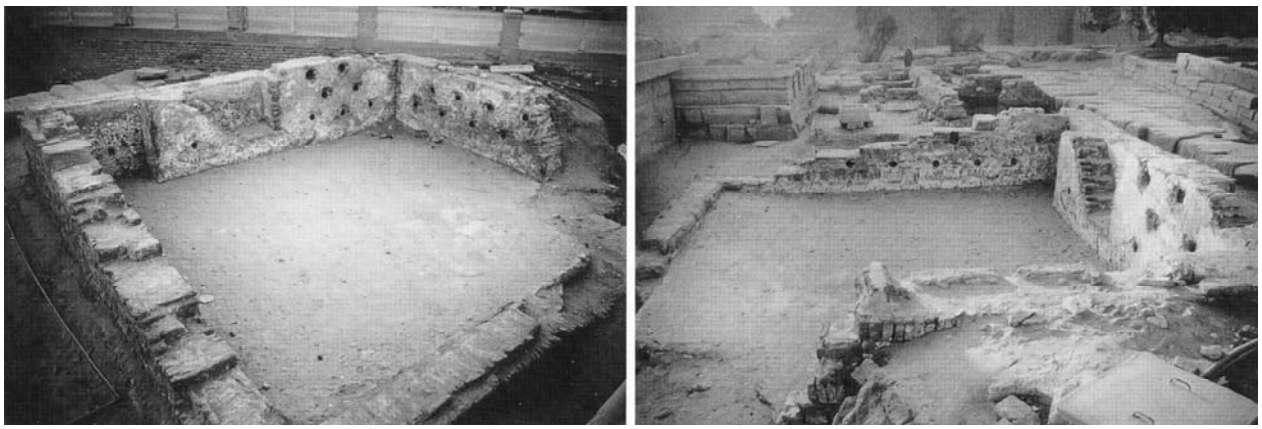


Figure 3: The pond at the end of the Avenue of Sphinxes at the Temple of Amun in Luxor.

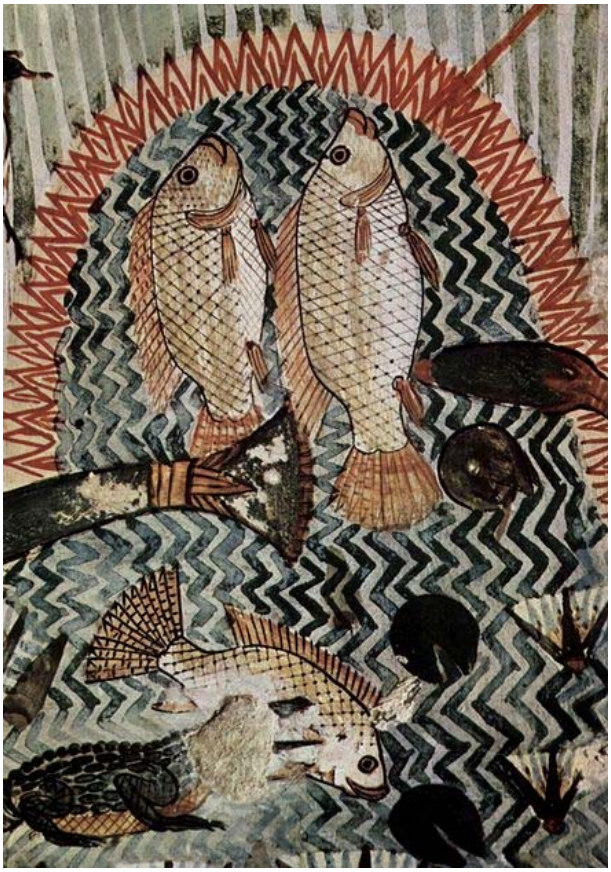


Figure 4: A detail from Menna's tomb showing tilapia swimming into his spear.

known to be jumpers - other species of fish could take advantage of them and eels could live in ponds without them. Note the built-in staircase that facilitated the cleaning of the tank after it had been emptied.

Illustrations of tilapia were very common in Egyptian wall paintings. The one in Figure 4 is a detail from Menna's tomb of three tilapia swimming into his spear. Menna held the title, "Scribe of the Fields of the Lord of the Two Lands of Upper and Lower Egypt," as well as field overseer of Amun. However, these were probably not two separate positions. He probably supervised temple owned agricultural lands which were dependencies of state granaries. He is thought to have worked for the Temple of Amun at Karnak, supervising the measuring of fields, inspecting the work on the land, prosecuting defaulters and recording the crop yield. He lived during the 18th Dynasty and probably worked under both Tuthmosis IV and Amenhotep III.

Ponds and pools were a common feature of the residential gardens of the wealthy and powerful of Ancient Egypt, and are shown in a number of tomb paintings. Beginning with the New Kingdom, pleasure gardens became a common feature of luxury residences in Egypt. According to paintings in tombs in Thebes from the 18th Dynasty (1552-1296 BC), the gardens of that time had a standard design. They had a pond, usually rectangular and in the center, filled with colorful fish, lotus blossoms in the water and flowers around the edges. Around the pond were successive rows of trees, including sycamores, palms, and grenadiers, alternating with flower beds. The edges of the water basins were sloping, with a stairway down one side so gardeners could collect water for irrigation.

The pond was often surrounded by walls or columns supporting grapevines. The walls and columns were decorated with colorful paintings of people, animals and plants such as the poppy and rose. Sometimes, as in the garden of Hatshepsut's temple at Deir el-Bahri, the pond was in the shape of a T, with one part of the T connected to a river or canal. The water was usually hoisted into the pond from the river by hand, or using a shadouf (Figure 5). Fish for food and ornament were raised in the ponds. They also were the home of migrating water birds.

Figure 5: Ancient Egypt—Shadouf.

The example in Figure 6 comes from the tomb of Rekhmire. Rekhmire was an ancient Egyptian noble and official of the 18th dynasty who served as Governor of the Town (Thebes) and Vizier during the reigns of Thutmosis III and Amenhotep II. He is noted for constructing a lavishly decorated tomb for himself in Sheikh Abd el-Qurna, part of the Theban Necropolis, containing lively, well preserved scenes of daily life during the Egyptian New Kingdom.

Like all very senior officials, Rekhmire had for his pleasure a pool in his large garden. This pool was also used for ritual practices upon the statue of the deceased, as here. Opinion is divided as to when such ceremonies were held; in any case it was not during the funeral. It is likely that the ceremony was repeated every year; the deceased could thus benefit from the new pool, drink from it, fish in it and gain sustenance from the products of its trees and gardens.

In this bird's eye view of the garden composed of four rectangles, the water in the central pool is rippled by the wind and full of flowers and fish; on either side shady Powering plants; around it an embankment lined by a row of fruit trees, and then another strip of green, bounded by other shade trees alternating with flowering shrubs. The facade of the house crowned by a cornice and with a large portal that is set amidst the greenery overlooks the short end.

The pool, surrounded by walls, is rectangular, lined with three rows of trees, sycamores on the outside (the 4th rectangle) and then alternately

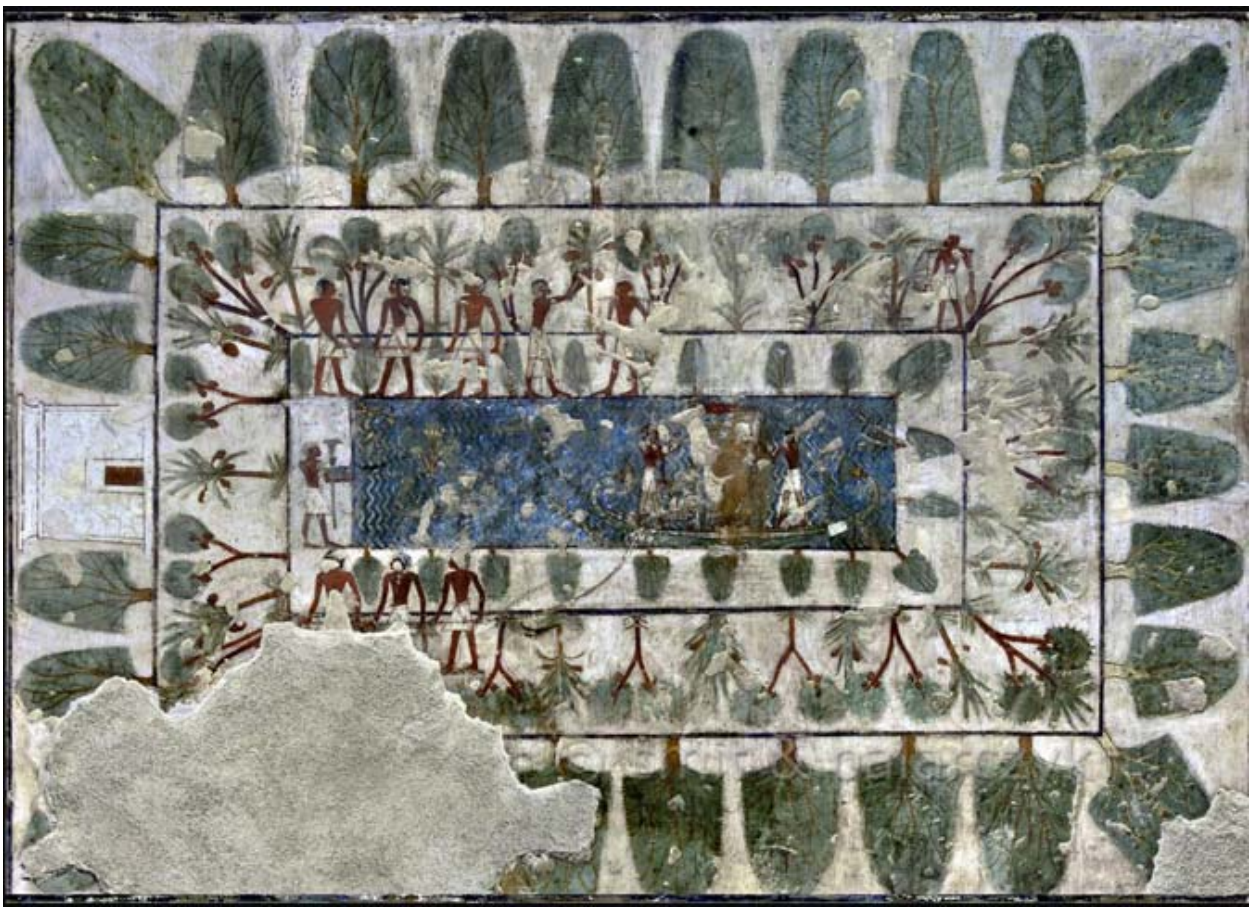


Figure 6: The garden of Rekhmire, an official of the 18th dynasty who served as Governor of the Town (Thebes) and Vizier during the reigns of Thutmosis III and Amenhotep II.

Figure 7: Henry Salt (1780–1827) was an English artist, traveler, collector of antiquities, diplomat and Egyptologist.

date palms and dom palms (3rd rectangle), then in the second rectangle other smaller sycamores. On the basis of aspective (as opposed to perspective), trees have been shown lying outwards. In the pool, covered with water plants, fish swim. A gardener is picking dates and two others bring water to irrigate trees. A boat is towed on the water by two groups of three haulers. Upon its middle stands the statue of the Vizier in an open chapel (this representation has been effaced). In front of the shrine, a priest makes a libation and censes, while behind, a priest laments with arms raised. On the left, on the bank, a man awaits the statue with a papyrus stem and bunches of onions.

Nebamun was a middle-ranking official scribe and grain accountant during the period of the New Kingdom in ancient Egypt. He is thought to have lived circa 1350 BC and worked at the vast temple complex near Thebes (now Luxor) where the state-god Amun was worshipped. His name was translated as “My Lord is Amun.”, and his association with the temple, coupled with the importance of grain supplies to Egypt, meant that he was a person of considerable practical importance, though not of the highest rank. He is known today because of the 1820 discovery of the richly-decorated Tomb of Nebamun on the west bank of the Nile at Thebes.

Henry Salt, the British Consul-General (Figure 7), had been encouraged to collect Egyptian relics by Sir Joseph Banks, a trustee of the British Museum at the time. From 1819, Salt’s agent was a young Greek, Giovanni (Yanni) d’Athanasi. It was during his excavations on Salt’s behalf that d’Athanasi would make his momentous discovery. D’Athanasi removed what he wanted from the Nebamun tomb simply by hacking and gouging fragments from the walls of the tomb. D’Athanasi’s workmen probably cut into the plaster surface of the walls with knives and saws, outlining rectangular pieces which they then pried off the walls with implements such as crowbars. Sometimes they removed the full depth of the mud plaster, but sometimes they carried away only a very thin layer and the edges inevitably suffered cracking and disintegration.”

Ten of the fragments taken by d’Athanasi were included in the first huge, batch of collections that Henry Salt sent back to the British Museum. After much haggling, the Museum settled for what Salt described as the “miserable sum” of £2,000, apparently not enough to even cover his expenditure s. After Salt died in 1827, d’Athanasi offered his services to the Museum in 1835 but fell out with the curators over his finder's fee and he refused to divulge the precise position of the tomb. After a failed venture as a picture dealer in London, d’Athanasi died in poverty in 1854, taking with him his knowledge of the site of the tomb.

Although the exact location of that tomb is now lost, a number of wall paintings from the tomb were acquired by the British Museum where they

Figure 8: Left - Nebamun hunting wild fowl from a skiff in marshland along the Nile. Right - a detail of the painting showing a pufferfish in the middle and one tilapia swimming into the scene and another swimming out.

are now on display. They are considered to be one of that museum's greatest treasures. These are works of art of the highest aesthetic quality. They were painted not by jobbing artisans but by true artists who made conscious aesthetic decisions, and were sometimes willing to break with the pictorial conventions of Egyptian art to achieve a surprising degree of naturalism. Archaeologists have no idea about the identity of the artist swho created them and are equally puzzled why painters of such talent were involved with a relatively minor clerk like Nebamun.

And so, in the scene where Nebamun is shown hunting wild fowl from a skiff in marshland along the Nile (Figure 8), the artist adheres to the conventions of Egyptian art by showing the accountant in profile and making him much bigger than the figures of his wife and young daughter who accompany him. But this artist goes further – he makes sure that Nebamun stands out by painting his flesh using impastoed (impasto is a technique used in painting, where paint is laid on an area of the surface very thickly, usually thickly enough that the brush or painting-knife strokes are visible) white under paint covered with a layer of red. Seen within the dark interior of the chapel, the figure would have appeared to glow.

The paintings were intended to provide a link between Nebamun's life and the way in which he would have wished to be commemorated by his family in death (the afterlife). Friends and family would have visited the painted upper part of the tomb, contemplate the paintings, leave gifts and hold feasts to commemorate his life.

Figure 9: A detail of the pond in Nebamun's garden, showing a number of tilapia swimming about.

Nebamun's garden (Figure 10) in the afterlife is not unlike the earthly gardens of wealthy Egyptians. The pool is full of birds and fish, and surrounded by borders of flowers and shady rows of trees. The fruit trees include sycamore-figs (*Ficus sycomorus*) , date-palms and dom-palms - the dates are shown with different degrees of ripeness.

On the right of the pool a goddess leans out of a tree and offers fruit and drinks to Nebamun (now lost). The artists accidentally painted her skin red at first but then repainted it yellow, the correct color for a goddess' skin. On the left, a sycamore-fig tree speaks and greets Nebamun as the owner of the garden, its words are recorded in the hieroglyphs. The pool is shown from above, with three rows of trees arranged around its edges. The waves of the pool were painted with a darker blue pigment; much of this has been lost, like the green on the trees and bushes.

Artificially-constructed fishponds were known to the Egyptians long before the Romans and the piscatorial heyday of the First Century AD. Although they were not hobbyists (my definition of the hobby is "A subject or pursuit involving fishes, undertaken primarily for pleasure during one's leisure time and to which a person is notably devoted"), they were THE aquarists of Stage I of the hobby.

Figure 10: Nebamun's garden.

THE MAKING OF AN HISTORIAN

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, January 23, 2016)

My interest in aquarium hobby history started in the 1960's when I wondered why the only such history almost always involved goldfish. The goldfish is not the earliest known aquarium fish nor was it of paramount importance in the hobby except in its very early years. Thus I set out to do something to rectify the situation. One starts any historical research with documents (or so I thought at the time) and in the 1960's this consisted primarily of aquarium books and magazines. I also started to expand the collection of books and magazines that I already had. Back in those days there was little interest in collecting, so the acquisition of these materials was cheap, compared to what some of these items bring today.

Two publications were of great help to me in this regard: for books it was Bashford Dean's *A Bibliography of Fishes*, and for magazines it was the *Union List of Serials*, both rather weighty tomes (the latter must weigh somewhere between 10 and 15 pounds!). Although a small number of facsimile editions of books were available at the time, like Smith's *The Fishes of Siam*, in general I had to purchase them and since this is history we are talking about here these were used books. Local libraries were of limited use except for the Lloyd Library (sundry old aquarium books and *Aquatic Life*) and the one in the Cincinnati Historical Society (the *Cincinnati Gazette* and the *Deutscher Pioneer*, mostly for information about Hugo Mulertt).

The acquisition of aquarium magazines was a slow and expensive process, involving mostly microfilm from those libraries that offered this service. Although a few books were available on microfiche, these were expensive and I did not have a microfiche reader. However, microfilm was not a problem since I was also a photographer.

I started the history series in *Aquarium Illustrated* and it ran for ten issues, from January/February 1966 to July/August 1967, ending when I took over the editorship of *The Aquarium* magazine. In the December 1967 issue of *The Aquarium* I re-started the history again from scratch, and it continued for a total of 22 installments, ending in the September 1969 issue. The series has been cited many times over the years. In the late 1980's Ross Socolof approached me with a view to having the series published as a single volume to help fund the American Cichlid Association's Guy D. Jordan Endowment Fund. This I did, pro bono, and the book appeared in 1987, Lee and Aline Finley doing most of the hard work of putting it together for publication. Its subsequent sales of over $3,000 were a significant addition to the Jordan Fund.

However, I was extremely dissatisfied with the history. Historians study the past by interpreting evidence. They work by examining primary sources - texts, artifacts and other materials from the time period. From comparing these sources and evaluating them in context, the historian develops interpretations, often in light of the interpretations of other historians although the interpretative writings of historians - books, journal articles, encyclopedia entries - are considered useful secondary sources. However, if what I had done was historical scholarship, then

so was the gossip columns of the *National Enquirer*. All I did essentially was to compile material from books and magazines. There was no proper bibliography nor was there any attempt to comment on the significance of developments as the hobby progressed from its development in England - the point at which I started the history - to the start of World War II - the point at which I ended it.

The process of historical analysis involves investigation and analysis of competing ideas, facts and purported facts to create coherent narratives that explain "what happened" and "why or how it happened." Thus I decided to rectify the situation by doing a lot of reading on what constituted historical research and starting over once again. One of the most interesting of the books I read was *The Historian as Detective, Essays on Evidence* (Winks, 1968).

This time, technology helped a great deal. In 1979 I built my first digital computer, a Heathkit H89 (from that year onward I have never bought a desktop computer; I build them myself), and in 1992 I had the first version of Photoshop (version 2.5) running on my home PC. Shortly afterwards I had added both a flatbed and a slide scanner to my equipment. Of course the biggest advance was the beginning of the World Wide Web, which made searches for material an order of magnitude easier, as well as providing digital copies of material otherwise difficult for me to obtain. Thus, with these technological advances in hand was born *The Toy Fish*.

The title I used, "The Toy Fish," was a term introduced into the hobby by Ida May Mellen in 1931. Some years before I started writing the book, Dr. James W. Atz, a good friend and distinguished former Curator and Dean Bibliographer in the Department of Ichthyology at the American Museum of Natural History, planned to write such an account himself. However, "The best laid schemes o' mice and men…" and Jim never did get around to it. Unknown to me at the time, he also had intended to use the title. Two minds with the thought!

By the year 2000, what I thought of as the Second Edition of *The Toy Fish* (I thought of the First Edition as being the series in *The Aquarium*) was almost completed but I had no publisher in mind. While attending the American Killifish Association Convention that year, several people asked me whether I was going to publish a new edition of my history. After thinking about it, I decided I would offer this Second Edition to the AKA in the way the First Edition was offered to the American Cichlid Association. However, there was a big difference between the First and Second editions as many more pages of text as well as illustrations had been added, making the publication cost much higher this time around. Lee Finley approached me and asked if I would be interested in writing a new edition. Lee had just published Jerry Ryan's *The Forgotten Aquariums of Boston* and was looking for his next book to publish. This was the perfect solution and since the Chairman of the AKA had not yet presented my proposal before the AKA Board of Trustees, the discussion with the AKA was closed on an amiable basis.

One of the pieces of software I thought I never would get involved with was desktop publishing. However, my wife was on the Board of Trustees of the Home Owner's Association of Lake Lorelei, Ohio and she wanted to publish an independent newsletter. She enlisted the help of a friend who had Microsoft Publisher, which she used for publishing fliers, but the requirements of the program for a bimonthly 36-page publication with many photos exceeded the capacity of her computer (it was painfully slow). My and my wife's computers were, on the other hand, state of the art and so I reluctantly agreed to get involved.

Mastering Publisher quickly turned out to be no problem. The text was prepared in Word (Publisher is a formatting program, not a text editor) and the illustrations in Photoshop. My wife did some of the photography and I did the rest. I am a fair graphics artist so I did the artwork and prepared all the advertising layouts.

The output was be printed by offset lithography, so I had to install a Postscript printer driver in Publisher to rasterize the images and produce the hardcopy on a laser printer. Photographs in Publisher cannot be printed out on a laser printer using the normal printer driver. They must rasterized or made into halftones - i.e., made up of black dots. This hardcopy was then photographed by the printer to make the negative plates for printing.

There always was a problem in getting the hardcopy right because of technical hurdles such as "dot gain," the spreading of the black ink dots that reduced the resolution and contrast of the images. I prepared the Second Edition of *The Toy Fish* in the same way and we ran into the same problems in producing acceptable halftones for Lee's lithographer. I can't remember the number of times the printer ran off galley sheets of the halftones for my and Lee's inspection, but it was many. Lee, by the way, wanted it named the "Revised and expanded Edition," and I had no problem with that at the time since it suggested correctly that more significant improvements were in store than just a version upgrade.

Lee and I have had discussions over the years about whether offset printing was the best way to go and we feel now that we should have investigated in more detail the POD (Print on Demand. i.e., a Xerox copy) process. The cost would have been almost double, but the process is easier and produces better output since the images are not halftones. Also, one produces only that number of books that you can sell; there are no remanded copies. To go POD one produces a pdf copy, which any office supply store can print (or you can print it at home). It is constructed from a Publisher file but does not involve a Postscript (ugh!) driver. This is the way Lee and I produced the smaller books he published later such as *The Guppy* and *The History of Aquarium Inventions*. All I had to do was to print the Publisher file to a pdf file (I used Adobe Acrobat) and turn it over to him. Later on I did the same for the Third Edition of *The Toy Fish* and sundry smaller books I wrote and published about the hobby.

One of the major problems I had in writing aquarium hobby history was in the matter of definitions. In the Second Edition of *The Toy Fish* I stated:

There is also, alas, a problem with precisely what is meant by the word, "hobby." Consider the following dictionary definitions: "A subject or pursuit of absorbing interest, undertaken primarily for pleasure during one's leisure time," "An individual pursuit to which a person is unduly devoted," and "A favorite occupation or topic, pursued for amusement." The first two definitions require a stricter criterion, i.e., absorbing interest or undue devotion; the third is much less demanding. None, however, specify the number or kind of tanks a person must maintain before it becomes a hobby, nor is there any standard scale available to us by which we can measure the degree of "absorbing interest" or "undue devotion." Even if such a scale existed, it would be hopeless to attempt to apply it to aquarists who lived a century or two ago. We may ask ourselves whether Anna Thynne was a hobbyist, or A.A. Ma-

conochie, or some unknown American who maintained several jars of native fishes during the Presidency of Andrew Jackson, but the answers are in no way clear.

I stewed over the definition and finally found a way out when I observed that the hobby had progressed in four clearly different stages. I gave each a name and the result was that I had sidestepped the knotty problem of a succinct definition. This made much more sense since the hobby was clearly a different hobby in each of the four stages. To this day, the paradigm still works. The four stages concept was presented to the *Aquarium Hobby Historical Society of America* in 2005 and was included in the Third Edition of *The Toy Fish* published in 2009.

However, at certain times a formal definition is needed. One instance is when deciding who or what was "first," such as when I stated in the Fourth Edition of *The Toy Fish* that the Romans were the first hobbyists. The definition I used for the aquarium hobby there was: "A subject or pursuit involving fishes, undertaken primarily for pleasure during one's leisure time and to which a person is notably devoted." When you define something, one may not always agree with you but at least they know exactly what the elements in dispute are.

Not all definitions are that easy, however. I wrote about the problem of determining who was first in my 2012 essay, "Who Invented the Aquarium?" In Great Britain in the early 1850's the de facto definition of an aquarium was a vessel containing water and plants, plus aquatic animals (excluding, of course, mammals and water fowl) in which the water was not aerated or changed. Note that fish were not necessarily included. Implicit in this definition was that the basis for the aquarium was the relationship that the plants absorbed the carbon dioxide that the aquatic animals generated whilst the animals absorbed the oxygen that the plants generated.

With these requirements as part of the set of criteria, I then added one additional criterion, that of priority of publication. Next, since fish were never a strict requirement, I decided to define four "firsts," not just one: (1) the freshwater aquarium sans fishes, (2) the freshwater aquarium with fishes, (3) the marine aquarium without fishes and (4) the marine aquarium with fishes. If, however, I added another criterion, that of the impact on the aquarium hobby in the Nineteenth Century, then the firsts for the freshwater aquarium and the marine aquarium change. The point here is that naming firsts is not always an easy endeavor and definitions are absolutely required to avoid misunderstandings.

The definition of "aquarium" was the subject of detailed analyses through the years by such renowned and respected figures as William Alford Lloyd (1876), Philip F. Rehbock (1980) and Stephen Jay Gould (1998). Both Rehbock and Gould relied greatly upon the so-called principle of the balanced aquarium for their definition of the word. Rehbock argued that the true aquarium is one that remains in a healthy state without requiring any renewal of the water, fresh or salt. Gould argued that the fish bowl is not an aquarium because it lacks the following defining feature: a *stable community* of aquatic organisms. Lloyd did not use the balanced aquarium principle for his definition since he argued that when one changed the water in an aquarium the polluted water went into the sewers and ultimately returned to the ocean where it was purified by natural means. In other words, keeping fish in a container devoid of plants is part of a cycle that did keep the oxygen and carbon dioxide in balance; it just didn't require that the purification took place in the aquarium.

However, trying to find a definition for the word "aquarium" is tantamount to an exercise in reinventing the wheel. An aquarium is a Latin word for a something that holds water, regardless of what is in it. Cato was the first author of record to use the word aquarium. Examples from his *De Agricultura*, written about 160 BC, include the following: situlum aquarium ("water bucket"), urceum aquarium ("water vessel") and bonumque aquarium ("well-watered"). Note, however, that aquarium here did NOT mean a container of water but water used as a modifier. Over the years, from Pliny the Elder, 77-79 AD, to Reisinger, 1830 and beyond, the word aquarium was used simply as a synonym for "water," as in *aquarium dulcium*, a phrase that meant fresh water.

I was unable to find any examples where the Romans used aquarium or its orthographic cousins in the sense of a container; however, it was frequently used to mean a watering place for cattle. Some have suggested that the Romans used the term to mean a water trough for cattle but this idea most likely came about through a mistranslation of the original Latin texts. (A detailed account of how the Romans used the word and its relatives can be found in my 2015 essay "A Few Words on the Origin of the Word 'Aquarium'.")

The word aquarium came to the aquarium hobby via the botanical community; John Loudon used the term in his 1824 *Encyclopaedia of Gardening* for various artificial ponds and greenhouses and suggested that fish might be added to them. However, the term goes back to Carl Linnaeus. Linnaeus was a big fan of the Latin language and was quite familiar with the term used by the Romans to describe a cattle watering place. Perhaps he thought that by analogy it was perfectly logical to use the term for a place to water aquatic plants. In any event, in his 1742 prologue to his *Hortus Upsaliensis*, Linnaeus defined the following terms under the heading of "Aquaria:" (1) Aquarium fluviatile, (2) Aquarium lacustre and (3) Aquarium palustre), denoting respectively a river pond aquarium, lake pond aquarium and marsh pond aquarium. Later horticulturists broadened the term to include the troughs in greenhouses that contained water for the growth of aquatic plants. Linnaeus did not have tanks in mind when he used the term, just small ponds. Future horticulturists modified the meaning of aquarium to include artificial vessels as well.

When Gosse introduced the term in 1854 for the container that housed fish and aquatic plants he referred to this use by horticulturists:

I have adopted the word Aquarium, as being free from the objections which lie against the other two [i.e., Vivarium and Aqua-Vivarium], while it possesses the neatness of the former, and the definiteness of the latter. The term had already been in use among the botanists, to designate the tanks in which aquatic plants were reared; and the employment of the same term for our tanks is not forbidden by the character of the service to which they are put, since this is not an alteration, but only an extension.

Thus, an aquarium is simply the container in which we keep our fishes. Thus, the Egyptians were our first aquarists (but not our first hobbyists). In fact, anyone who keeps even a single goldfish in jar whose water is changed at intervals is an aquarist.

Having solved the hurdle of definitions, after five years of additional research and writing I finally completed the third edition of *The Toy Fish*. That this was a significant expansion is shown by the following table:

	SECOND EDITION	THIRD EDITION
WORDS	75,062	163,248
ILLUSTRATIONS	242	514
BIBLIOGRAPHIC ENTRIES	119	319
PAGES	204	391
CHAPTERS	24	27
ADDENDA ENTRIES	5	9
INDEX ENTRIES	463	618

As can be seen, the number of words and illustrations had more than doubled, the increases being almost entirely due to additions and not merely changes or alterations. Many of the new illustrations were of noted figures in the history such as Henry Dennison Butler, William Emerson Damon, Shirley Hibberd, Joseph Winn Fiske, Henry Bishop, Gustav Armbruster, Otto Gneiding, Raymond Potts and many others.

New chapters had been added and others expanded. Much new material relating to Dr. Robert Wilson Shufeldt, Ida Mellen, Christopher Coates and William Alford Lloyd were also added, as well as that relating to other major personalities. Additionally, many aspects of the hobby that were mentioned only in passing in the Second Edition were expanded in this one.

A significant new inclusion was a lengthy preface that placed the early development of the aquarium hobby in this country in a new perspective, including women's issues, how and by whom aquarium fishes and equipment were marketed, the effect of changing technologies, and the impact upon the hobby of varying economic factors between 1870 and 1938.

A major addition was a detailed history of aquarium glass from the Romans to the present day, a history for which curators at the major glass museums were unable to provide any significant input and for which I had to seek help elsewhere. Another major addition dealt in detail with a rigorous scientific method, based upon mass transfer and absorption coefficients and previously unknown to the aquarium hobby, for determining the number of fish that populate an aquarium of given dimensions, various aeration conditions and different types of fish. Although the sample calculations I showed provided new evidence for the reasons behind the success of Victorian aquarists, the formulas, tables, and graphs provided enabled aquarists to do their own calculations for present-day purposes. In 2009 I decided to produce a very limited number of copies of this Third Edition via POD and offered them at cost to members of the *Aquarium Hobby Historical Society of America*; about 60 were sold.

I had intended that the Third Edition of *The Toy Fish* would be the last edition but certain assertions had been made in print and on the Internet concerning the Romans that had to be refuted. It was necessary to remove the material on the Romans from the history of glass - excepting the Roman glass history - and devise a new section devoted to them. Except for this, only minor additions were made in this edition and my resolve to do no more editions finally was put into effect. The Fourth Edition was offered to the *Aquarium Hobby Historical Society of America* in digital form (pdf) only and there will be no further editions.

During my time with the Yahoo *Aquarium Hobby Historical Society of America* group I started to worry about the loss of important historical material in some of my posts and in my uploaded files (for others, that is, since all my materials are well backed-up) should Yahoo fail. Thus I collected what I had written to date and started a new book called *A Compendium of Aquarium Hobby History Society Articles* (although it contained a few that had not been published there) and in 2012, when it stood at

223 pages, I offered it on digital form (pdf) to members of the Society. In 2015 I changed the name to *Essays on Aquarium Hobby History*, following Steven Jay Gould's lead in referring to his monographs as essays. Adding material to books already published without redoing their format is difficult; writing an essay where one doesn't have to worry about where it is placed it in a book takes a great load off an author if he is also the publisher. The essays book has allowed me to write about aquarium hobby history as the spirit moves me, without worrying about how it gets published.

I prefer my work to appear in the pdf format (although I occasionally just use Word) for two reasons (1) Anyone can read them since pdf readers are free and easily available, and (2) the format has a search function enabling one to find anything quickly, including even text in captions to images. With services like DropBox, even large volumes such as the essay book can be distributed quickly and easily to select audiences. Some people still prefer hard copy, but there is no restriction on anyone printing their own by going with the POD process; with a pdf copy then, one gets the best of both worlds.

ADDENDUM

Several times over the years my friends have tried to persuade me to write something about the history of the aquarium hobby after the end of World War II. However, it should be noted that I had dropped out of the aquarium hobby - publically, not privately - after my tenure as Editor of *The Aquarium* ended in December 1971 in order to pursue my doctorate and I did not resume my public persona until I joined the *Aquarium Hobby Historical Society of America* Yahoo group in 2003.

The problem for me in writing about aquarium history after World War II but prior to 1972 is that I was part of that history and my objectivity could easily be challenged. It doesn't make any sense for me to write about aquarium history after 1972 either - especially with history that deals with personages of that time - since there are many people alive who are better equipped to write about it. Because I live in the Cincinnati area, which is not noted as being a significant aquarium hobby center, the number of face-to-face acquaintances I had during this time period was limited. Finally, as this essay has shown, my interest in the history of the aquarium hobby has lain primarily elsewhere, not in the period after World War II, although I have written sundry history that did include material after that date.

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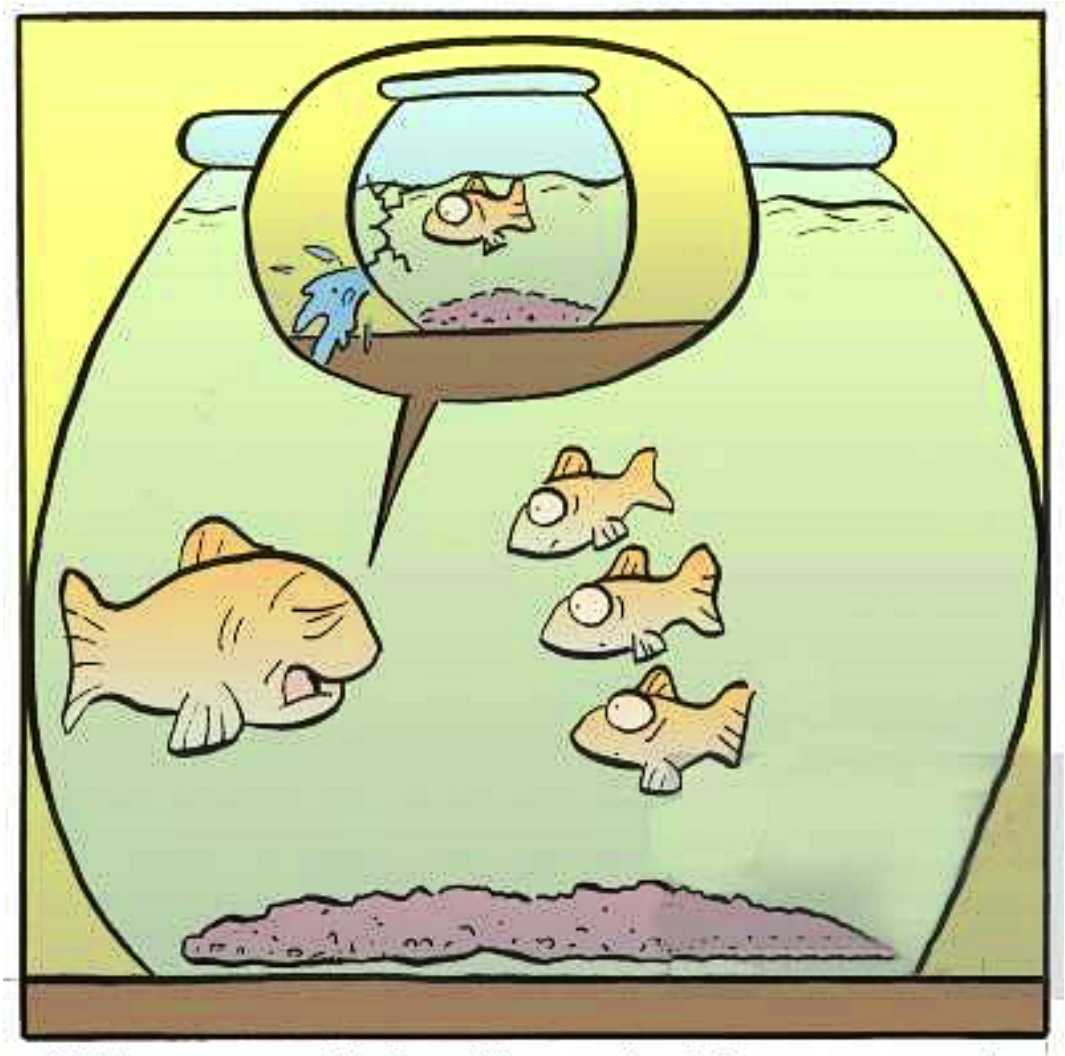


SUMER: THE HOME OF THE FIRST AQUARIUM?

by Albert J. Klee, Ph.D.

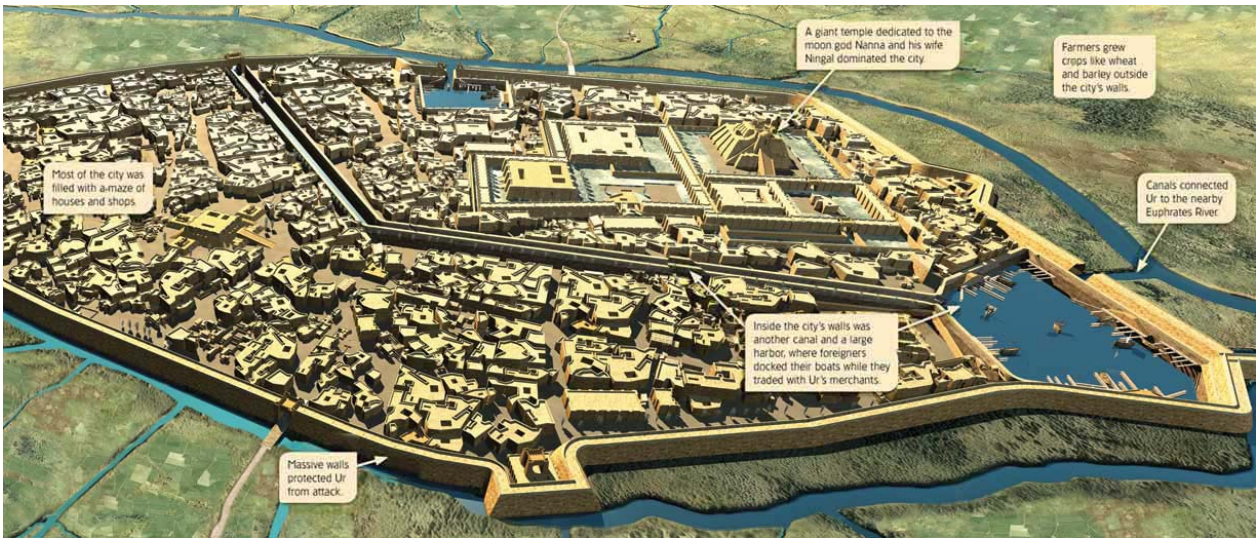
(Aquarium Hobby Historical Society of America, Facebook Files, March 13, 2016)

Sumer was the southernmost region of ancient Mesopotamia (modern-day Iraq and Kuwait) which is generally considered the cradle of civilization. In the biblical Book of Genesis Sumer is known as Shinar. According to the Sumerian King List, when the gods first gave human beings the gifts necessary for cultivating society, they did so by establishing the city of Eridu in the region of Sumer. While the Sumerian city of Uruk is held to be the oldest city in the world, the ancient Mesopotamians believed that it was Eridu and that it was here that order was established and civilization began.

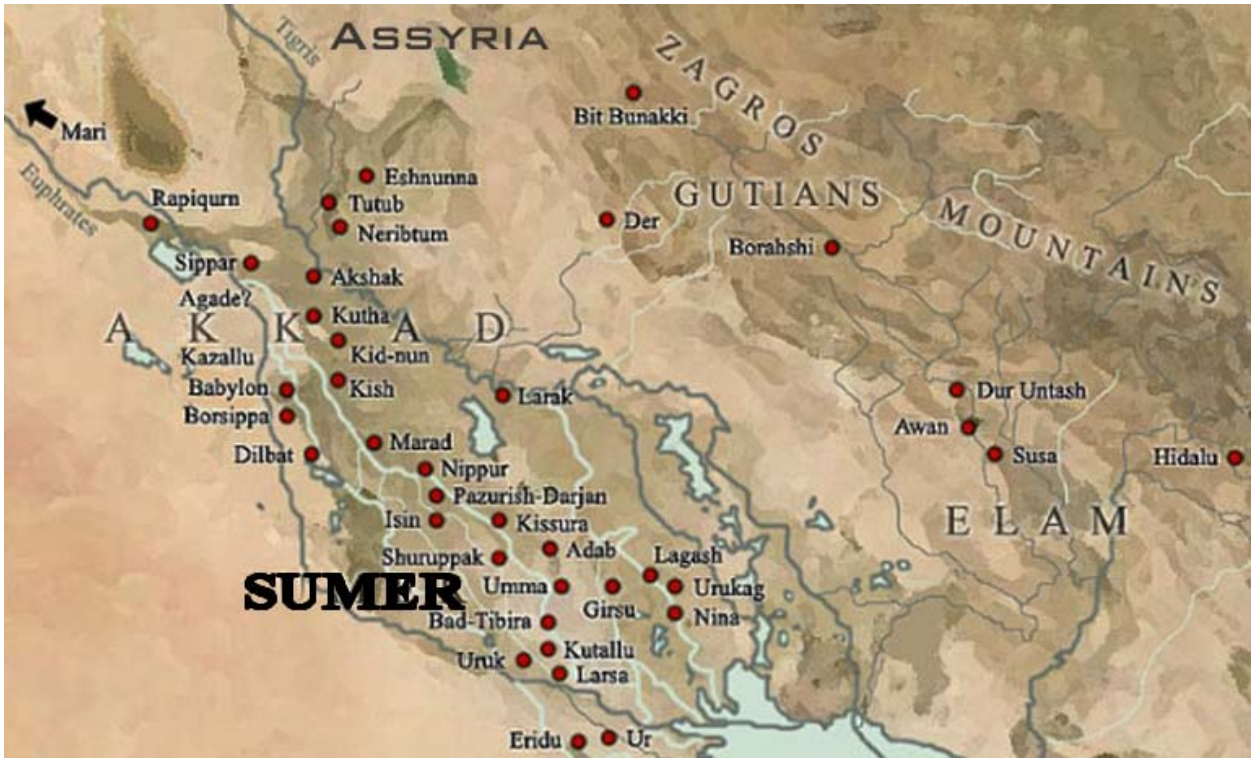
The region of Sumer was long thought to have been first inhabited around 4500 BCE. This date has been contested in recent years, however, and it now thought that human activity in the area began much earlier. The first settlers were not Sumerians but a people of unknown origin. Whoever these people were, they had already moved from a hunter-gatherer society to an agrarian one prior to 5000 BC.

Whenever the Sumerian civilization was first established in the region, by 3600 BCE they had invented the wheel, writing, the sailboat, agricultural processes such as irrigation and the concept of the city (though China and India also lay claim to `the first cities' in the world). It is generally accepted that the first cities in the world rose in Sumer and, among the most important, were Eridu, Uruk, Ur, Larsa, Isin, Adab, Kullah, Lagash, Nippur and Kish. The city of Uruk is held to be the first true city in the world. It has been noted that these places were founded, at least as villages, much earlier than c. 5000 BCE.

The last period in Sumerian history - 2047-1750 BC - is known as The Sumerian Renaissance due to the remarkable advances in culture – touching upon virtually every single aspect of civilized human life – which were made. The kings of Ur, Ur-Nammu and Shulgi, set cultural advancement as the goal of their administrations and maintained a peace which allowed for art and technology to flourish. Whether invented before or during this period, the tools, concepts, and technological innovations in place during that time solidified the Sumerian's place in history as the creators of civilization as we know it. Among the 'firsts' in history from the region are the first schools, the first proverbs and sayings, the first messiahs, the first Noah and the Flood stories, the first love song, the first legal precedents in court cases, the first tale of a dying and resurrected god,



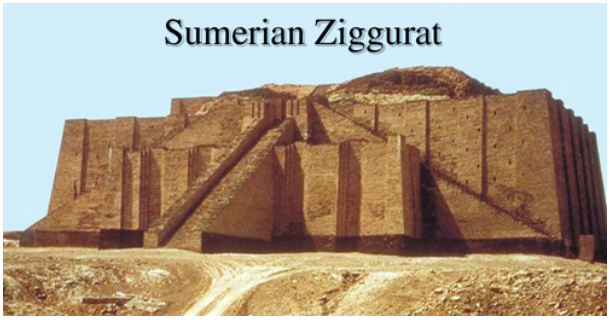
A schematic of the Sumarian city of Ur.



the first funeral chants, first biblical parallels, the first moral ideas and, of greatest interest to us here, the first aquarium.

Although a wall was constructed 155 miles long to keep those they called `the barbarians' out of Sumer proper, the barrier proved ineffective. The wall could not be properly manned or maintained and, further, was not anchored to any solid barrier at the end points and so invaders could simply follow the wall on the one side to either end point and then walk around it. The forces of neighboring Elam breached the wall and marched on Ur, sacking it and carrying away the king c. 1750 BC. With the fall of Ur a severe famine resulting from climate change and the over-use of the land caused many to migrate for points south. Among these, it is thought, was Abraham, who left Ur to settle in the land of Canaan. Abraham was the first of the three biblical patriarchs and his story, told in chapters 11 through 25 of the Book of Genesis, plays a prominent role as an example of faith in Judaism, Christianity, and Islam.

Cuneiform Sumarian script



Zigguratu, an Assyrian word, means "height."

In the animal world, the Sumerians had a deep, tender, affection for the fish, the helpless creature that often evoked tragic images in the minds of the poets, especially those who composed lamentation liturgies. Miguel Civil (Miquel Civil i Desveus) is an expert in Sumerian and Ancient Mesopotamian studies and is widely considered the world expert in the use of the cuneiform script to write down the Sumerian language. In a poem translated by Civil (1961) and designated by him as "The Home of the Fish," the anonymous author depicts the construction of a home for the fish, a kind of well-furnished and abundantly provided aquarium, where all sorts of fish could live in undisturbed peace, safe from preying birds and predator sharks.

The text consists of an address purported to be uttered by some individual who for one reason or another was an ardent lover of fish. It begins with a reassuring announcement that the speaker has built a house for the fish, large, spacious, and unapproachable, and provided it with fine food and drink, especially beer and sweet cookies.

"My Fish, a house…..
My Fish I have built a house for you, I have built a granary for you,
In the house an extra court, an extended sheepfold, I have built for you,
Its center I have covered with incense, I have dug (?) a well of jubilation, a place that rejoices the heart,
No one can approach your closely threaded (?) house, I have bedecked (?) it with plants,
In the house there is food, food of top quality,
In the house there is drink, drink of well being,
In your house, no flies swarm (?) about the liquor bar,

The Abgal are seven Sumerian demigods said to have been created by the god Enki to give civilization to mankind. They served as priests of Enki and as advisors or sages to the earliest "kings" or rulers of Sumeria before the flood. They are credited with giving mankind the moral code, the crafts, and the arts. They were seen as fish-like men who emerged from the sweet water Apsu. In the form called the puradu-fish (carp?) they are commonly represented as having the lower torso of a fish, or dressed as a fish, . They have also been depicted with wings, having either a human head or an eagle's head. All three forms are shown here.

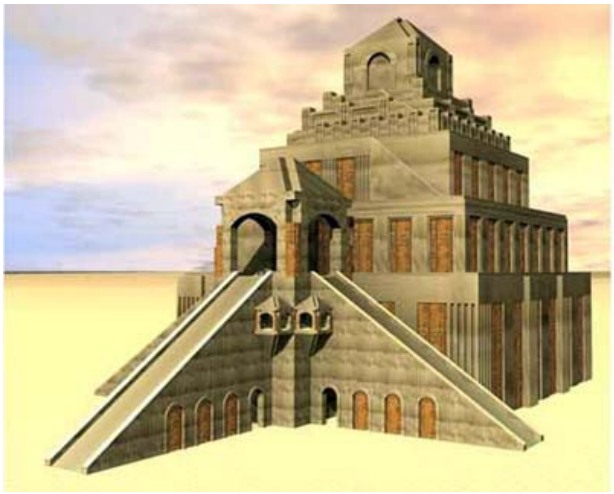
In your entrance (?) no complainer sets an inimical foot.
At its threshold and bolt where flour is sprinkled, I have set up the censer,
The house smells sweet like a forest of sweet smelling cedar,
By the house I have placed beer, I have placed fine quality beer,
I have placed there honeybeer and sweet cookies as…"

The speaker now urges the Fish to let all his friends, acquaintances, companions, relatives, in fact anyone who so wishes, come into his house.

"Let your acquaintances come,
Let your dear ones come,
Let your father and grandfather come,
Let your son of the elder brother and son of your younger brother come,
Let your little ones and your big ones come,
Let your wife and your children come,
Let your friends and your companions come,
Let your brother-in-law and your father-in-law come,
Let your crowd (whoever says) I, too, would enter, come,
Let none of your neighbors be left out."

But it is his *Fish*, his "beloved son," that the speaker is primarily concerned with, and so he addresses him saying,

"Enter my beloved son,
Enter my goodly son,
Day is passing, night is coming,
Enter by the light of the moon.
When the day will have passed, the night will have come,
Having entered, you will be at rest there, I have fitted out a place for you there,
In its midst I have arranged a 'seat' for you,
My Fish, when lying no one will disturb you,
When sitting, no one will start a quarrel with you.
Enter my beloved son,
Enter my goodly son.
Like (in?) a brackish canal you will not 'know' agitation (?),
Like (in?) river silt you will not 'know' disturbance,
Like (in?) flowing water do not spread, do not (yet) spread your bed,
Although the moonlight has entered, do not (yet) spread your bed,
I would come with you that I might gaze in wonder,
Like a . . I would come with you that I might gaze in wonder,
Like a dog I would come with you to your sniffing place that I might gaze in wonder,
Like a . . I would come to where you 'stand,' that I might gaze in wonder.
Lo! Like an ox to your stall, like a sheep to your fold!
When you enter like an ox to your stall,
My Fish, Ashimbabbar (the god of the New Moon) will rejoice with you.
When you enter like a sheep to your fold,
My Fish, Dumuzi will rejoice with you."



Another Sumarian Ziggurat.

Following a lacuna of about fifteen lines we find the speaker saying,

"My Fish, may all kinds of fish enter with you," a statement that introduces an itemized listing of some sixteen different fish, each described with a brief, pithy, riddle-like comment; those that can be identified with some degree of certainty are the barbel, large and small, the carp, the sturgeon, the catfish and the eel. The speaker now makes an urgent plea to the Fish to come quickly to his newly built home, for the day has passed and danger is lurking all about him from the fish-eating birds and the sharks, concluding with these words:

**"My Fish, the day has passed, come to me,
The day (?) has passed, come to me,
The queen of the fishermen, the goddess Nanše, will rejoice with you."**

According to Civil,

"The poem is a monologue by a deity, in all probability Nanše who, as "mother of the fish," has built a new house for them, and invites all of them to come and spend the night there, where they will find a comfortable place of rest and will be safe and secure from all the animals which usually prey on them. It is always difficult to place works of Mesopotamian literature in the categories devised by classical rhetoricians. The anthropomorphic descriptions place our composition close to the fable, but it cannot be considered as such, because the classical definition of a fable always includes some kind of action, and no action at all is involved in our text. In some other respects we may consider our poem as lyrical: it is based on the author's sentiments evoked by the multiple aspects of aquatic life, and on the emotional appeal of a "sweet home." Other secondary themes interwoven with this are the "naming of the fish"—to be compared perhaps with Adam naming all living creatures in the Garden of Eden or, more probably, it is simply a display of erudition—and the attempt to explain how water birds prey on fish, in spite of the fact that both of them are under Nanše's protection."

It should be noted that Fishing and the fishing industry were a major source of Sumer's food supply, especially in the earlier millennia of its history. Close to a hundred different types of fish are mentioned in the Sumerian economic and lexical texts, of which some thirty-odd can now be tentatively identified according to the Finnish Orientalist, Armas Salonen (Salonen, 1970). In the extant text of the "Home of the Fish," sixteen are named and described in terse, pithy phraseology, and of these a half dozen or so can be roughly identified. Marie-Louis Thomsen, the author of *The Sumerian Language, An Introduction to*

Ancient Lagash in Sumer.

Its History and Grammatical Structure (it has become the standard grammar of Sumerian) provided a different interpretation of the poem (Thomsen, 1975):

"In brief, we may summarize the whole text as an address to the fish, inviting them to spend the night in a certain house. So far we may take it at face value, but certain questions have to be raised. First, who is the speaker of this monologue? In view of the fact that Nanše is mentioned in the third person in the concluding line, she would seem to be excluded. We could then suggest that it is a fisherman, and this would explain, too, the explicit mention of Nanše as the queen of the fishermen here.

"This solution discloses an entirely different purpose in calling the fish, namely the desire of every fisherman, that the fish will swim into his trap, net, or weir. Thus the text becomes meaningful if we imagine the fisherman reciting, or better singing, the text, while he places his trap in the river and waits for his catch. In this case the 'house' would actually turn out to be a metaphor for a weir, and the description of it as an attractive house simply serves the purpose of trapping the fish. The concluding section, according to which the fish, by entering the 'house,' will be safe from the birds of prey, is of course ambiguous. If the fish hurries into the weir, it will indeed escape the birds, but be caught by the fisherman instead.

" Considering this, we must conclude that the interpretation of Nanše as a protector of the

fish … is to be revised. To all appearances Nanše, just because the fish belong to her, is the protector and helper of the fisherman, or maybe a fisherman herself."

Samuel Noah Kramer (1897- 1990) was one of the world's leading Assyriologists and a world-renowned expert in Sumerian history and Sumerian language. The title of this essay is "Sumer: The Home of the First Aquarium?" with a question mark because Kramer published a book in 1981 titled "History Begins at Sumer, Thirty-Nine Firsts in Recorded History" in which he includes the invention of the aquarium as one of the firsts. However, Kramer does not comment on Civil's or Thomsen's interpretations but simply takes the literal point of view that the poem describes an unnamed individual who provided food and housing for fishes, which he held in high esteem. So, which of these three expert's interpretation should we adopt?

The Civil and Thomsen versions both rely upon assumptions. In the case of Civil he assumes that the author is a god or goddess (he suggests Nanše, a water and fishing goddess) and that Nanše is protecting the fish in her charge. However, there is nothing in the text that refers to any deity as the author. Although Nanše is mentioned it is in the third person, so she cannot be the author. Thomsen's assumption is a real jump as she suggests that all the protection mentioned in the text is nothing more than a series of fish traps, just the opposite of what the text relates. What is left then is Kramer's interpretation, which is to take the text at its face value, sans conjectures that require a leap of faith and which cannot be proven. Considering the fact that Kramer's reputation far exceeds that of the other two, this text then is a record of the first aquarium and, perforce, the first aquarist.

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Gold and lapis lazuli fish. They were found in the Royal graves at Ur on Queen Pu-abi, close to the pins that held her cylinder seals to her cloak.

"THE FROG DOES NOT DRINK UP THE POND IN WHICH IT LIVES"—INCAN PROVERB

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Post, March 22, 2016)

In Andean belief, Titicaca is the birthplace of the sun. In addition, it's the largest lake in South America and the highest navigable body of water in the world. The lake is located at the northern end of the Altiplano basin high in the Andes on the border of Peru and Bolivia. The western part of the lake lies within the Puno Region of Peru, and the eastern side is located in the Bolivian La Paz Department. Although the region is considered in the tropics, Titicaca's cold water sends a chill through the body upon touch. The cold sources and winds over the lake give it an average surface temperature of 50 to 57 °F. In the winter (June – September), mixing occurs with the deeper waters, which are always between 50 to 52 °F.

Lake Titicaca is home to more than 530 aquatic species, about 90% of them being endemic. This region has given rise to complexes of endemic cyprinodontids, totaling perhaps 43 species, largely in the genus *Orestias*.

The islands in Lake Titicaca may be mistaken for natural ones, but rather are rafts woven of totora reeds. The rafts are littered with houses for the

Aymara women prepare a meal of freshly caught killifish on a floating reed island in Lake Titicaca. (David Wallace, The Arizona Republic.)

Dozens of freshly caught killifish are thrown into a clay bowl on a floating reed island in Lake Titicaca in Peru in March. (David Wallace, The Arizona Republic.)

indigenous people, the Aymara, who live on the water and rely upon the lake's fish to survive. Their ancestors lived in the region for many centuries before becoming a subject people of the Inca in the late 15th or early 16th century, and later of the Spanish in the 16th century. The Aymara eat their karachi - their name for the Orestias species - like potato chips; fried to a crisp they crunch just like them. At lunchtime, these fish fill ceramic bowls that are passed around to everyone who lives on their floating island.

The Aymara face a problem familiar to those in other parts of the world: invasive species have fundamentally changed the balance of Lake Titicaca. Unfortunately, habitat destruction, pollution from mining, and introduced species has led to major declines. The umanto, *O. cuvieri*, the world's largest killifish at 10.6 inches, is probably extinct. The Peruvian government has listed 6 other *Orestias* species as Critically Endangered and another 13 as Vulnerable. Here, the invader is the rainbow trout.

This three million-year-old lake has changed dramatically in the last century, changes that were predicted by an 1872 British expedition. These explorers described 20 unique fish: one species of catfish and 19 Orestias. Their report concluded that since all of the fish were small, the lake was unproductive. However, Samuel Garman, an ichthyologist well-known to killifish aquarists, described the lake four years later (in A. Agassiz and S.W. Garman, "Exploration of Lake Titicaca," *Bull. Mus. Comp. Zool*., 3, 276-278) as an opportunity. He wrote: "A more inviting opportunity for a grand experiment in fish-culture can hardly be imagined than is offered here in the extensive sheet of pure water with its numerous mountain streams, complete isolation, abundance of vegetation, and vast number of animals."

Fast forward now to 1935, some 63 years after the expedition, when Peruvian and Bolivian officials met and decided that they should consider introducing supplemental fish to the lake they shared. They felt the karachi were not a sufficient food source to sustain the local population. The United States Bureau of Fisheries (the United States Commission of Fish and Fisheries was created in 1871 to investigate, promote, and preserve the fisheries of the United States; in 1903, it was reorganized as the United States Bureau of Fisheries which operated until 1940) was asked to conduct a study of Titicaca, and Milton C. James, the Assistant Chief of Fish Culture, was assigned the task. Sigh! The lake would never be the same.

A subsistence fisherman navigates his boat while fishing in Lake Titicaca in March. The many dozens of native karachi he catches in his nets in one day of fishing will feed his family for an entire week. (David Wallace, The Arizona Republic.)

A trout farm is seen in the middle of Lake Titicaca. North American trout were introduced into Lake Titicaca in the 1930s and have had a negative effect on the native killifish. (David Wallace, The Arizona Republic.)

After only a month of research, James decided upon a number of species that could be suitable for the South American great lake. The rainbow trout is one of the most widely introduced of fishes and may be regarded as global in its present distribution although, in the tropics it is only established at altitudes above about 4,000 feet. The first introductions of rainbow trout were for sporting purposes but its adoption for aquaculture led to an accelerated spread in the 1950's. Furthermore, although introduced for angling, many host countries subsequently expanded the distribution of the species for culture. It is now one of the main species cultured in temperate zones and at higher altitudes in the tropics.

The first round of transplants - lake trout fingerlings - arrived at the lake from North America in 1938. Compared with the tiny karachi, trout were a substantial source of protein swimming through the lake's waters. It was intended that the trout would stimulate a commercial fishery and add an additional food source for the people of the region. However, trout became the top predator in the lake. Suddenly many karachi were consumed by larger fish and the ones that weren't eaten had to compete with trout for food. Ironically, some 30 years later, Michigan was on the receiving end of fish importation when it introduced Pacific salmon to the Great Lakes. The exotic salmon there have crowded out native species and caused their populations to plummet.

In Lake Titicaca, the trout (trucha as they are called here) explosion transformed local fishing practices. Rainbow trout have been the most successful of all North American trout introduced to Lake Titicaca. They are now caught by hook,

farmed, sold in local markets and served in restaurants in Puno alongside the local staples of quinoa, potatoes, llama, guinea pig, trout and kingfish. The kingfish, *Basilicthys bonariensis* (but locally called pejerrey), is another invasive fish. They are even more voracious hunters than trout, and their arrival in 1955 caused a decline in trout numbers. Today, trout are most commonly cultivated in floating farms on the lake.

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Rainbow trout have been implicated in the disappearance or decline of many small native species, through either predation or competition. They have, together with the pejerrey, been responsible for some decline in Lake Titicaca of stocks of *Orestias* and in the parasitic catfish species of *Trichomycterus*. As mentioned, *O. cuvieri* has disappeared since the introduction, and *O. pentlandii*, *Trichomycterus rivulatus* and *T. dispar* have been considerably reduced in abundance.

A trout farm in the middle of Lake Titicaca in March. Dead trout are visible, killed by choppy water in the pens. Trout, first introduced from Michigan in the 1930s, and have had a negative impact on the native killifish in Lake Titicaca. (David Wallace, The Arizona Republic.)

THE CARP FIASCO

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Post, March 22, 2016)

The law of unintended consequences, often cited but rarely defined, is that the actions of people - and especially that of government - always have effects that are unanticipated or unintended. Economists and other social scientists have heeded its power for centuries; for just as long, however, governments have largely ignored it. This was not the first blunder committed by our U.S. Fish Commissioners. Arriving in the United States during the mid-1800s, the increasing waves of immigrants could scarcely believe that this vast new land had no carp. It had been a cultivated food source, garden element and symbol of strength and courage in Asia for over 4,000 years, and similarly esteemed in Europe for nearly 2,000. Inspired by the European model (whereby the Austrian princes of Schwarzenberg maintained 20,000 acres of carp ponds), scattered entrepreneurs here began to import the prized fish, hoping to provide a familiar and profitable food staple to the rapidly growing nation. Julius A. Poppe was one of the most successful, expanding a stock of five common carp imported from Germany in 1872 into a thriving California farm by 1876. Fielding orders from throughout the country, he actively began to lobby for the national cultivation of the hearty fish:

"There ought to be one person in every county who would raise choice carp as stock fish to sell to others to fatten for their own tables. It would be a cheap but sumptuous food and at the same time very convenient, as they are ready to be eaten at all times of the year."

In the Commission's 1872-73 report, commissioner Spencer Baird noted:

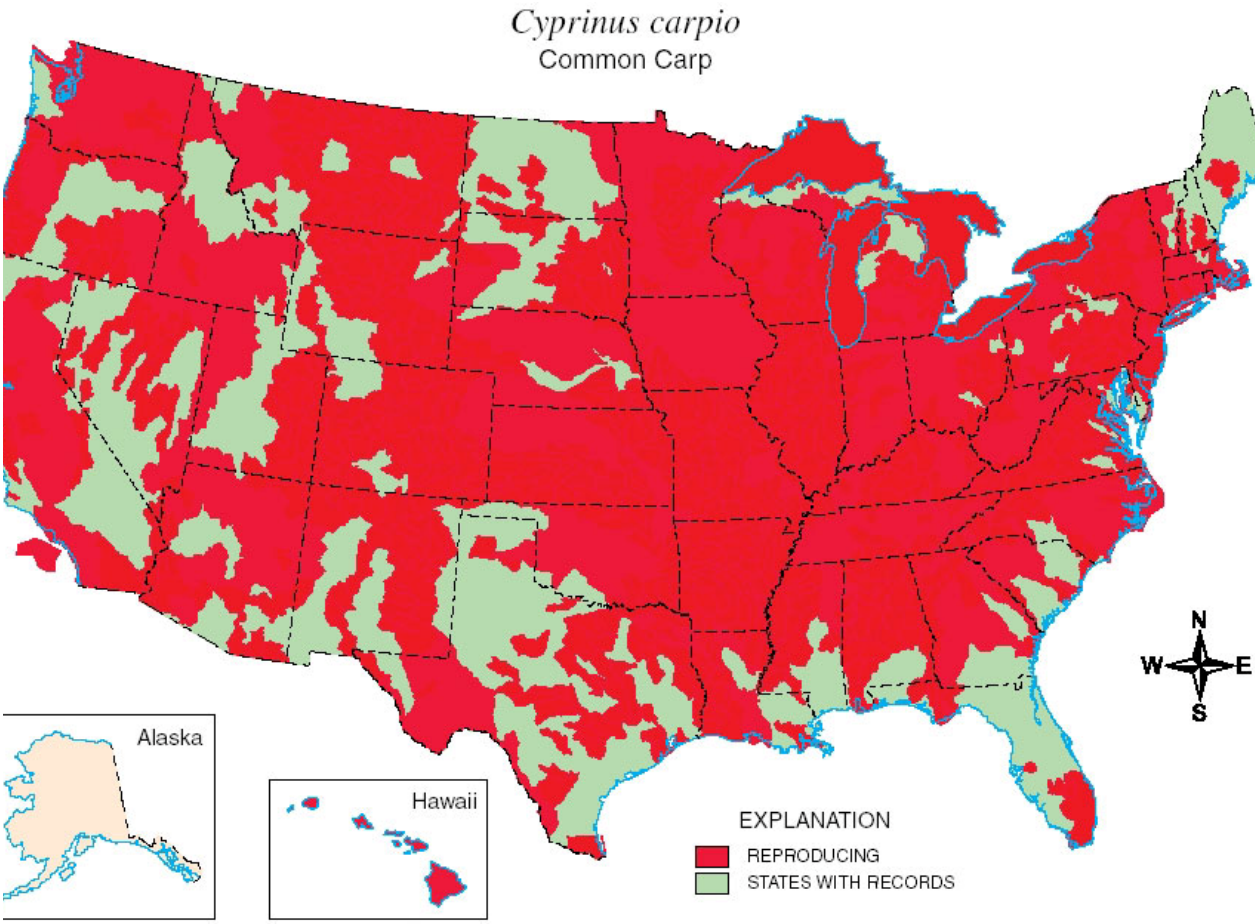
"Sufficient attention has not been paid in the United States to the introduction of the European carp as a food fish, and yet it is quite

The common Carp. This enormous freshwater fish is considered vulnerable to extinction in the wild, and yet it's also listed as one of the worst invasive species in the world. This contradiction is human-caused: It has been domesticated as a fish stock and has, either accidentally or illegally, been introduced to ponds and lakes on almost every continent in the world. The damage carp do to their new homes is extensive.

These fish were swarming in the O'shaugnessy Reservoir at the Columbus Zoo. A dad had brought a loaf of white bread, and his kids had a blast feeding these huge fish. They watched intently, thinking they were just another part of the zoo spectacle, not realizing that these fish don't live in a tank.

safe to say that there is no other species that promises so great a return in limited waters. It has the pre-eminent advantage over such fish as the black bass, trout, grayling, &c., that it is a vegetable feeder, and, although not disdaining animal matters, can thrive very well on aquatic vegetation alone. On this account it can be kept in tanks, small ponds, &c., and a very much larger weight obtained, without expense, than in the case of the other kinds indicated. It is on this account that its culture has been continued for centuries. It is also a mistake to compare the flesh with that of the ordinary cyprinidae of the United States, such as suckers, chubs, and the like, the flesh of the genuine carp (Cyprinus carpio) being firm, flaky, and in some varieties almost equal to the European trout."

Thus the U.S. Commission of Fish and Fisheries began an intensive effort of carp cultivation in 1877. In the late 1870's, Hugo Mulertt was appointed Assistant Commissioner of Fishes for the District of Southern Ohio and the surrounding area. It turned out that the area around Cincinnati was ideal for the cultivation of fishes and in a short while it became the leading producer of German carp. Subsequent efforts by state Fish Commissions had also introduced the carp to many area waters and by 1883, the fish's remark-



States color coded green represent those from which the species has been recorded at least once from natural waters within state borders. States color coded red are where there is evidence of natural reproduction in the wild. Once a nonindigenous fish establishes a reproducing population, it may persist indefinitely, becoming a permanent addition to the fauna.

able ability to live and reproduce in most every water condition allowed it to quickly infiltrate others.

By the turn of the century, the introduction of the carp was such a "success" that both public agencies and sportsmen had come to regard the fish as a nuisance. While tons of free-swimming carp were being harvested from area waters, they were not comparable in taste to either the selectively bred pool-cultivated carp of Europe or to the native game species and thus were useless as a food source. People had rushed into the venture without knowledge of the procedures involved. They ate carp during the spring spawning season, when the flesh was of poor quality. It was cooked incorrectly, without the European techniques that rendered it palatable. (I often wonder what Mulertt thought of his involvement in the carp affair.)

Their habit of eating by slurping up tidbits on the bottom of a river or pond and spitting out detritus made the water turbid. Such native predator fish as the pike had difficulty seeing prey through the haze. In feeding, carp dislodged or damaged aquatic vegetation, a food source for some waterfowl and shelter for other fishes. They could cause riverbank erosion in scouring for food. Sportsmen suspected that they were crowding out more desirable fish. By the turn of the century, the carp's reputation was in tatters.

"Some years ago the cries went up all over Michigan that the German carp be planted in our rivers," wrote the August 24, 1899 Benton Harbor Daily Palladium. "Now that we have them the lovers of game fish are wishing they could be exterminated, for it is said that they are destroying the spawn of our best river fish, and that they themselves are scarcely fit to eat. Carp are depopulating the Kalamazoo River of its best fish."

Conceding to the fish's permanence, carp removal programs began in the 1950s. None, however, were successful. Ironically, the greatest present promise for carp control hearkens back more than a century, when carp was intended to become a great renewable food source. A steady, or hopefully increasing, market for carp and carp products could today provide the prolonged check

Grass Carp (*Ctenopharyngodon idella*).

Black Carp (Mylopharyngodon piceus).

Bighead Carp (*Hypophthalmichthys nobilis*).

upon their population that State removal programs have been unable to due to limited resources.

Unfortunately, we now have another carp problem. Asian carp - there are many types but usually only the grass (*Ctenopharyngodon idella*), black (*Mylopharyngodon piceus*), silver (*Hypophthalmichthys molitrix*), and bighead carp (*Hypophthalmichthys nobilis*) are meant by the term - were introduced into Southern fish farm ponds in the 1970s and quickly spread across the United States. Asian carp are fast-growing, aggressive and adaptable fish that are outcompeting native fish species for food and habitat in much of the mid-section of the United States. They are now on the verge of invading the Great Lakes.----

ADDENDUM
(Lingua in maxillam or "tongue in cheek")

There are other ways to solve the carp problem, although it would involve digging large holes in city neighborhoods and filling them with water. For example, a wide sinkhole in East Detroit was the result of a utility job done years ago by the energy company DTE Energy, according to Gregory Eno, a spokesman for the Detroit Water and Sewerage Department. Left unrepaired for nearly four years it has recently been turned into a fishing pond. Neighbors were tired of dealing with the hole, so they decided to turn it into something they could enjoy. They've added blue gills, goldfish and also carp. "We like our fish, but honestly we'd like the road fixed," they said.

DTE Energy told ABC News,

"While we are still investigating how the damage occurred on Hull Street, we are working collaboratively with the city to make sure the road is repaired and safe for the residents who live in the area". As for the water in the hole, it's from a leak that the Detroit Water and Sewerage Department is currently trying to track down. "We're not sure about the source of the leak, but we are currently investigating that," Eno said. "Our goal is to get it rectified, get the water shut off and the hole drained within 24 to 48 hours."

After the water is drained, what happens to the hole is up to DTE Energy, Eno said. He added that the department has reached out to those individuals who put the fish into the hole and that they are hoping they will take the fish out there. If not, the department may work with Animal Control to "safely remove the fish and relocate them to another habitat," he said. One couldn't write a better fiction story than this true one!

THE ANCIENT FISHPONDS OF HAWAII

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, April 2, 2016)

The building of fishponds in Hawaii cannot be dated precisely but ancient chants and legends indicate ponds existed in Hawaii as far back as the 14th century. In mythology, the builder of the first Hawaiian fishpond is Ku-ula-kai, "Ku of the abundance of the sea," a member of the Ku family of gods. As told in stories, Ku-ula-kai built the fishpond at Kaiwiopele in Hana on Maui. Ancient Hawaiian fishponds were noted in the 1826 journal of William Ellis, the naturalist on James Cook's third voyage (1776–1779):

"They [the Hawaiians] have numerous small lakes and ponds, frequently artificial, wherein they breed fish of various kinds, and in tolerable abundance."

The Moi or Pacific Threadfin (*Polydactylus sexfilis*) is known as the most desired fish in Hawaii. In the ancient Hawaiian days, this fish was the fish for kings where only the royalty were allowed to eat this fish, commoners caught eating the fish faced severe punishment. The fish were such an important thing to the ancient Hawaiians that they would build ponds to farm these fish and help the population grow making sure this fish would never go extinct.

The Moi (*Polydactylus sexfilis*).

A makaha or sluice gate.

Each pond had a set of sluices or gates that controlled the seawater flow and the fish available in the pond for harvesting. A grate of vertical wooden sticks built into the pond walls allowed small fish to enter from the open sea and prevented larger fish from leaving. The grate aided water circulation, fish harvesting and stocking, and silt removal. The gate was a natural location for animal or human poachers as fish swarming the entrance during high tides were easy targets. A guardhouse built on top of the fishpond wall next to the gate was where the guard stayed while guarding against poachers and attending to pond maintenance. As payment for his labor and vigilance, he was allowed to eat fish from the pond not reserved for the ruling chief. The Moli'i pond

A Moli'i sluice gate.

had five such sluices, and three of them were still in place in 1972 when the pond was listed on the National Register of Historic Places listings in Oahu. This system of harvesting ocean catch was unique to Hawaii, and does not exist within other areas of ancient Polynesia.

Moli'i, Huilua, Kahaluu and He‘eia, are the only four original Hawaiian fishponds remaining on Oahu among the 100 or so that once existed on the island. Moli’i is the only one still operational and commercially successful. It encompasses 125 acres and fish cultivated in the pond - Tilapia, Mullet and Moi - are sold to local markets. Hawaiian fishponds are unique and feature advanced forms of aquaculture found nowhere else in the world. The techniques of herding or trapping adult fish with rocks in shallow tidal areas is found elsewhere but the six styles of Hawaiian fishponds, especially the large walled ponds, were technologically advanced and efficient, as their purpose was to cultivate pua or baby fish to maturity.

The 4,000 feet wall which partitions the Moli'i pond from Kaneohe Bay dates back to the earliest Hawaiian settlement of the land, and is traditionally attributed to the Menehune of Hawaiian mythology. The Menehune are said to be a people, sometimes described as dwarfs in size, who live in the deep forests and hidden valleys of the Hawaiian Islands, far from the eyes of normal humans. were said to be superb craftspeople. Legends say that the Menehune built temples, fishponds, roads, canoes, and houses. Some of these structures that Hawaiian folklore attributed to the

The Moli'i fishpond showing present-day commercial operations.

Aerial view of the He'eia fishpond.

Menehune still exist. The craftsmanship applied in constructing the wall is similar to brickwork, in that the gaps and crevices between the stacked stones are plugged with coral and smaller rocks.

The He'eia Fishpond is a walled (kuapā) style fishpond enclosing 88 acres of brackish water. The kuapā is built on the Malauka`a fringing reef that extends from the shoreline surrounding the pond out into Kāne`ohe Bay. Built approximately 600-800 years ago by the residents of the area, the wall is possibly the longest in the island chain measuring about 1.3 miles (7,000 feet) long and forms a complete circle around the pond. This is unique as most other fishpond walls are either straight lines or half circles connecting one point of shoreline to another.

The puka or hole in the He'eia Fishpond before reconstruction.

The Pani ka Puka campaign workers lined up ready to start the job.

The wall is composed of two separate volcanic rock walls parallel to one another on the outer edges and the 8 foot area between them is filled up with mostly coral and in some places rock and dirt. This compact style of wall slows water flow, allows the pond to maintain a base water level even at the lowest tides, and forces more water to the sluice gates. He'eia Fishpond has six sluice gates – three along the seaward edge that regulate salt water input and three along He`eia stream that regulates fresh water input. It is unknown who commissioned He'eia Fishpond to be built but it likely required thousands of residents to pass and stack rocks and coral for approximately two to three years to complete the massive wall.

Pani ka Puka was a campaign to raise the $100,000 needed for the repairs as well as mobilize hundreds of volunteers in the community to

Dec. 3, 2014 Pani ka Puka Blessing Ceremony.

The completed wall with the hole repaired.

assist with the physical labor needed to fix the wall by the end of 2015. On December 12, 2015 between 7:30am and 12:30pm, nearly 2,000 people from across the street, across our island chain and even across the Pacific joined the effort to turn a vision and dream into reality. The 50-year old puka (= "hole") in He'eia Fishpond is a puka no more. The human chain line spanning 2,000 feet moved several tons of coral and rock and the final sluice gate, the latter without it ever touching the ground. This feat and outpouring of community strength on behalf of fishpond restoration has not been seen in Hawaii in over 200 years.

Putting the final touches on the sluice gate.

The finished sluice gate and guardhouse.

The He'eia Fishpond looking towards the land.

THE MYSTERY OF LADY PEN'S FISH

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, May 4, 2016)

The following entry made by Samuel Pepys in his diary on May 28, 1665 is well known among aquarium hobby historians:

"Thence home and to see my Lady Pen, where my wife and I were shown a fine rarity: of fishes kept in a glass of water, that will live so for ever; and finely marked they are, being foreign."

The "Lady Pen," it should be noted, was Margaret Penn (1622-1682), the mother of William Penn of Pennsylvania.

Aquarists have tried to pin down the fish in question, the first being William Alford Lloyd in 1876 and, much later, Cristopher Coates. Lloyd stated:

"The Chinese kept gold and silver carp for amusement long before they were introduced into Europe during the second half of the seventeenth century. It was probably some such fish as these which are alluded to by Pepys in his Diary (quoted as a motto to this pamphlet), and doubtless vegetation grew, and was encouraged to grow, in the glass and porcelain vessels in which these household pets were kept, and so constituted them in some measure as "Aquaria."

Coates, on the other hand, suggested that the fish in question was the Paradise fish, *Macropodus opercularus* and his is the view most commonly accepted. In their 1968 book, "The Goldfish," Hervey and Hems write:

"It is unlikely that these fish were goldfish, and Dr. C. W. Coates, of the New York Zoological Society, has expressed what he calls the 'educated guess' that the fish were Paradise Fish (*Macropodus opercularis*), which is finely marked in the sense that the word 'finely' would be used by a seventeenth-century writer, and which by reason of its supplementary breathing organ, would be able to live for a very long time in a small container. Certainly, at this time, goldfish were not generally known in England; for Willughby (1635-72), old Izaak Walton (1593-1683), and others do not mention them, especially, they are not mentioned by John Ray (1627-1705) in his *Synopsis Methodica Piscium*, posthumously published in 1710."

However, I would like to play Devil's Advocate and suggest a different approach to the question. We know four things from Pepys' entry:
1. The fish were foreign, i.e., not native to England;
2. There was more than one fish in the glass;
3. The fish were finely marked;
4. The fish could live in a glass of water "forever."

Let us now see which of these requirements better fits Lloyd's assessment and which better fits that of Coates.

With regard to Number 1, Hervey and Hems argue that there is no evidence that the goldfish had arrived in England at or prior to this time, placing their importation to England in the early years of

Samuel Pepys (1633-1703).

the eighteenth century or perhaps in the late seventeenth century, i.e., sometime between 1692 and 1705. The Paradise fish - one of the first ornamental fishes available to western aquarium keepers - was imported much later, in 1869, to France by Pierre Carbonnier in Paris. Hervey and Hems are in error when they state that goldfish were first imported into the Netherlands in 1753 or 1754, as I have shown in the 4th edition of my "The Toy Fish" that the Jesuit, Martinus Martini, brought 10 goldfish to Holland in 1653.

I mention this because Margaret Jasper ("Lady Pen") was the daughter of John (Jan Baptiste) and Alet Jasper. The Jaspers were wealthy Protestants in County Clair (Ireland), London and The Netherlands. Records reflect that the Jaspers traveled often between Ireland and England, maintaining homes in both countries. Margaret first married Nicasius Van der Shure, a Dutchman and a merchant from Rotterdam in the Netherlands based in County Clare. He was killed in the 1641 Irish uprising, Margaret then inheriting all of his land.

Both her father and her first husband were Dutch and it is known that she spoke Dutch as well. In London, Margaret Jasper Van der Shure, known as "the gay widow," married Capt. William Penn, who later became Admiral William Penn, in London on June 6, 1643 and brought to this marriage Irish lands valued at more than 8000 pounds. This was the very same year Martini brought the goldfish to the Netherlands. Through relatives in Holland, she could easily have received some goldfish, either from this importation, offspring from this importation or from later exportations to the Netherlands. It should be noted that Penn himself had important naval and military connections with Holland.

With regard to Numbers 2 and 3, male Paradise fish are fairly combative, harassing and attacking each other and so cannot be kept together, especially in tight quarters. Thus if Pepys saw Paradise fish then he saw only females, otherwise he would have commented on the male's impressive finnage and coloration. However, although their markings are less impressive than that of the males they do have pointed fins, at least faint vertical bars and some color. Pepys, however, comments on none of these. He uses the adverb "finely" to describe the markings of the fish but among the many meanings of this word are included "beautifully," "elegantly" and "extremely well." In other words, since it can be used to say that something is very good or impressive, the markings of goldfish can also be described in this manner. Note that in red goldfish the red scales are edged in yellow, forming very fine lines that can be vertical, horizontal or even diagonal, depending upon the light. This effect can also be observed in goldfish of lesser or different pigmentation.

With regard to Number 4, glass is from the Old English glæs which means glass or a glass vessel and Pepys' reference to glass was to the latter and not to what we consider a drinking glass today. He comments that the fish will live forever in such a container, but Pepys knew nothing about the fish in question so this bit of Pepysian hyperbole can only be explained if Pepys had been informed that the fish had been kept successfully in her household for some time before his visit.

Sir William Penn (1621-1670).

Coates - surprisingly - jumped to the conclusion that the only fish that could be kept in small quarters for long times is the Paradise fish, a fish that did not arrive in Europe until 217 years later. An anemone kept in an unaerated, unfiltered small glass jar by Sir John Graham Dalyell and several others to whom it was passed on, survived for 59 years, a much more difficult feat considering that an anemone is a marine animal.

The water must be changed in all small containers that are without filtration or aeration regardless of whether the fish kept are air-breathers or not, since a buildup of rotting food, algae or feces are health risks to the fish and the resultant cloudiness of the water detracts from seeing them, destroying the usefulness of the aquarium as an ornamentation. An example of such present-day water changes with air breathing fishes is bettas kept in small containers, whose owners change their water on a regular basis. It also should be noted that water changes do not require anything but common sense; if the water becomes cloudy, the average person will change it without any further ado. Whether a fish survives in such quarters or not depends upon the care its owner gives it, not whether it breathes atmospheric air or not.

However, just keeping a fish alive in a small container under these circumstances must have appeared as something short of a miracle in 1665, as the only such previous recorded event was that due to Jeanne Rondelet, who had kept a fish alive in the mid-1500s in a glass of water for three years, something I doubt Pepys was familiar with. There being no reason why Lady Penn's success would not continue, it is not surprising that Pepys declared her fish would live forever. In any event, if the water is changed, goldfish (or even Jeanne Rondelet's unknown fish) could, in the Pepysian sense, also live forever.

Upon reflection it can be seen that, save for the fact that the fish were foreign and that there were more than one in the glass container, Pepys' diary entry really provides no information at all as to their identification. There are many definitions for the adverb "finely" and the statement that the fish "…will live so for ever…" if true at all is as true for goldfish (or almost any other fish) as it is for the Paradise fish.

Lloyd's conjecture in 1876 that Lady Penn's fish were goldfish lost favor over the years when no evidence was unearthed to show that the goldfish had been introduced into England prior to 1655. That, and Coates' fanciful conclusion that a fish could only "live so forever" in a small glass container if it were an air breather, have been refuted in this essay.

In matters like these I tend towards the use of Ockham's razor, which states that among competing hypotheses, the one with the fewest assumptions should be selected. Although I have previously (in "The Toy Fish") raised some questions about the identification of Pepys fish being the Paradise fish, I now favor the view of William Alford Lloyd much more favorably.

When the 1641 Irish Rebellion commenced, Margaret Jasper Van der Schuren inherited all of his land. She immediately fled on to London leaving all her holdings unattended. During her absence these holdings were Confiscated and Margaret never received compensation. Later, William Penn served in the Commonwealth Navy during the English Civil War and was rewarded by Oliver Cromwell with estates in Shanagarry and Clonakilty in County Cork, Ireland. The lands were seized from Irish Catholics in retaliation for the failed Rebellion. This ruin in Shanagarry is one of those estates.

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ADDENDUM I: SAMUEL PEPYS

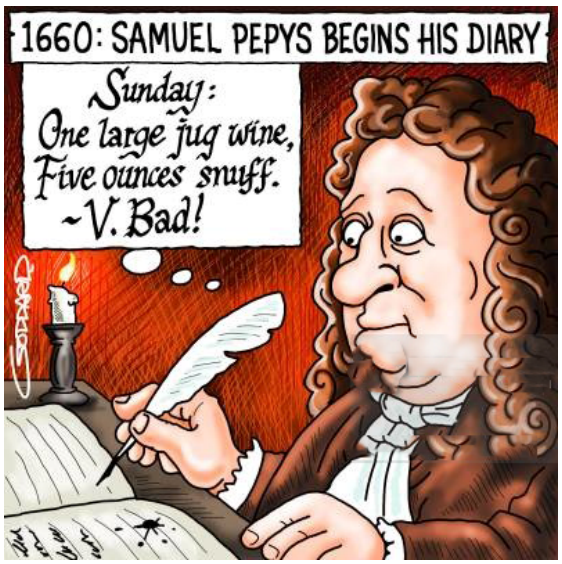
A key source for the adult life of Penn is the Diary of his next door neighbor, Samuel Pepys. Pepys (1633-1703), was an English naval administrator and Member of Parliament who is most famous for the diary he kept for a decade while still a relatively young man. Although Pepys had no maritime experience, he rose by patronage, hard work, and his talent for administration to be the Chief Secretary to the Admiralty under both King Charles II and King James II. His influence and reforms at the Admiralty were important in the early professionalization of the Royal Navy.

Penn is a figure of considerable importance in British naval history. Later, as Lord High Admiral and General at Sea for Parliament he helped to draw up the first code of tactics provided for the navy. It was the base of the "Duke of York's Sailing and Fighting Instructions," which continued for long to supply the orthodox tactical creed of the navy. He was an early proponent of fighting in line ahead, so as to bring as much firepower as possible to bear. After his death, his son, William, accepted the grant of land in the American colonies in lieu of money owed by the Crown to his father, and he named the new colony Pennsylvania in his father's memory.

Unsurprisingly, Penn appears several times in Pepys diary. Sir William Penn and Pepys were much thrown together, and were alternately very friendly and very jealous of each other. Penn frequently annoyed Pepys, both by his interference in what the latter considered his peculiar province - the governance of his office, and by his want of official aptitude. Tidiness, method, and business habits were all essentials in Pepys's eyes, and there is no evidence that Sir William Penn was at home in these departments of practical work.

Some of the many instances of Pepys's ill-humor with Penn were evidently caused by jealousy. Penn wished the Commissioners to take rank in the office in accordance with their relative social positions. Pepys was determined that he alone should be master in his own office, so that he was constantly anxious to prevent Penn from taking precedence of him.

The Earl of Sandwich was an English Infantry officer who later became an Admiral, and was killed at the Battle of Solebay, first naval battle of the Third Anglo-Dutch War; he also was the first cousin of John Pepys, the father of Samuel Pepys. When Pepys first associated with Penn, he found him sociable but cunning, but when Sandwich's jealousy of Penn began to break into the open, it did also with his protégé, Pepys, and ever after the pages of his Diary were filled with vituperation respecting this very successful admiral. The following is a typical entry:



"To the office, where the falsenesse and impertinencies of Sir W. Pen would make a man mad to think of." [April 5, 1666]

But he is referenced perhaps most vividly when we read of Penn's empting of a chamber pot, the stench of which drove Pepys off the roof of his house where, for relaxation, Pepys had installed a railing:

"At night home and up to the leads [roof]; but were, contrary to expectation, driven down again with a stinke by Sir W. Pen's emptying of a shitten pot in their house of office close by; which doth trouble me, for fear it do hereafter annoy me." [April 30, 1665]

Pepys describes his first meeting with Margaret Penn thusly:

"At noon dined at home and after dinner my wife and I to Sir W Pen's to see his lady, the first time, who was well looked, fat short old Dutch woman, but one that hath been heretofore pretty handsome, and is now very discreet and I believe hath more wit than her husband. Here we stayed talking a good while and very well please I was with the old woman at first visit." [August, 1664]

Note: Old for a woman at that time meant any age past twenty-five. Lady Penn was probably two or three years past forty.

Two years later, Pepys had changed his view of Lady Pen:

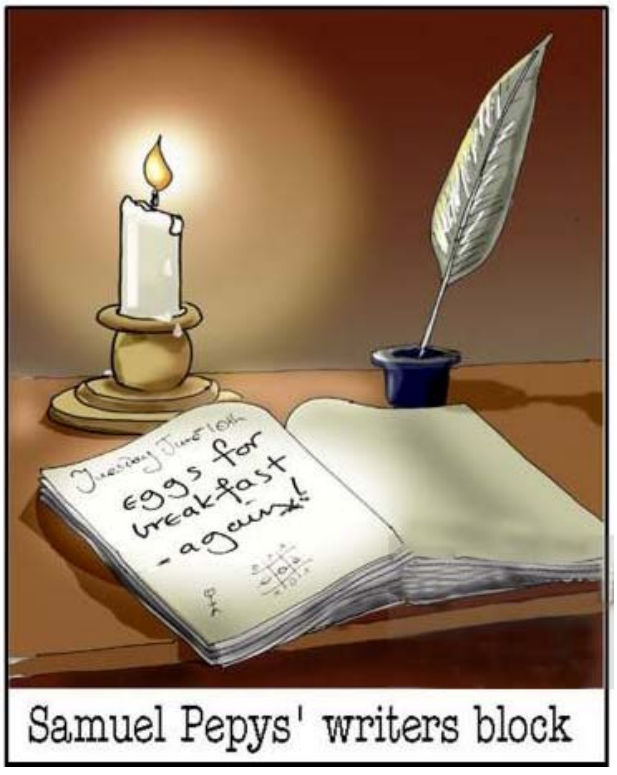
"At noon dined at home and so to my office again, and taking a turne in the garden my Lady Pen comes to me and takes me into her house…with whom I, notwithstanding all my resolution to follow business close this afternoon, did stay talking and playing the foole almost all the afternoon, and there saw two or three foolish sorry pictures of her doing, but very ridiculous compared to what my wife do. She grows mighty homely and looks old." [April 12, 1666]

Although plainly dressed the Penn newlyweds still had a capacity for high spirits. (Admiral) Penn was described by Pepys as one whose pranks included "drinking the susceptible into a stupor, singing bawdy songs and supping at midnight off bread-and-butter on the roof." Pepys found Penn "a very merry fellow" [October 9, 1660] with a wife with a similar approach to life.

Margaret has been describes as a "merry widow" and even in later age she had not lost her carefree proclivities. Pepys described one of Margaret's pranks :

"So home, vexed, and going to my Lady Batten's, there found a great many women with her, in her chamber merry, my Lady Pen and her daughter, among others; where my Lady Pen flung me down upon the bed, and herself and others, one after another, upon me, and very merry we were, and thence I home and called my wife with my Lady Pen to supper, and very merry as I could be, being vexed as I was. So home to bed" [April 12, 1665].

Two years later, however, Pepys' view of Penn and his wife changed significantly because of a notorious gossip, another neighbor and friend. Mrs. Turner was the wife of Thomas Turner, a minor official in the Navy Office. Twenty years before, when Turner was a petty naval officer, they had been intimates of Sir William's. Mrs. Turner was a middle-aged, talkative, disappointed woman, inquisitive about happenings in the Navy Building



where she, too, lived. In 1644 she had been a close (and persistent) neighbor of the Penns when, newly married, they lived in Great Tower Street in two rooms "one over another." Twenty years later, she held a strong grudge against Sir William and Lady Penn, mainly for benefits forgotten and for Sir William's success. Her gossip was constant and colored and malicious. Endlessly, she picked up trifles to the discredit of the Penns and unfortunately, Pepys listened to her.

"Then we fell to talk of Sir W. Pen, and his family and rise. She [Mrs. Turner] says that he was a pityfull [fellow] when she first knew them; that his lady was one of the sourest, dirty women, that ever she saw… she brought my Lady, who then was a dirty slattern, with her stockings hanging about her heels, so that afterwards the people of the whole Hill did say that Mrs. Turner had made Mrs. Pen a gentlewoman… and that in short his rise hath been his giving of large bribes…" [May 21, 1667]

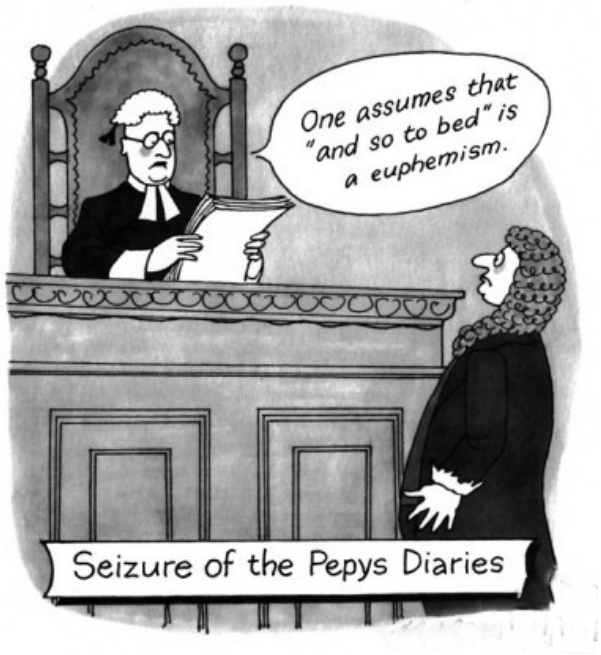
Pepys set down Mrs. Turner's talk as all true, facts and feeling. "Upon the whole, she told me stories enough to con-firm me that he [Sir William] is the most false fellow that ever was born of woman, and that so she thinks and knows him to be."

However, Pepys was accustomed to set down unfavorable opinions (formed on the spur of the moment) of persons to whim he was attached. Doubtless Pepys, while educating himself for the efficient discharge of his duties, learned much from Penn and it is certainly a blot in his character that he showed so little appreciation in his writings of their eminent position as practical seamen who had seen much hard fighting and occupied prominent positions in their profession. He may, however, have shown them more consideration in real life. It is evident that the strong words used in the Diary were only the hot expressions of passing feelings which were not followed by unfriendly action. There is every reason to believe that Pepys remained a cordial friend of Penn to the last, and this is corroborated by the evidence of the sincere friendship of the admiral's son - William Penn, the Quaker - for Pepys.

Pepys' philandering's are legendary and his diary was written in a shorthand that could not easily be read by a casual browser. There are, however, some passages of a secretive nature where, for reasons of concealment or because his passion deserves a special language, he resorted to a private code involving words based on Spanish, French and Italian. In this account Deborah "Deb" Willet (1650–1678) was a young maid employed by Pepys and his wife:

"...and he being gone, I called Deb. to take pen, ink, and paper and write down what things come into my head for my wife to do in order to her going into the country, and the girl, writing not so well as she would do, cried, and her mistress construed it to be sullenness and so was angry, and I seemed angry with her too; but going to bed, she undressed me, and there I did give her good advice and beso la [kissed her], ella [she] weeping still; and yo [I] did take her, the first time in my life, sobra mi genu [on to my knee] and did poner mi mano sub her jupes [put my hand up her skirts] and toca su [touch her] thigh, which did hazer [give] me great pleasure; and so did no more, but besando-la [kissing her] went to my bed." [March 31, 1668]

The things one gets involved in when studying the history of the aquarium hobby!



ADDENDUM II:
MARTINO MARTINI

Martino Martini (whose Chinese name was Jitai Wei Kuang-guo) was born in 1614 in Trento, Italy. After finishing high school studies in Trento in 1631, he entered the Austrian province of the Society of Jesus, from where he was sent to study classical letters and philosophy at the Roman College, Rome (1634-37). However his interest was more in astronomy and mathematics which he studied under the great Athanasius Kircher. Kircher was a 17th-century German Jesuit scholar and polymath who published around 40 major works, most notably in the fields of comparative religion, geology and medicine. Kircher has been compared to Leonardo da Vinci for his enormous range of interests, and has been honored with the title "Master of a Hundred Arts." Martini's request to be sent as a missionary to China had already been granted by Superior General of the Jesuits. Already on his way to China, he did his theological studies in Portugal (1637-39) where he was ordained as a priest in 1639 in Lisbon.

Martini embarked in 1640 and arrived in Macao in 1642. He began to study the Chinese but in the following year he crossed the border and took up residence in Hangzhou, which was his home port for some time. From there he crossed throughout the different provinces of the empire to gather scientific information, particularly on the geography of the Chinese empire. Along the way he visited Beijing and the Great Wall

When the Manchus invaded China in 1644 and seized Beijing and all of the whole empire, leading to the fall of the Ming dynasty, Martini ran into great danger. However, he was protected by lower officials who believed in the science and wisdom of the Jesuit. He did not hesitate to sometimes intervene with military and civil authorities to save lives.

In 1650 the superior of the mission sent Father Martini to Rome in order to explain and defend the missionary approach encultured of China Jesuits. Chinese customs that are not contrary to the Christian faith were respected and even encouraged by the missionaries, but that was not the view in Europe, especially by the Franciscans and Dominicans.

The travel was long and dangerous. The route passed through the Philippines on the way to Amsterdam where he arrived on August 31, 1653. In Amsterdam, Antwerp, Vienna and Munich he met with printers and prepared the edition of three important books including his famous *Novus Atlas Sinensis China*. He finally arrived in Rome in the spring of 1655.

In Rome, Martini delivered a lengthy memorandum prepared by the Chinese Jesuit missionaries, detailing and justifying their missionary approach. The discussions and debates lasted five months, following which the Propaganda Fide issued a decree in favor of the Jesuits in March 23, 1656.

In 1658, Martini was back in China. The trip lasted nearly two years as he was captured by pirates and a ransom had to be paid for his release. Only four of the ten young Jesuits who accompanied him arrived safely. Back in Hangzhou he resumed his pastoral work among the new Christians in the region. From 1659 to 1661, he built a triple nave

Martino Martini (1614-1661)

church, the current Cathedral of the Immaculate Conception of Hangzhou. Soon after, on June 6, 1661, Martini died of cholera in Hangzhou at the age of 47.

His great work, the *Novus Atlas Sinensis China* (1654), was published in French translation, without maps, under the title of *Description Géographique de l'Empire de la Chine traduite d'un autheur Chinois par le père Martini* (1655). It is remarkable for its precision and its positive assessments of Chinese society.

The following is an excerpt from Martini's *Description Géographique de l'Empire de la Chine*:

"La montagne de Cinking est proche de Ghanghoa, où il y a un lac, qui, pour n'estre pas des plus grands, ne laisse pas d'occuper deux cens arpens de terre; il est fameux & renomme pour les petits poissons dorez qui s'y peschent, que les Chinois ont nomme pour cet effet Kinyu, car la peau brille, pour estre en quelque façon entretaillée de lignes d'or: tout le dos est comme parsemé de poudre d'or: ils ne font point plus longs que le doigt, ils ont une queue à trois pointes, quelques fois à deux, par fois elle est simple & un peu large; ils font curieux à voir : ceux de la Chine en sont beaucoup d'estat, les nourrissent avec beaucoup de soin dans leurs maisons & dans leurs jardins de plaisance, en des vaissaux qui font faits tout exprès; les grands Seigneurs leur donnent quelques fois à manger de leur main, se joüent souvent avec eux, come si ces poissons connoissoient leur maistres, & qu'ils voulussent resmoigner le plaisir & le divertissement qu'ils reçoivent, lors qu'ils sont honorez de leur presence: un de ces petits poissons vaut bien par fois deux ou trois escus d'or, fur tout, lors qu'ils ont toutes les bonnes marques que les Chinois desirent."

Dropping this into Google Translate produces a lot of garbage since this is old French with spellings and words not found in current dictionaries. One example: Every beginning student of French learns first the word for "to be," which is être. In Martini's book it is estat. Also, Martini refers in this excerpt to acres (arpens) but it is French acres he has in mind and one French acre is about 50% larger than one of ours. In any event, my translation of the above follows:

"The mountain of Cinking is near Changhoa, where there is a lake, which, although not being the greatest, occupies three hundred acres of land. It is famous and renowned for the small golden fish within it, and because their skin shines between lines edged in gold, the Chinese have named this effect Kinyu. The whole back is like strewn with gold dust and they are no longer than a finger. They have a tail with three points, sometimes two, sometimes it is simpler and a little large; they are curious to see. The Chinese make much of their existence and feed them with great care in their houses and in their pleasure gardens, in vessels that are made just for this purpose. The great Lords give them some time to eat from their hands and often play with them as if the fish knew their masters, and they show that they like the pleasure and diversion they receive, when they honor their presence. When they have all the right markings that the Chinese desire, one of these small fish is worth two or three gold crowns."

This is probably the first reference to the Kinyu (also known as Chin-yü; in Japan it is Kingyo) or common goldfish in a Western publication in addition to providing an explanation of the name. Martini does not indicate that the locals bred these fish found in the lake but he does mention that the more prized (because of their markings) were kept by the Chinese in their houses and in their garden pools.

HUGO MULERTT AND THE TALKING GOLDFISH

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, April 23, 2016)

In aquarium hobby history, some events are important but not interesting; others are unimportant but are interesting. This is one of the latter. The following is from the 1883 edition of "The Goldfish and its Systematic Culture With a View to Profit," by Hugo Mulertt:

"The goldfish, we are told, like many other things, originated in China, though, so far as this is concerned, its history is involved in much obscurity. The first mention we find of it is in the "Arabian Nights' Entertainments," in the story of the Fisherman and the Genii, a story, which like those accompanying it, is of Persian origin."

This story was repeated an interview with Mulertt that appeared in The Brooklyn Daily Eagle on December 16, 1894.

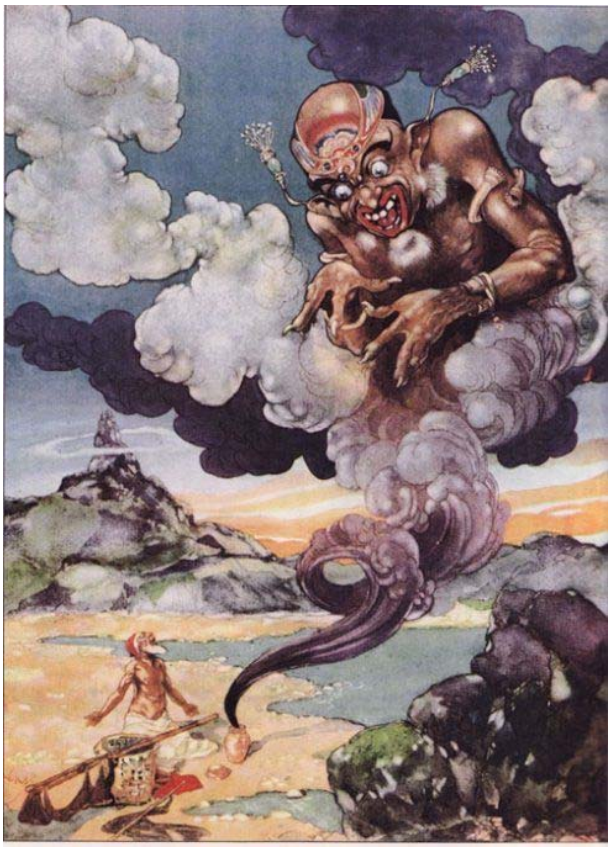
I never did follow up this claim - nor did anyone else that I can remember - until recently when I recalled that "The Arabian Nights' Entertainment or Thousand and One Nights" is a collection of about four hundred old oriental stories, chiefly from Persia, India, and Arabia, none of which had I had previously associated with goldfish.

"The Fisherman and the Jinni" [Genie] tells the story of a fisherman whose nets retrieve a yellow vase from the sea. When he opened it,

"…there came forth from the jar a smoke which spired heavenwards into aether (whereat he again marvelled with mighty marvel), and which trailed along earth's surface till presently, having reached its full height, the thick vapour condensed, and became an Ifrit [an Arabian genie or jinne], huge of bulk, whose crest touched the clouds while his feet were on the ground. His head was as a dome, his hands tike pitchforks, his legs long as masts and his mouth big as a cave ; his teeth were like large stones, his nostrils ewers, his eyes two lamps and his look was fierce and lowering."

The Ifrit, who has been trapped for hundreds of years had decided to kill the man who rescues him. The fisherman tricks the Ifrit into returning to the vase:

"He began by asking the Ifrit, 'Hast thou indeed resolved to kill me?' and, receiving for all answer, 'Even so,' he cried, 'Now in the Most Great Name, graven on the seal-ring of Sulayman the Son of David (peace be with the holy twain!), and I question thee on a certain matter wilt thou give me a true answer?' The Ifrit replied 'Yea;' but, hearing mention of the Most Great Name, his wits were troubled and he said with trembling, 'Ask and be brief.' Quoth the Fisherman, 'How didst thou fit into this vase which would not hold thy hand; no, nor even thy foot, and how came it to be large enough to



The fisherman confronting the Ifrit.

contain the whole of thee? 'Replied the Ifrit, 'What! dost not believe that I was all there?' and the Fisherman rejoined, 'Nay! I will never believe it until I see thee inside with my own eyes.'"

Then the Ifrit began to change himself into smoke, which, as before, spread over the sea and the shore, and which, then collecting itself together, began to go back into the vase slowly and evenly till there was nothing left outside. Then a voice came from the vase which said to the fisherman, **"Well, unbelieving fisherman, here I am in the vase; do you believe me now?"** The fisherman instead of answering took the lid of lead and shut it down quickly on the vase.

The fisherman then tells him the story of "The Wazier and the Sage Duban," and after the story, the Ifrit promises to reward the fisherman, and indeed shows him a magic lake full of strange fish:

"The Ifrit burst into laughter and stalked away, saying to the Fisherman, 'Follow me' and the man paced after him at a safe distance (for he was not assured of escape) till they had passed round the suburbs of the city. Thence they struck into the uncultivated grounds, and crossing them descended into a broad wilderness, and lo in the midst of it stood a mountain-tarn. The Ifrit waded in to the middle and again cried, Follow me and when this was done he took his stand in the centre and bade the man cast his net and catch his fish. The Fisherman looked into the water and was much astonished to see therein vari-coloured fishes, white and red, blue and yellow; however he cast his net and, hauling it in, saw that he had netted four fishes, one of each colour. Thereat he rejoiced greatly and more when the Ifrit said to him, 'Carry these to the Sultan and set them in his presence; then he will give thee what shall make thee a wealthy man; and now accept my excuse, for by Allah at this time I wot none other way of benefiting thee, inasmuch I have lain in this sea eighteen hundred years and have not seen the face of the world save within this hour. But I would not have thee fish here save once a day.'"

When he brings the fish to the King he is much pleased with their colors and orders his cook to prepare the fish. The fisherman receives four hundred dinars. When the slave-girl puts the fish in a frying-pan, a fissure appears in the wall and a beautiful lady appears. She reminds the fish to remember the agreement, they assure her and then the fish turn black as charcoal.

"…as regards the cookmaid, she took the fish and cleansed them and set them in the frying-pan, basting them with oil till one side was dressed. Then she turned them over and, behold, the kitchen wall clave asunder, and therefrom came a young lady, fair of form, oval of face, perfect in grace, with eyelids which Kohl-lines [eye shadow]enchase, Her dress was a silken head-kerchief fringed and tasseled with blue; a large ring hung from either ear; a pair of bracelets adorned her

The young lady thrusting her rattan rod into the frying pan containing the fishes.

wrists; rings with bezels of priceless gems were on her fingers ; and she hent in hand a long rod of rattan-cane which she thrust into the frying-pan, saying, 'O fish! O fish! be ye constant to your covenant?' When the cook-maiden saw this apparition she swooned away. The young lady repeated her words a second time and a third time, and at last the. fishes raised their heads from the pan, and saying in articulate speech 'Yes! Yes!' began with one voice to recite 'Come back and so will I! Keep faith and so will I! And if ye fain forsake; I'll requite till quits we cry!'

"After this the young lady upset the frying-pan and went forth by the way she came in and the kitchen wall closed upon her. When the cook-maiden recovered from her fainting-fit, she saw the four fishes charred black as charcoal…"

The King is amazed and orders the fisherman to bring new fish, which he does. A second time the lady appears. Consulting the fisherman as to where he got the fish, the King goes to the lake. Even the oldest inhabitants said that there wasn't such a lake as there was now and the King swears to find the truth of this mystery. After a long walk he finds a palace built of stone plated with iron. He enters the palace but can't find anyone. Then he hears a lament and goes to its source. He finds a man stuck in stone from his middle downwards who tells him his story.

The prince's wife had given him a sleeping potion each night and then left him to visit her lover. One night, the prince does not drink the potion and secretly follows his wife. When he encounters her lover, a black slave, he attempts to kill him but only wounds him. In order to punish him,

The prince secretly follows his wife and finds her in the bed of her lover

his wife, who actually is a powerful sorceress, turns his kingdom into a lake and the citizens of the four faiths, Muslem, Christian, Jew and Zoroastrian she turned into fishes: Muslems white, Zoroastrians red, Christians blue, and the Jews yellow (the woman who talked to the fishes in the Sultan's kitchen was, of course, the sorceress Queen). Next she turns the prince's lower half into stone and, as he cannot move, punishes him by lashing him with a whip every day.

Hearing this tale, the king kills the black slave and forces the wife to lift the spell. The Prince is restored to his former self, the fish are turned back into people, the King cuts the Queen into two with his sword and the fisherman is rewarded.

Mulertt seemed to have assumed that the Arabian Nights' Entertainments were true instances of actual occurrences, rather than a collection of folklore. In any event, he should have read the compete Fisherman's Tale before claiming that the fish were goldfish. He was careless in thinking that the fish were of all four colors at the same time - thus confusing them perhaps with calico goldfish - and he missed the explanation of just what the fish were. In Mulertt's time in Cincinnati, the city had numerous breweries. Perhaps he wrote the preface to "The Goldfish and its Systematic Culture With a View to Profit" while spending too long a time at one of its many Biergartens. Schande über Sie Hugo!

NOTES:

1. Genii is the plural form of genie and jinn is the plural form of jinni. Mulertt was a little confused about this.
2. I prefer the Richard F. Burton unabridged and unexpurgated English translation of the Arabian Nights Entertainment, the full title being, "A plain and literal translation of the Arabian Nights entertainments, now entitled the book of the Thousand Nights and a Night with introduction explanatory notes on the manners and customs of moslem men and a terminal essay upon the history of the Nights," printed by the Burton Club for private subscribers only, Vol. 1, 1885). Burton did his translation because he was dissatisfied with the translation available at the time. The following were his reasons:

"Our century of translations, popular and vernacular, from (Professor Antoine) Galland's delightful abbreviation and adapta-tion (A.D. 1704), in no wise represent the eastern original. The best and latest, the Rev. Mr. Foster's, which is diffuse and verbose, and Mr. G. Moir Busseys, which is a re-correction, abound in gallicisms of style and idiom ; and one and all degrade a chef- d'oeuvre of the highest anthropological and ethnographical interest and importance to a mere fairy-book, a nice present for little boys."

A Japanese artist's interpretation of the Arabian Nights fishes.

JEANNE RONDELET

by Albert J. Klee, Ph.D.
(Aquarium Hobby Historical Society of America, Facebook Files, May 4, 2016)

Ah, it all seemed so simple! Over the years my statement in *The Toy Fish* that Rondelet had claimed that his wife, Jeanne, had kept a fish alive in a glass of water for three years has often been repeated and copied. I knew that they were married in 1538 so if I could find out when she died I could narrow down the time interval in which she kept the fish.

There are three main early sources for biographical information about Rondelet's wife: **1.** "Gulielmi Rondeletii Vita, mors, et epitaphiae," in Joubert, Laurent, *Operum Latinorum, tomus primus* (Lyon, 1579), Lib. IX, pp. 185–192; 2 [in Latin], **2.** Planchon, Jules Emile, "Rondelet et Ses Disciples," Boehm & Fils, Éditeurs du Montpellier Médical, Place de l'Observatoire, 1866 [in French] and **3.** Kingsley, Charles, "Rondelet, The Huguenot Naturalist," a lecture given at Cambridge in 1869 [in English]. I found the first and third to be the most helpful as this essay is concerned with Madame Rondelet, and not so much with her husband.

Rondelet got his doctorate in 1537, and next year fell in love with and married a beautiful young girl - Jeanne Sandre - who seems to have been as poor as he. The newly-married Rondelet determined to apply for employment and to Venice he would have gone, leaving his bride behind, had he not been stayed by one of those angels who sometimes walk the earth in women's shape. Jeanne Sandre had an elder sister, Catharine, who had brought her up. She was married to a wealthy man, but she had no children of her own. For four years she and her good husband had let the Rondelets lodge with them, and now she was a widow, and to part with them was more than she could bear.

She carried Rondelet off from the students who were seeing him safe out of the city, brought him back, settled on him the same day half her fortune, and soon after settled on him the whole, on the sole condition that she should live with him and her sister. For years afterwards she watched over the pretty young wife and her two girls and three boys and over Rondelet himself, who, immersed in books and experi-ments, was utterly careless about money, and was to them all a mother - advising, guiding, managing, and regarded by Rondelet with genuine gratitude as his guardian angel.

The 1550s were Rondelet's palmy days. He had a villa outside the city where may be seen the rem-

Guillaume Rondelet (1507-1566), known also as Rondeletus (Rondeletius).

nants of the great tanks, fed with water brought through earthen pipes from the Fountain of Albe, wherein he kept the fish whose habits he observed. But trouble was coming. In 1559 he lost his sister-in-law, to whom he owed all his fortunes and watched over him and his wife like a mother, then in 1560 he lost Jeanne under most painful of circumstances - she died in a few days of a hemorrhagic inflammation - and then his best -beloved daughter. Jeanne had been married to Rondelet for 23 years and had borne him five children (Rondelet and his wife had three sons and two daughters but only the daughters survived). Conservatively speaking, the years 1538-1557 would have been the interval in which she keep her fish but a more likely interval would be 1540-1550. A reasonable point estimate, therefore, would be 1545.

My next quest was to pin down the original source for Rondelet's assertion that his wife kept a fish for three years. I vaguely recalled that it was Jim Atz but, not having his material conveniently at hand, I Googled the phrase. I came up with two hits that boggled the imagination and almost gave me a cardiac arrest!

The following appeared in *Littell's Living Age*, No. 716, pg. 419, - 13 February, 1858. The magazine essentially reprinted articles from other magazines and this one came from *Blackwood's Magazine* and was titled, "Hunger and Thirst"; as was common in those days, the article had no author's name:

"Rondelet kept a fish three years without food, and Rudolphi [Karl Asmund Rudolphi - (1771-1832) - was a Swedish-born naturalist, who is credited with being the "father of helminthology"] a *Proteus anguineus* five years! ...and with regard to the fish, some doubts may be entertained whether it did not find worms and larvae in the water."

The following was titled "A philosophical essay declaring the probable causes whence stones are produced in the greater world from which occasion is taken to search into the origin of all bodies, discovering them to proceed from water and seeds: being a prodromus [i.e., a forerunner or precursor] to a medicinal tract concerning the causes and cure of the stone in the kidneys and bladders of men." It was written by Dr. Thomas Sherley and printed in London in 1672 for privately for William Cademan.

Sherley (1638-1678) was a physician and the essay describes the origin and supposed causes of the formation of stones in the earth and in living things. Sherley sets forth and develops at length the thesis that all stones and metals have seeds from which they grow, as in the two other kingdoms of nature like botany and animals. The seed is invisible, but is often present in vapors that rise from the center of the earth. His ideas are based upon ancient traditions, principally Aristotlian philosophy.

Laurent Joubert (1529-1582). Joubert was a student of Guillaume Rondelet.

"Animals also are nourished by water; some immediately, others mediately. Immediately, from meer water, as Salmon, Sturgeon, and several other sorts of Fish, in whose stomacks no food, that I know of, was ever yet found. And to confirm this; Rondeletius {French physician and naturalist, Guillaume Rondelet (1507-1566)} [an Author of good credit] affirms, that his Wife kept a Fish in a large glass, and fed it with nothing but water [so long] till it grew so big, that it could no longer be contained in the glass; which they were forced to break to get it out."

Note: The Latin form of Guillaume Rondelet is Gulielmus Rondeletius. I should also mention that the Latin form of Jeanne Rondolet is Ioanna Rondeletius.

The thing that immediately struck me was that one article claimed that it was Rondelet who kept the fish and the other that it was his wife. If Rondelet kept the fish then he would get the credit for being the first Stage II aquarist and Lady Margaret Penn would be the first woman aquarist of record. However, the *Littell's Living Age* article was published - anonymously - 313 years later than our point estimate. - and the Philosophical Essay was published 127 years later and written by a highly educated man. Thus I decided in favor of Jeanne Rondelet being the one who kept the fish.

Both accounts, however, mention as fact that the fish were not fed during the entire three years. This was something new and I searched and found the Atz reference I was originally looking for. It turned out to be an article Jim had written for *Natural History* in early 1949 (Atz, James W., "The Myth of the Balanced Aquarium," *Natural History*, pp. 72-77 and 96, February 1949). In it he stated: "According to Boyle, Guillaume Rondelet, a Renaissance student of aquatic life who died in 1566, once claimed that his wife had kept a fish alive in a glass of water for three years." Atz, for some reason, did not say anything about the fish not being given any food during its stay in the glass but, as it turned out, Boyle did.

The Boyle in question was Robert Boyle (1627-1691), a British chemist and natural philosopher, best known as the discoverer of Boyle's Law. Boyle's Law is one of the laws in physics that concern the behavior of gases,, i.e., the relationship between the volume of a gas and its pressure at a constant temperature. When a gas is under pressure it takes up less space; the higher the pressure, the smaller the volume. The Law states that pressure is inversely proportional to the volume.

The problem was that the complete works of Robert Boyle takes up six volumes (Volume I

Jules Émile Planchon (1823-1888).

contains 1,073 pages!) and Atz did not indicate in which of these works the Rondelet quote could be found. However, after some Internet dredging I finally found it.

In *The Sceptical Chymist* (published in London in 1661), Boyle attacks the Aristotelian theory of the four elements (earth, air, fire, and water) and also the three principles (salt, sulfur, and mercury) proposed by Paracelsus. Instead, he developed the concept of primary particles which by coalition produce corpuscles. According to this concept, different substances result from the number, position, and motion of the primary matter - conceptually the simplest of all possible accounts. According to this view, all natural phenomena were explained not by Aristotelian elements and qualities (the remnants of a biological mode of construal), but by the motion and organization of primary particles.

My copy of *The Skeptical Chymist* was published by J.M. Dent & Sons in London and in New York by E.P. Dutton & Co. and on pages 214-215 we find:

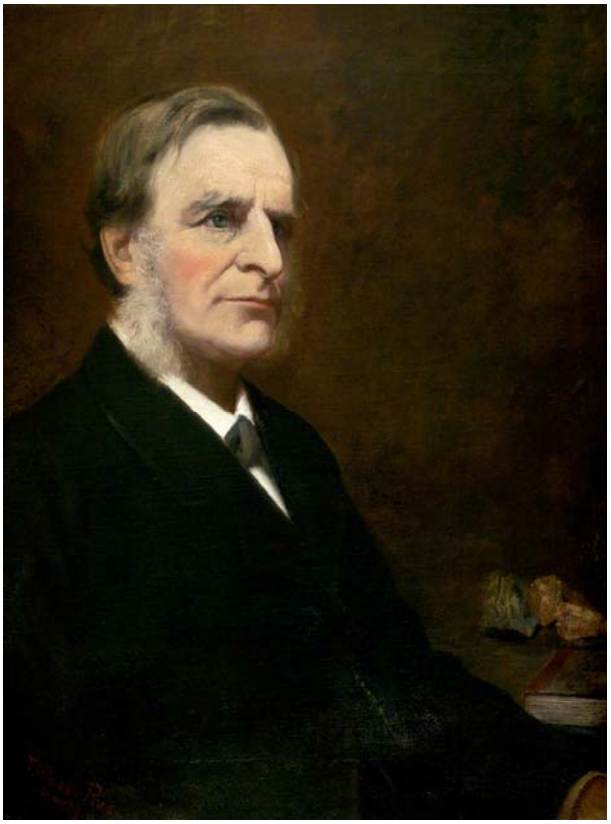
"And, these last arguments may be confirmed by the experiment I have often had occasion to mention, concerning the mint I produced out of water. And partly by an observation of *Rondoletius* concerning the growth of animals also, nourished but by water, which I remembered not to mention, when I discoursed to you about the production of things out of water. This diligent writer then, in his instructive book of fishes, affirms that his wife kept a fish in a glass of water without any other food for three years; in which space it was constantly augmented, till at last it could not come out of the place, at which it was put in, and at length was too big for the glass itself, though that were of a large capacity."

The original source then is Rondelet's *Libri de piscibus marinis in quibus verae piscium effigies expressae sunt*, published in 1554. The following is from Book I, Chapter XII which describes the nourishment of fishes:

"In Gallia Narbonensi curiosi quidam in vasis vitreis aqua plenis diu nutriunt, certumque est quo purior suerit aqua,eo diutius vitam producere, celeriter aute interire, si quid aliud praeter aquam vt panem, aut aliud quippiam solidioris alimenti in vas coniecerint. Hoc modo suauissima coniux mea tres annos piscem domi aluit, sicque educatus in eam corporis molem accreuit, vt tandem nec vas eum capere, nec qua ingressus fuerat, eadem exire potuerit."

The English translation follows:

"In the province of Narbonne, some of the curious [keep fish] in glass jars of water for a long time, adding no bread or any other solid



Charles Kingsley (1819-1875).

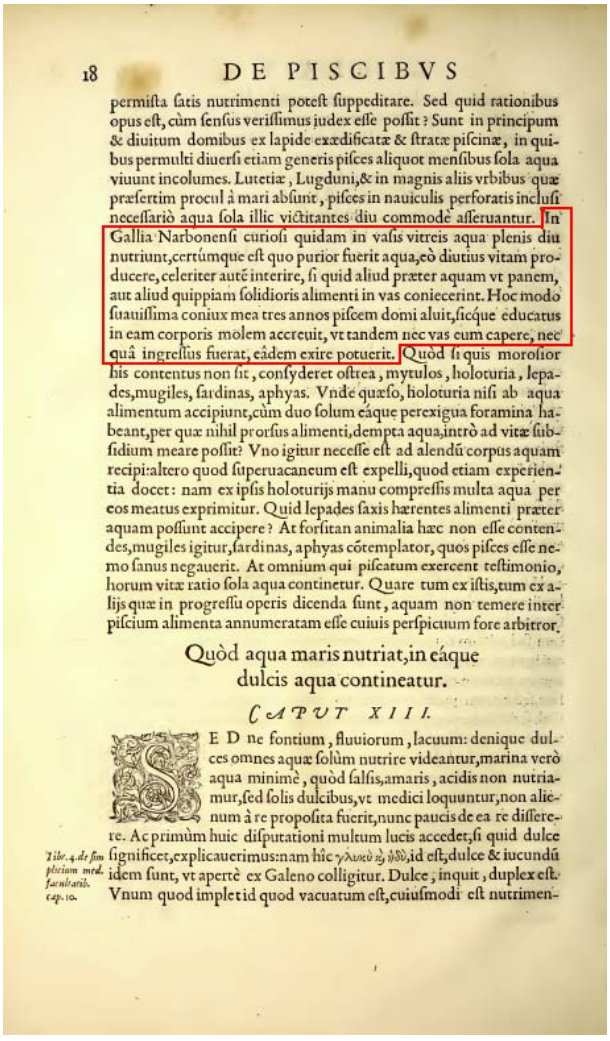
Robert William Boyle (1627-1691).

food to the water, since the longer the food lasts, the faster the fish die. In this way my sweet wife kept a fish at home for three years; she reared it so well that finally it was too large for the jar and could not leave through the opening through which it had been introduced."

Notes:
(1) Narbonne presently is a commune in southern France about 528 miles from Paris. French communes are roughly equivalent to townships or incorporated municipalities in the United States. However, they may be a city of 2.2 million inhabitants like Paris, a town of 10,000 people, or just a 10-person hamlet.
(2) Rondelet loved his wife very much. Here he describes Jeanne as his "sweet wife; in his will, he refers to her as "my dear wife."

Thus we now know that Jeanne Rondelet kept a fish in a large glass vessel ("glass" at that time did not mean a drinking glass) of water without any food given to it by her for three years, after which it had grown too large for the container and too large to be able to remove it through the opening through which it was originally inserted. Whether the glass had to be broken to release the fish is not clear, but the inference is there. As to how a fish could survive that long without food and in addition, grow, is a mystery. One possibility is that it ate insects that inadvertently fell into the opening of the jar. If consumed immediately, the water would have remained unpolluted. Since Rondelet did not name any particular person in Narbonne, Jeanne Rondelet remains as the first person of record to keep a fish alive in a glass container.

So ends my journey to learn more about Jeanne Rondelet and her fish. I enjoyed the trip while it lasted!



18 DE PISCIBVS

permista satis nutrimenti potest suppeditare. Sed quid rationibus opus est, cùm sensus verissimus iudex esse possit? Sunt in principum & diuitum domibus ex lapide exædificatæ & stratæ piscinæ, in quibus permulti diuersi etiam generis pisces aliquot mensibus sola aqua viuunt incolumes. Lutetiæ, Lugduni, & in magnis aliis vrbibus quæ præsertim procul à mari absunt, pisces in nauiculis perforatis inclusi necessariò aqua sola illic victitantes diu commodè asseruantur. In Gallia Narbonensi curiosi quidam in vasis vitreis aqua plenis diu nutriunt, certúmque est quo purior fuerit aqua, eò diutius vitam producere, celeriter autẽ interire, si quid aliud præter aquam vt panem, aut aliud quippiam solidioris alimenti in vas coniecerint. Hoc modo suauissima coniux mea tres annos piscem domi aluit, sicque educatus in eam corporis molem accreuit, vt tandem nec vas eum capere, nec quâ ingressus fuerat, eâdem exire potuerit. Quòd si quis morosior his contentus non sit, consyderet ostrea, mytulos, holoturia, lepades, mugiles, sardinas, aphyas. Vnde quæso, holoturia nisi ab aqua alimentum accipiunt, cùm duo solum eáque perexigua foramina habeant, per quæ nihil prorsus alimenti, dempta aqua, intrò ad vitæ subsidium meare possit? Vno igitur necesse est ad alendũ corpus aquam recipi: altero quod superuacaneum est expelli, quod etiam experientia docet: nam ex ipsis holoturijs manu compressis multa aqua per eos meatus exprimitur. Quid lepades saxis hærentes alimenti præter aquam possunt accipere? At forsitan animalia hæc non esse contendes, mugiles igitur, sardinas, aphyas cõtemplator, quos pisces esse nemo sanus negauerit. At omnium qui piscatum exercent testimonio, horum vitæ ratio sola aqua continetur. Quare tum ex istis, tum ex alijs quæ in progressu operis dicenda sunt, aquam non temere inter piscium alimenta annumeratam esse cuiuis perspicuum fore arbitror.

Quòd aqua maris nutriat, in eáque dulcis aqua contineatur.

CAPVT XIII.

SED ne fontium, fluuiorum, lacuum: denique dulces omnes aquæ solùm nutrire videantur, marina verò aqua minimè, quòd salsis, amaris, acidis non nutriamur, sed solis dulcibus, vt medici loquuntur, non alienum à re proposita fuerit, nunc paucis de ea re disserere. Ac primùm huic disputationi multum lucis accedet, si quid dulce significet, explicauerimus: nam hîc γλυκὺ καὶ ἡδὺ, id est, dulce & iucundũ idem sunt, vt apertè ex Galeno colligitur. Dulce, inquit, duplex est. Vnum quod implet id quod vacuatum est, cuiusmodi est nutrimen-

Lib. 4. de simplicium med. facultatib. cap. 10.

The entry in Rondelet's *Libri de piscibus marinis in quibus verae piscium effigies expressae sunt* (outlined in red) where I found his mention of his wife keeping a fish three years in a glass vessel without adding any food to the water.

The Missing William Alford Lloyd Manuscript

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, June 4, 2016)

After Robert Warington demonstrated the principle of the balanced freshwater aquarium in 1850, the next step was to do the same for the marine aquarium. The problem was that keeping higher order aquatic plants in freshwater was a whole lot easier than keeping higher order aquatic plants in seawater, the higher order aquatic plants in the latter being mostly the large red (*Rhodosperma*) and green (*Chlorosperma*) algae.

In the freshwater aquarium, one of the problems was the *conferva* (plural *confervae*), meaning at the time any simple filamentous green algae. (Many *confervae* are now usually placed in the genus *Tribonema. Confervae* are present in seawater as well.) Under certain lighting conditions these would rapidly cover the higher order plants and the balance would be destroyed. The following are extracts from Warington's work on the freshwater aquarium (Warington, 1852):

While the slimy snail, finding its proper nutriment in the decomposing vege-table matter and minute confervoid growth, prevents their accumulation by removing them, and by its vital powers converts what would otherwise act as a poison into a rich and fruitful nutriment, again to constitute a pabulum for the vegetable growth, while it also acts the important part of a purveyor to its finny neighbours.

At present I am attempting the same kind of arrangement with a confined portion of sea water, employing some of the green sea weeds as the vegetable members of the circle, and the common winkle or whelk to represent the water snails.

The following is an example of problems with confervae in the marine tank (Hughes, 1875):

The silky greenish-black filamentous confervas (*Spirulina* and *Oscillatoria*) spring up with marvelous rapidity in hot months, covering rock work, glass, and shingle, and proving most difficult intruders to dislodge. In fact they cannot he thoroughly exterminated without a regular scouring process, invol-ving much time and trouble. Mr. Lloyd says that conferva, like fire, "is a good servant but a bad master." Its growth may be checked by the absence of light, and by rubbing the sides of the Tank, and the glass front, with a spade -shaped cleanser, covered with folds of lamp-cotton…

In his article demonstrating the proof of principle for the marine aquarium, Warington stated (Warington 1853):

My first object was to ascertain the kind of sea-weed boat fitted, under ordinary circumstances, for keeping the water clear and sweet, and in a sufficiently oxygenated state to sustain ani-mal life. And here opinions were at variance, for one naturalist friend whom I consulted, advised me to employ the Rhodosperms; another stated that it was impossible to make the red weeds answer the

Green hair algae, a *conferva*, growing on *Anacharis* plant leaves.
(Source: Aquariumbasics.com.)

purpose, as he had tried them, and strongly recom-mended the olive or brown-coloured Algae; while, again, others thought that I should be more successful with those which had in theory first suggested themselves to my own mind, namely the Chlorosperms. After making numerous unsuccessful experiments with both the brown and red varieties of Algae, I was fully convinced that, under ordinary circumstances, the green weeds were the best suited for the purpose.

In this way Warington managed to keep blennies, gobies and sculpins, as well as invertebrates. In the following year Gosse reported on his experiences with Rhodosperms (Gosse, 1854):

The Rhodosperms, or Red Sea-weeds, must be the test of success in any attempts to cultivate the marine Algae, and this for several reasons; such as their superior; the great number of their species; their delicacy of habit; and their organic rank in the class. The Chlorosperms, or Green Sea-weeds, have been mastered; and the central tanks in the Zoological Society's Aquarium afford interesting and easily accessible examples of the successful treatment of these. Here the visitor sees a profuse growth of *Ulva, Enteromorpha*, and *Conferva* covering the slate ends of the tanks with their abundant vegetation, all of which has grown since last summer; and an object of exquisite beauty is presented by a large stone completely concealed by a crop of the lovely *Bryopsis plumosa*, which has overspread its surface with luxuriant fronds growing so densely as to remind us of a bank of moss, though greatly excelling it in elegance, and affording shelter to myriads of tiny *Entomostraca*, that play in its foliage like clouds of moving dust. Hitherto, however, the Rhodosperms have resisted domestic culture, refusing, like the eagle, to propagate in captivity. [Gosse refers here to Bryon's, "The prison'd eagle will not pair."]

After describing his experiences, Gosse concluded**:**

The facts above recorded are sufficient to show that there is nothing in the nature of the Rhodosperms to prevent their being cultivated in confinement, with a facility far superior to that which attends the culture of multitudes of terrestrial plants that reward the skill and perseverance of the horticulturist.

A four-page manuscript written by William Alford Lloyd entitled "Observations on Mr. Gosse's paper pp. 488–91," was recently found by Fernando E. Vega at the National Agricultural Library (NAL), Beltsville, Maryland, USA. Dr. Vega is a research entomologist at the NAL.

The manuscript, written on pages embossed on the left upper corner with "Zoologische Gesellschaft Hamburg," was tipped-in in a volume of the *Annals and magazine of Natural History*, on the last page of an article by Philip Henry Gosse (1854), "On the growth of sea-weeds," and provides interesting insights into Lloyd's thoughts about Gosse's work. The manuscript was written twelve years after Gosse's paper was published, when Lloyd was Director of the Hamburg Aquarium (1862–1868), a position he had secured with the help of the Heinrich Adolph Meyer (1822–1899), whose name is mentioned in the manuscript. An examination of the *Annals and magazine of Natural History* at the NAL also revealed that volumes 3–8 (third series, 1859–1861) were stamped "H. Adolph Meyer" on the title-page.

A Rhodosperm, *Delesseria decipiens*.

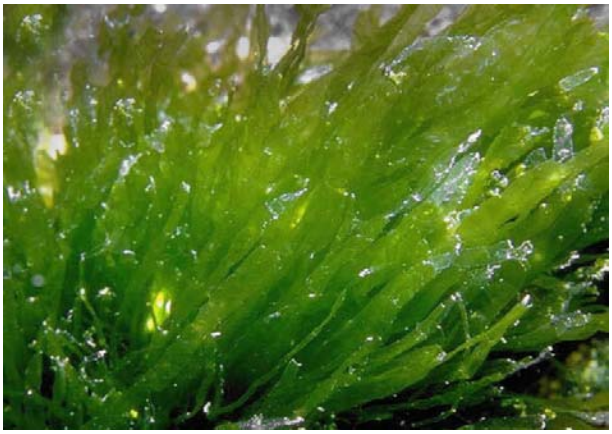
Thus, the volume containing the manuscript originally belonged to Meyer and was acquired in 1895 by the NAL (the volumes were also stamped "August 26 1895").

Lloyd's manuscript took exception to some of Gosse's 1854 statements:

Observations on Mr. Gosse's paper pp. 488–91. These notices were written by Gosse when he kept Aquaria at 58 Huntingdon St., Islington, London, 12 years ago. His tanks consisted of several vessels of varying shape & materials placed in windows of an ordinary dwelling-room at the top of the house, and it will be perceived that April was the time when the notes were written. But, during the next & the following hot summers (1855 & 1856) most of the Rhodosperms described were spoiled by being grown over with *confervæ* & other parasitic plants, so that the character of the red plants was quite obliterated by the effects of excessive light, while another tank standing in the same room between the windows, & therefore not exposed to direct illumination, was not so visited by *conferva*, & the plants in it remained tolerably free from parasites & preserved their normal colours. The same thing has been experienced in the Hamburg Aqm. where Rhodosperms in tanks under the full light of skylights have become grown over, while others in complete or partial darkness have continued clean. As to the central tanks in the Regent's Park Aquarium, referred to here by Gosse, & elsewhere, ("Aquarium" 2nd ed: p. 277–8 1856) as affording examples of successful Alga growing, time has shown that they have done nothing of the kind, for they, too, after a period, succumbed to their great enemy – Light – & are now no longer existing. It has been said that the red algae growing in Dr. Meyer's cellar in Hamburg contradicts this theory about light, but it doesn't, on the contrary, it harmonizes with it. Certain plants grow there, certainly, & are free from *conferva* but then the room has the coolness & subdued illumination of a cellar, while the Hamburg Aquarium, obtaining its light from skylights, has in it more of the circumstances of a hot-house than a cellar. Of course, there are varying degrees of light, & this amount of illumination, combined with a low and equable temperature has been well hit in Dr. Meyer's case. Absolute darkness may not be required, but even much greater darkness than Dr. Meyer possesses may be employed with advantage. Let him still further decrease his illumination & increase the motion of the water, & a still greater success will result. Mr. Gosse is much out of his reckoning in saying that the Chlorosperms "have been mastered." Certainly *Ulva, Enteromorpha, Cladophora, Bryopsis*, & a few others have been grown in tanks by Gosse, & in Regent's Park, in Paris, Hamburg, & elsewhere, but only by chance, & Gosse has himself often told me that neither he nor anyone else could with certainty grow them twice running, & that the cause of failure was unknown. My experience coincides with this, & therefore there has been nothing "mastered," but I can with certainty cultivate many Rhodosperms.

W. A. Lloyd Oct. 25th 1866 p.s. Oct. 27th 1866.

I have further to reason that not only did Gosse's red algæ, referred to in his paper, became in time disfigured by *conferva* but the seawater itself became opaquely green in consequence of the appearance of millions of



A Chlorosperm, Enteromorpha intestinalis.

locomotive plants, which Gosse, thought were spores, but which Dr. Cohn of Breslau [the Dr. Cohn Lloyd refers to here is Ferdinand Julius Cohn (1828-1898), a German biologist and one of the founders of modern bacteriology and microbiology] **has since determined to be a separate algæ *Chlamydomonas marina*. I remember calling on Gosse one hot day in July 1856, when he was fastening the Times newspaper round his tank to keep out the light, & he was in a state of wild despair & mentally tearing his hair with vexation, because as he said, he wrote instructions for the public to keep Aquaria, & he could not keep his own – either plants or animals!**

At the time Lloyd wrote this manuscript, he had been Supervisor of the Hamburg Aquarium for four years and perhaps was much too busy supervising the installation of the tanks and circulating system, and planning to make the Hamburg aquarium the largest and most modern in Europe, to follow it up by its publication. However, I think the real reason was that Lloyd and Gosse were close friends and Lloyd might have delayed publication for fear of alienating him. Lloyd often presented Gosse with the rarer specimens his marine collectors sent, which were either new to him or to science.

Their friendship was cemented when Lloyd in the autumn of 1858 he came across a strange worm-like anemone and discovered it to be a new species. Before submitting a monograph about its discovery he sent Gosse a specimen and Gosse asked if he would allow him to call it *Cerianthus Lloydii*. Gosse explained that the priority of discovery must go to Lloyd enterprise, and that it would also give him the opportunity of mentioning Lloyd's commercial undertakings. By this time Lloyd's practical ability, obtained by the necessity of keeping both his marine animal and seaweed stock alive and well, was now being widely recognized. Gosse, for example, often sought Lloyd's advice on the affect light and temperature had upon the aquarium. Lloyd's friendship with Gosse was mentioned by Gosse's son, Edmund (Gosse 1890): **"The late Mr. W. Alford Lloyd, whose affectionate devotion to my father deserves the warmest recognition…"**

After Lloyd took over as Aquarium Manager of the Crystal Palace Marine Aquarium in 1869, he authored the *Official Hand-Book to the Marine Aquarium of the Crystal Palace Aquarium Company (Limited*). The following are Lloyd's comments, written in 1873 (Lloyd, 1876):

…but with the exception of the knowledge taught by Warington and Gosse, namely, that a few of the red algae can be grown in captivity in darkness or in much shade, or by the interposition of coloured media, the means of systematically cultivating seaweeds of my kind—whether green, red, or brown—is as yet hardly known to us,* and especially with regard to the green ones, as *Ulva, Enteromorpha*, and *Porphyra*. By chance, indeed, sometimes one here and there (and even difficult kinds occasionally, as *Delesseria, Laminaria*, and others) may be

Philp Henry Gosse (1810-1888), taken in 1863.

grown more or less well; but as the reason is unknown, a repetition of success can seldom be obtained…

*** Since this passage was written, however, several of the red algæ have grown luxuriantly in this aquarium, chiefly in the dark corners of the north and south rooms. The species are *Phyllophora, Gymnogongrus Griffithsiea, Polyides rotundus, Iridia edulis, Chondrus crispus, Gelidium corneum, Rytiphlaea pinastroides, Corallina offcinalis*, and several others. (April 1873.)**

In this way, Lloyd said what had to be said without alienating his friend. In an article published a few years later, Lloyd admitted, somewhat plaintively (Lloyd, 1876),

This leads me to say that at present we do not know how to grow the higher marine algæ, the red, the brown, or even the green kinds, at will. Sometimes I succeed, but always by chance, not knowing why.

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Willian Alford Lloyd (1815-1880).

PROBLEMS IN AQUARIUM HOBBY HISTORY RESEARCH

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, June 18, 2016)

From time to time, I have discussed some of the problems I have encountered in doing research on the history of the aquarium hobby. A recent one involved trying to pin down an original reference. It started with the following statement by William Alford Lloyd in his "Hand-Book to the Marine Aquarium," published in 1876:

"Mr. Ward had, however, before 1849, made seawater by artificial means, and had grown marine plants in it."

I was interested in finding the original source for this statement and the first information I found was in Shirley Hibberd's "The Book of the Fresh-Water Aquarium or Practical instructions on the Formulation, Stocking, and Management in All Seasons, of Collections of River Animals and Plants," published in 1869: "With this opinion I quite concur, and it is agreeable to have to associate Mr. Ward's name with the subject before us, for he was one of the early pioneers, and at a meeting of the British Association at Oxford, 1849, communicated an account of his success in growing marine algae in artificial sea-water." I was surprised and somewhat amused that Hibberd chose to place this information in his "Book of the Fresh-Water Aquarium" instead of his "Book of the Marine Aquarium." In any event, the British Association that Hibberd referred to was the British Association for the Advancement of Science so I consulted their Annual Report for that year but was unable to find any mention of Ward mentioning artificial seawater.

I suspected that Hibberd had the wrong date so with A set of key words and phrases I did a Google search and came up with two relevant hits, one in "The Gardener's Chronicle and Agricultural Gazette," p. 524, London, July 31, 1847" and the other in "The Floricultural Cabinet, Florist's Magazine," p. 236, London, September, 1847. Since the reports did not differ, I am reprinting the entry as found in the Chronicle:

BRITISH ASSOCIATION.

Friday, June 25.- Section D.- Mr. WARD made some remarks on the results of his plan of growing plants in closed glass cases. He stated that the most perfect success had attended this plan, in bringing plants to this country from tropical climates. Where it had not succeeded it arose from the ignorance or of those who superintended it. In some instances the cases had been covered with tarpauling, thus preventing the access of light to the plants. Frequently they had not enough soil to grow in, or had not sufficient water. Unless the plants were placed as much as possible in their natural condition they would not do well in these cases, any more than any where else. Mr. Ward drew attention to the opportunity these cases afforded to the poor, in thickly populated towns, of cultivating a taste for natural objects. He read an letter from an artisan, who stated that growing

Nathaniel Bagshaw Ward (1791-1868).

plants in these cases had afforded him the most agreeable source of relaxation after his day's labour. Mr. Ward also stated, that not only could land-plants, and the higher forms of vegetation be grown in these cases, but that the various forms of marine Algae had been cultivated in artificial salt water.

Ah! This solved the problem (or so I thought at the time). It was the 1847 meeting of the British Association, not the 1849 one as Hibberd had it. Now all I has to do was to obtain a copy of the 1847 Annual Report and to find Ward's comments. Now these reports contain about 800 pages and one would go blind trying to go through each page to find a particular item. What I typically do, therefore, is to scan the document and OCR (Optical Character Recognition) it. The process starts with a pdf file (the 1847 Report in this case and the 1849 Report I first examined) where each page is an image and ends with each page containing text, which is searchable. The OCR process is lengthy and takes about a half hour to complete so I find something else to do while the program is doing its magic. Unfortunately, no matter what words I searched for - Ward, artificial, salt water, etc., Ward's comments just weren't in the Report. Furthermore, in both the Chronicle and the Floricultural Cabinet, Ward's paper was followed by a reference to one given by Charles Daubeny on the results of his experi-

The Wardian case was a portable airtight greenhouse developed by Nathaniel Bagshaw to protect live plant material during transportation overseas.

ments on the growth of plants in closed glass cases. This paper was not found in the Annual Report either.

I decided to find out what Stephen H. Ward, Ward's son, had to say so I read his paper titled "On Wardian Cases for Plants, and Their Applications," the substance of a lecture delivered at the Royal Institution on March 17, 1854. In this paper the following note appeared in the appendix:

At the Meeting of the British Association at Oxford, in 1847, Mr. Ward called attention to the fact, that all the lower marine algae might be grown in these cases by means of salt-water artificially prepared."—Athenaeum, July 3rd, 1847.

Like the Gardener's Chronicle, the Athenaeum was large, in newspaper style, set up in three columns and had much more detail than was in the Association's Annual Report. The Association did not include the smaller, less important communications its Annual Report, whereas independent journals like the Chronicle, Floricultural Cabinet and Athenaeum did. Ward's report, however, read quite differently in the Athenaeum (No. 1027, p. 715, July 3, 1847) from that in the Chronicle and the Floricultural Cabinet:

FRIDAY

Mr. WARD made a communication on the subject of Growing Plants in Closed Cases. Ilia object was to give the results of a long experience of his plan, as well as to point out some errors with regard to the use of these cases. Time had enabled him to mature his plan, and to try it with every form of plant; and he might say that, whether for transpor-tation from one climate to another, or for growing plants under circumstances where they could not be exposed to the atmosphere, it was perfectly success-ful. Palms had been transported from the tropics in these cases; and roses had blossomed in them ex posed to a southern aspect in London. In order to secure the proper growth of plants in these cases, they should hare moisture, be planted properly in soil, and exposed to the light if these conditions were not attended to, the cases would fail. Some-times, in voyages, they were covered over with boards or tarpauling—and the plants, not having light, were of course destroyed. Mr. Ward read some letters, showing that this plan of growing plants in closed cases might be made to contribute to the comforts of the poor in large towns, as the cases may be made at a small expense, and supplied with plants all the year round. He also called attention to the fact that all the lower

A large Wardian Case build against a window, which was very fashionable.

marine Algae might be grown in these cases by means of salt water artificially prepared.

Note that these reports were written by reporters who worked for - or were paid by - the periodicals in which the reports appeared (in the case of the reports in the Chronicle and the Floricultural Cabinet, it is almost certain that they were written by the same reporter). Periodicals need to publish information as soon as possible and the associations involved published their information annually. Furthermore, the associations of the day did not publish everything so reporters would attend meetings of the individual sections of the associations where many of the exchanges were not published by the parent associations except for their official transactions. Thus, a reporter for a botanical magazine would be sure to attend the meeting of the Botany Section of the British Association for the Advancement of Science where he would take notes of informal discussions and exchanges he thought might be of interest to his readers, Ward's comments being an example. Different reporters, of course, would produce reports of the same exchanges that would agree roughly but look quite different.

The last line of the reports above highlights a discrepancy between the Athenaeum version and the other two, the former stating that "all the lower marine Algae *might* be grown in these cases by means of salt water artificially prepared," and the latter stating that "the various forms of marine Algae *had been* cultivated in artificial salt water." The difference between "might be" and "had been" is significant. If the former, then Ward had not actually kept marine algae in artificial seawater, and even if it is the latter, Ward did not claim that he had been the one who did. The best that can be said is that Ward was the first on record to evince an interest in using artificial seawater in the marine aquarium.

Although, I solved my original problem, I discovered a much bigger one on the way!

Pteridomania or "Fern Fever" - made possible by the Wardian Case - was a fad that swept through England during the 19th century. Ordinary people not only started to mail-order exotic ferns to grow at home, but they set out in search of the perfect specimen.

HAND-BOOK TO THE MARINE AQUARIUM

June 23, 1873, by William Alford Lloyd

(Aquarium Hobby Historical Society of America, Facebook Files, June 10, 2016.)

In 1854 the Crystal Palace, a cast-iron and plate -glass structure originally built in Hyde Park, London, to house the Great Exhibition of 1851, moved from its temporary site in Hyde Park to its more permanent location at Sydenham, an affluent south London suburb of large villas. It had only been on the site for twelve years when in 1866 it experienced the first of a number of fires, which destroyed the North Transept. The fire left a large desolate area which had become a charred eyesore. There were insufficient funds to reconstruct the north end and it was not until 1870 that a plan was put before the directors to construct a marine aquarium. The directors saw its potential and the derelict site was opened as a salt water aquarium on August 22, 1871. It consisted of a building of one story high, measuring altogether about 400, feet long and 70 feet wide. There were 100,000 gallons of seawater, of which 80,000 gallons were below the floor of the saloon, and 20,000 gallons in the tanks where the animals were shown. These tanks were sixty in number, and varied in capacity from forty to 4000 gallons each. Thirty-eight of the tanks were for the public exhibition of creatures and their associated plants, and were contained in a saloon and two smaller rooms, but the remaining twenty-two tanks, for the storage of surplus animals, were in a gallery (behind the large show tanks), and were not shown to the public. All the public tanks were fitted with plate glass, varying in thickness from three eighths of an inch to one inch. The water for the tanks was brought by train from the sea at Brighton, and briefly the aquarium was the largest of its type in the world.

The Crystal Palace after its move to Sydenham Hill in 1854

What made the Crystal Palace Aquarium special was the fact that it was a marine and not a freshwater exhibit. No one before had created a working marine aquarium of this scale and diversity. The Crystal Palace was lucky to secure the services of William Alford Lloyd, the leading aquarist of his day, who developed a system of continuous circulation of the water, which was kept in the dark as much as possible and at strictly governed temperatures. Machinery to achieve this was doubled up to ensure the continuous flow. Excavations of the reservoirs have also shown that downward slopes were built into the system. These were designed to increase the 'scouring' action of the water and make the system as natural as possible.

Although not a commercial success, the site was regarded throughout the aquarium world for its technical merit and innovation. Excavations have yielded samples of the vulcanite piping that the water ran through, which was quite cutting edge for its day but necessary, as seawater could not travel through metal conduit. Charles Darwin is said to have been a regular visitor. Unfortunately, the Aquarium's popularity soon waned and in the summer of 1878, the Crystal Palace Aquarium Company was unable to pay Lloyd's salary of £400 per annum, forcing him to look elsewhere for other work.

After Lloyd took over as Aquarium Manager of the Crystal Palace Marine Aquarium, he authored the *Official Hand-Book to the Marine Aquarium of the Crystal Palace Aquarium Company (Limited*). The Fourth Edition, published in 1876, has 134 pages, 31 pages of which contain a detailed definition of what an aquarium is, a history of the aquarium, he reason why aquaria in private houses have met with such little success, problems with some public aquaria, the history of experiments with marine vegetation, aeration of small and large tanks, the decoration of aquaria, the plan of the Marine Aquarium and a description of its tanks, the effects of light on the aquarium and its inhabitants, shipping marine animals, feeding the marine animals, oxygenation, temperature and the construction of the Marine Aquarium.

All this is fascination information and I wanted to archive it. However, my copy of the Hand-Book was digitized by the University of Chicago and the result was disastrous, to say the least, since alternate pages are so faint that they are barely readable, much less able to be scanned. As I was unable to find a better digitalization of this edition, I bit the bullet, copied the faint pages into Photoshop, darkened them and then re-scanned them. This helped but they still needed considerable editing and my eyes were bleary in the process. To avoid having others go through this, I present this introductory material for general use. *Any comments I may make on selective portions of the text will be enclosed in square brackets to distinguish them from Lloyd's text.* Some of Lloyd's paragraphs are lengthy and I have broken them up into smaller paragraphs to assist in their reading.

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An Aquarium is an arrangement for the maintenance of living animals* under the following three conditions:—

1st. The water must not be changed, though it may receive addition from time to time of whatever it may lose, as, for instance, in fresh water by evaporation, or in such solid matters as are taken from it in the course of the formation of the shells and other hard parts of creatures existing in it.

2nd. The water must be not only kept in a pure and respirable condition by its absorption of atmospheric air at its surface, which absorption may or may not be increased by putting the water in motion in any convenient manner, but this purity must be assisted by the presence of vegeta-

tion growing in it and tending to decompose the poisonous carbonic acid gas evolved from the animals, such vegetation taking up the carbon of the gas into its own substance, and liberating the resulting oxygen for the use of the creatures.
3rd. The animals must not be lung-breathers, that is to say, they must be either such as the sea-anemones and corals, and some others which have the function of respiration diffused over their entire bodies; or, be such as the creatures above them (up to and ending with fishes), which are provided with gills during their whole period of existence. As lunged animals do not require the purifying processes just alluded to, an aquarium is not for their use, and they are therefore excluded from it; and this exclusion applies even to such aquatic animals as water-lizards, frogs, and salamanders in their adult states.

*The word "animals" throughout this Hand-Book is to be understood as a collective term for all creatures kept in aquaria.

[In William R. Hughes' 1874 paper, "On the Principles and Management of the Marine Aquarium," he comments: "Exception may be taken to the third of Mr. Lloyd's propositions because the admission or rejection of lung-breathers in no way interferes with the balance of the Aquarium, and it is, therefore, a mere matter of opinion." In this I agree.]

These conditions apply alike to marine and to fresh-water aquaria. It is not known how long the same water may be kept unchanged, with the necessary occasional additions referred to; but periods of ten years with no apparent detriment are frequently met with. The duration of life of animals in aquaria depends on their kind. Thus there are now in England many healthy sea-anemones which have been in aquaria for the last eighteen years; and some fishes, as pike and carp, for ten years; while other fishes, as cod and turbot, grow so quickly in captivity as soon to become inconveniently large; and there are some, chiefly belonging to the herring family, which, though capable of being safely transferred during journeys of a dozen hours in duration, usually die from some unknown causes (possibly one main cause being change of temperature) in a few minutes, or in an hour or two after being placed in an aquarium. But in the case of a large number of animals living naturally in rivers or near the shores of the sea rather than in the open ocean, but always more or less concealed by the water in which they exist, an aquarium presents absolutely the only mode by which they can be conveniently observed alive at all times.

Bearing in mind the three conditions here laid down, neither the "Vivaria" of the ancient Romans, nor modern sea- and fresh-water ponds, or receptacles of any kind, in which fishes and other creatures, for table or show purposes, were or are kept in captivity in water in communication with the sea or with flowing fresh water, in which the water is changed constantly or otherwise, can be termed "Aquaria" in the conventional sense to which it is now necessary to restrict the word.

[For present day purposes, this is too restrictive a definition of the word "aquarium."]

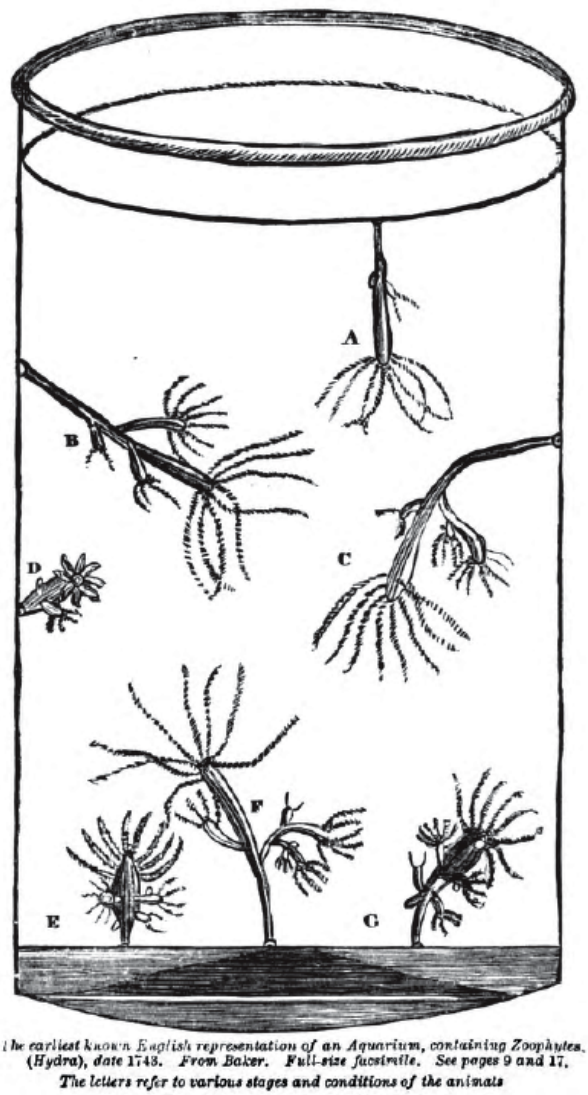
In China and Japan it is known that for many centuries dealers in living fresh-water fishes have observed that when a green silky filamentous plant or "weed "grows spontaneously under the influence of light in the vessels in which the fishes are kept, they are more healthy than in vessels in which such vegetation has not appeared; and thus, but empirically, the Chinese and Japanese have long since so far made aquaria. Still, as this result has not been arrived at by the exercise of reason, and by the intelligent application of known laws; and as the water was additionally kept pure by being constantly renewed, or changing it, this ancient people cannot be said to have invented "Aquaria." The Chinese kept gold and silver carp for amusement long before they were introduced into Europe during the second half of the seventeenth century. It was probably some such fish as these which are alluded to by Pepys

in his Diary (quoted as a motto to this pamphlet), and doubtless vegetation grew, and was encouraged to grow, in the glass and porcelain vessels in which these household pets were kept, and so constituted them in some measure as "Aquaria."

In the early editions of the late Mr. N. B. Ward's book "On the Growth of Plants in closely glazed Cases," there appeared a supplement where it is stated that in a German work on the microscope and on microscopic objects, by Martin Frobenius Ledermidler, in three volumes quarto, 1760, 1761, and 1762, there is a representation of an aquarium with plants and animals in it, and with visible bubbles of oxygen arising from the plants under the stimulus of light, the animals thereby being healthily maintained. This is a mistake, however, as in the plate referred to (No. 87, vol. ii.) [Note" See the accompanying image.] there are certainly plants and animals, but the appearance alluded to by Ward as a collection of air-bubbles is certainly caused by some minute organisms which are being lifted out by a glass tube for examination. In the descriptive text, pages 170 to 174, it is distinctly stated that the plants were merely put into the jar because certain animals were attached to them, but if it had been known that the water could have been preserved clear and unchanged by the chemical action of the vegetation, such a fact would naturally have been told as one of great interest.

About the middle of the last century much attention was given to a minute fresh-water zoophyte, the *Hydra,* and it became almost as much a fashion to keep it alive in glass jars, as it was a hundred years later to keep its larger marine relatives, the sea-anemones. In the books of Trembley in France, and of Baker in England, its mode of maintenance is described and figured; but nothing is said of employing vegetation to aerate the water without changing it. Yet, on carefully reading Baker's book—date 1745—there can be no doubt of his having unwittingly employed some self-grown low form of vegetation as a purifying agent, and that therefore be kept aquaria which did not need any change of water, had he been aware of the balancing principle. His interesting and somewhat rare volume shows this in several places.

Towards the close of the century, namely, in 1790, the late Sir John Graham Dalyell began to keep living marine animals for observation, in his house in Edinburgh, and continued this practice till his death, about 1850; but he changed the sea-water two or three times a week, though many of the animals lived for eight or ten years; and one



The earliest known English representation of an Aquarium, containing Zoophytes, (Hydra), date 1743. From Baker. Full-size facsimile. See pages 9 and 17. The letters refer to various stages and conditions of the animals

The Earliest known English representation of an aquarium containing zoophytes (hydra). From Henry Baker, "An Attempt towards a Natural History of the Polype," R. Dodsley, London, 1743.

sea-anemone (*Actinia mesembryanthemum*) taken by him from the sea in August 1828, is still alive and well. But Sir John knew nothing of employing plants to evolve oxygen, and thus to preserve a balance of life with unchanged water, though Dr. Joseph Priestley (1733—1804), the discoverer of oxygen gas, and the first observer of the fact that that gas is emitted by plants under the influence of light, and therefore the earliest enunciator of the main principle upon which the maintenance of aquaria depends, had published this discovery and observation. Ingenhousz also had shown that plants evolved this gas. Therefore, if Dalyell knew this, he did not apply the principle. Indeed, a reference to books of zoology for the whole of this period, and long before and after, shows that naturalists were in the habit of keeping aquatic animals without turning to account this self-supporting idea; even though in 1833 the late Professor Daubeny again showed how oxygen is given out by plants under the influence of light, and explained the exact manner in which it is done.

In 1840 Madame Power kept marine animals alive in Messina, and when, in 1860, a public aquarium was set up in Paris for the first time, she being then a resident in Paris, it was stated that she had invented aquaria; but this lady, by her own showing, knew nothing of the employment of plants in the manner stated, though she might have used them so, unconsciously, and derived benefit from them.

In 1837, and afterwards in 1842, Mr. Ward directed attention to the possibility of applying to the preservation of living animals a modification of the same plan that he employed for living plants in his “Wardian cases”; and in 1841 he set up in London a fresh-water aquarium, the water of which was maintained pure and unchanged, and the animals healthy, by the action of growing plants. This is the first recorded fresh-water aquarium on the compensating principle.

In 1842 the late Dr. George Johnston, of Berwick-on-Tweed, made a little marine arrangement consisting of six ounces of sea-water in a glass jar, in which animals and plants balanced each other, without any change of the fluid for a period of eight weeks, or perhaps longer; and he records the fact as demonstrating the dependence of the two organisms on each other. His object, however, was to prove the vegetable nature of a calcareous sea-weed, and not to show the possibility of maintaining an aquarium—that was merely incidental to his main purpose.

The very first recorded person who, endeavouring to keep marine animals far from the sea (in London), and feeling the difficulty of doing so, set about devising means to overcome it, was Mrs. Thynne, who (as recorded by Mr. Ward), in the spring of 1847, sent to the sea for weeds to place in water for her animals in town, in order to keep them in good condition. It will be seen that this lady did not do this by accident, while doing something else of more consequence to her, but introduced plants for a definite and avowed purpose, stated beforehand, and this was more than anyone else ever before her did with sea animals and sea-water.

[Regarding these comments on the work of Power, Johnson and Thynne, Lloyd did not consider that Power or Johnson kept an aquarium even though they maintained them using the balanced aquarium principle because it was incidental to the purpose of their work. Again, this was a restriction only applied by Lloyd.]

In the summer of 1849 the late Mr. Robert Warington, of London (with precisely the same intention and success as Mrs. Thynne with sea-water), began experiments with fresh-water aquaria, and in January 1852, he commenced applying the balancing principle to marine creatures, plants, and sea-water, and at the same time, Mr. P. H. Gosse, also in London, began his experiments with sea-water animals and plants.

[Here Lloyd seems to give Gosse and Warington equal credit for being the first to show the proof

of principle of the marine aquarium. Warington gets priority as a result of an interview that appeared in *Chamber's Edinburgh Journal* in 1852. Gosse followed up with an article published later that same year in the *Annals and Magazine of Natural History* and this was followed by Warington's article that appeared in 1853 in the *Annals*. However, Gosse's article contained nothing new (no fish were involved), whereas Warington's article was a tour de force and dealt with vertebrates as well as other marine animals. At this time they were not neck-to-neck as Lloyd implied; Warington was at least a half race track ahead.]

At about this period (1848-9) Dr. David S. Price successfully carried out some experiments on the equilibrium of vegetable and animal life in marine aquaria. Dr. E. Lankester kept small freshwater fishes and plants together on the balancing principle in 1849 and 1850, and so did at the same time Mr. (now Dr.) J. S. Bowerbank, at his house near London, where the late Mr. D. W. Mitchell, the then secretary to the Zoological Society of London, saw such an arrangement, which suggested to him the erection of a fish-house or aquarium in the Society's Gardens, Regent's Park.

This building, commenced in the summer of 1852, and opened to the public in May 1853, was the first public aquarium in England or anywhere,

An artist's rendition of the Marine Aquarium. The Aquarium was long and narrow (see layout on page 16). Here visitors are walking past Tanks 1 through 18a.

and still exists in nearly its original state, save in the diminution of light. Whatever may be its deficiencies consequent on being erected at a period when there was no experience available for guidance in its formation, it originated by far the greater part of the popular movement in the cultivation of aquaria in Britain and elsewhere, which prevailed as a kind of mania from 1854 to 1860, reaching its highest pitch in the last-named year, and then declined till it almost ceased to exist in its domestic aspect, in 1862.

During this period the taste for the subject was greatly fostered by a series of admirably illustrated works on British marine zoology from the pen and pencil of Mr. Gosse; and he was followed by many other writers, both of complete works and of magazine articles, and by many compilers of more or less merit; so that the date of the great bulk of aquarium literature generally is from 1853 to 1859. It was Mr. Gosse also who in 1854 greatly assisted inland aquarium keepers by showing that sea-water could be manufactured by adding its solid components to fresh water, and that animals would live and thrive in such a composition. Mr. Ward had, however, before 1849, made sea-water by artificial means, and had grown marine plants in it. [Actually, Ward had reported this at a meeting of the British Association for the Advancement of Science on June 25, 1847 (Hibberd is responsible for the 1849 date). The full text can be found in the *Athenaeum*, No. 1027, p. 715, July 3, 1847].

Such artificial sea-water answers very well: indeed the large aquaria at Hanover and Berlin have no other. Mr. Gosse records how several of the substances found in real sea-water, such as lime, iron, silica, and iodine, not introduced by him, were found in his artificial sea-water after a period of employment in aquaria; but it must be remembered that it is not possible to put a marine animal into artificial sea-water without some minute quantity of the real sea-water adhering to the creature, even if it has been previously long kept in artificial sea-water, and the very smallest quantity which thus finds admission may be enough to serve as a vehicle for the introduction and after-increase of the substances referred to, as well as of vegetation. Artificial sea-water has been made in London from distilled water, and the mixture afterwards boiled, and then closely stopped up in a glass jar strongly heated to destroy organic matters; but yet, on exposure to light for a few months, sea-weeds appeared in the jar without its having been unstopped.

The reason why aquaria in private houses have met with such small success may be found in the natural difficulty of the whole thing; in the general want of a knowledge of zoology among those attempting it; and in the difficulty of producing a sufficiently comprehensive and practical manual of instructions on the subject. General laws can only in such cases be stated, as it is not possible to give any definite rules, applicable under all circumstances, respecting the kind, sizes, and number of animals which may be permanently kept in a given quantity of water, inasmuch as the capability of the water for maintaining the animals in a private house (and even in a building specially made for aquarium purposes), is liable to continual change from various circumstances, among which temperature is a principal one, and regulation of light is another. Such capability is also greatly affected by the proportions of the vessel containing the water, for if the fluid is spread-out in shallow masses, its absorption of air by mere surface contact with it, and its consequent good condition is much greater than when it is piled up (so to speak) in tall masses with small surface area. It often has happened, therefore, that when an aquarium has been for some time in a flourishing condition, it has presented no manifest sign of containing as many animals as it can conveniently support in health, the temptation has arisen to add more creatures, perhaps some which are specially beautiful or interesting, and should there have been no appliance, in such cases, for any continuous aeration derived from constant motion (independently of passive contact of the water surface with air) to compensate for the new and excessive introductions, the collec-

tion has begun to show signs of being overcrowded. This may or may not be perceived; if not some animal, less hardy than its fellows, then dies, and is not immediately taken out; an increase of temperature perhaps takes place, the impurity from the dead animal (or perhaps from a morsel of uneaten and unremoved food) spreads quickly, then other creatures succumb, each death hastening the demise of the others, until in a few hours, especially in hot weather, the whole suddenly collapses, and becomes a dark and foul-smelling mass of corruption, the blacker and the worse in odour if the aquarium is marine. But such failures result from the wrong application of the principle, and not from the principle itself being wrong, the correctness of which is proved by the fact that if the water (whether sea- or fresh-water) which has been in an aquarium during such a mishap, be sufficiently exposed to the oxygen of the atmosphere, it will once more become transparent and pure.

It is not precisely correct to suppose that water is ever in a state of decomposition under such circumstances. Water is a chemical combination of two gases, oxygen and hydrogen, and it is an excessively difficult and slow process to separate them. Therefore it is only something contained in the water which decomposes, and if that something can be removed by the action of the free oxygen of the surrounding air, the water becomes again pure. Now, most decaying organic matters proceeding from animals and plants, singly or both together, can be so acted upon and removed; and if such matter can be thus taken away when it is present in such quantities as to make a highly putrescent mass, it is obvious that it can also be removed and got rid of in the same way, but as gradually as they come, when it emanates from healthy animals in a healthy aquarium, just as well as when in this imaginary case it has accumulated and become quickly poisonous. But the difficulty is to avoid giving the oxygen more work than it can thus gradually do, which object is attained by so limiting the animals that they will comfortably live within prescribed conditions, on the most unfavourable terms, and this applies both to aquaria with currents and many animals, and to aquaria without currents and with few animals; So to judge, however, needs more experience than the general public have been as yet found to possess; and before such experience has had time to be gained, the failures, and consequent discouragement, have been almost universal. “The balance of existence” between plants and animals in a streamless aquarium is never easy to maintain, and therefore amateurs have usually to choose between the meagreness of a tank with but very few and small animals in it, and one with so many that the destruction of the whole may be very quickly brought about by some small adverse circumstance; and there is frequently no choice between an aquarium with the water looking dull from an insufficiency of oxygen, a state caused by a want of the light indispensable to the development of vegetation, and one exposed to so much light that the water is rendered opaquely turbid and of a greenish-brown hue by the countless spores or seeds evolved from the plants. A stream of water in an aquarium, however, with the greater part of the water being in a separate vessel, the latter containing no animals and never exposed to light, while a smaller part of the water contains the animals, and is moderately illuminated, at once surmounts many difficulties, and is (so to speak) a fly-wheel which carries the whole machine of an aquarium over its “dead points.” But such an arrangement is expensive, and its working needs much attention. Attempts, however, were made to facilitate the maintenance of animals by increasing the surface and decreasing the depth of water in tanks, so as to give a large absorbing power to the field, and thus in a measure to compensate for the absence of motion. This was suggested by Mr. Gosse and by Mr. Warington, as before mentioned here, but it was found that scarcely any amateur would be content with keeping creatures of a certain kind and size, and in numbers suitable for such an arrangement, and in trying to keep more, failures took place, as has been described.

It was felt, too, that the light admitted to most receptacles used as aquaria was excessive, and led to an excessive growth of vegetation by rea-

son of an unnecessary amount of glass employed in their construction, and therefore the sides of such vessels were improved by being made opaque, and only one side was left of glass for convenience of observation. Quite early in the course of his experiments, Mr. Warington devised the form of tank which he named the "slope-back tank," from its resembling a box with its back receding upwards and backwards; this slope being placed towards a window, the light entered the tank from above, as in nature, and without undue shadow, and the creatures had also choice of various depths of water upon the shelving bank. This contrivance was afterwards much improved-upon by Mr. E. Edwards, of Menai, who converted the triangular space below the slope into a receptacle for water in a state of darkness, and containing no animals, but in contact with the water in the part of the tank where the animals lived; which arrangement, termed the "dark-water- chamber slope-back

Room I (see layout on page 16) containing tanks 28 to 36. A smaller room, H, containing tanks 19 to 27 was at the north end of the building.

tank," is perhaps the best existing form of tank without a current of water, as the fact of about half the whole quantity of fluid being in darkness tends much to retard the too rapid growth of some weeds, the spores or seeds of which ore disseminated in the water to such an extent as to make it opaque. This principle has been carefully recognized in the Crystal Palace aquarium, where about four-fifths of the water is kept in darkness, and only one-fifth in light. Dr. W. B. Carpenter, on April 18th, 1872, gave in the Crystal Palace a lecture entitled "Researches in the Deep Sea" (being an account of his personal experiences), and in course of it he bore testimony to the accuracy of the most essentially important principle employed in this aquarium in its direct imitation of the actual ocean, i.e. a great reserve is maintained to counteract the effects of light, as well as to be drawn upon for the adequate oxygenation of the show tanks where the animals are kept.

The larger the quantity of water, the greater will be the health of the animals kept in it; and this system enables the bulk of fluid to be very largely increased, but without correspondingly increasing the cost of construction and maintenance. Dr. Carpenter has also compared sea-water as found in the sea, to "a weak broth," in reference to the large quantity of decomposing organic matters it contains. Such matters would be very injurious in an aquarium, however harmless in the open sea—hence the value of depriving it of such substances by storing in a reservoir before using it. The dark-water-chamber tank of Mr. Edwards's for a time retarded the decline in the taste for domestic aquaria, but nothing could sustain it permanently while the public expected far more results than could possibly be attained by given means; those means being naturally very small under such limited conditions as were implied by little vessels containing animals in water often in a temperature and in light unnatural to them, and without the continual motion to which water in a state of nature, as in seas and rivers, is ever subject. Such motion was first pointed out as being desirable in aquaria, by E. W. H. Holdsworth.

In 1853, a public aquarium was opened for a few weeks in the Surrey Zoological Gardens, London; after which, another was formed in the Zoological Gardens of Dublin. Subsequently others were set up in public institutions in Belfast, Galway, Edinburgh, Scarborough, Weymouth, Vienna, the Crystal Palace, and in one or two other places; but the one in Dublin is note-worthy, as the late Dr. R. Ball, its manager, devised a method of keeping the sea-water in occasional motion by passing bubbles of air through it from a pair of bellows worked by visitors. This system, though of some small value in little arrangements, is of but very trifling worth in a series of great tanks, where it has been recently applied with much waste of steam power. In America there was an aquarium at Boston; and another formed a part of Barnum's Museum in New York. In all these the animals were sometimes in a series of tanks, sometimes in only one; but in every instance there was the same defect that usually characterizes private aquaria, namely, a stock of animals excessive in number and size, or wrong in kind, which dwindled at last to none at all. Combined with these drawbacks was the want of constant motion in the water (in the form of flowing streams, and not merely in the form of bubbles of air), with too much light and heat, developing too much vegetation.

About this time, Mr. Warington in some printed communications of his, termed an aquarium a "self-supporting arrangement"; but the application of such a phrase to any arrangement needing attention from without, such as the feeding of the animals, the removal of dead ones, the addition of water to compensate for evaporation, &c., is evidently erroneous. [Another quibble on the part of Lloyd.] It could only be correct in reference to such a thing as that which was set up some years ago, a couple of really self-supporting small aquaria, one sea-water and one fresh, consisting of two glass vessels, each of a quart capacity, which were filled with equal quantities of water and atmospheric air, and then hermetically sealed. No visible plants or animals were introduced, but

after a few weeks' exposure to light, both vegetation and creatures appeared, oxygen was evolved, and successive generations of plants and animals, humble in organization and minute in size, appeared, lived, and died for a series of years, with a rapidity which varied with the varying temperature and light of the seasons of the year. These arrangements were, so far as they went, perfect microcosms.

Up to about 1857 it was the practice to introduce oxygenating vegetation, generally the sea-weeds *Ulva* and *Enteromorpha* (sea-lettuce and sea-grass) growing on stones. Occasionally, possibly once in a thousand instances, these plants grew and flourished, but they almost always died; and some other plants, mainly the silk-weeds (*Conferva*), preceded by a microscopic growth of still lower organized plants (Diatomaceæ and Desmidiaceæ), grew up in their place. It then occurred to experimenters that the visible introduction of vegetation might advantageously be omitted altogether, leaving the *Conferva* to appear and grow by the action of light on the spores or seeds invisibly existing in water, as they grew ages before—in the fish receptacles of the Chinese and Japanese. This plan (which, in its immediate application to a London aquarium, was suggested by some vegetation which appeared in the drinking-glass of a bird-cage suspended in a window) was found to succeed much better than the former one, as the vegetation thus grown was healthy and vigorous, because it was the kind suited to the self-chosen conditions offered it, and gave off oxygen freely.

It is curious to think, therefore, that every person who at any period kept animals in water, which was left unchanged long enough and sufficiently exposed to light, must have obtained a vegetation which would render a change of water needless, if the observer had but know n it, as it really was known though not understood by the Orientals long periods ago. There can be no doubt but that Ledermüller, and Trembley, and Baker, and others, maintained their *Hydras* in good condition by the action of minute vegetation grown spontaneously on the inner surfaces of their glass jars; that Dalyell was similarly assisted without being aware of it; that Warington need not have introduced *Valisneria* or any other already visible plant in the vessel in which he made his first fresh-water experiments in 1849; that there was no occasion for him, in his early sea-water attempts in 1852 to successively experiment as to which of the three classes of sea-weed, the red, or brown, or green (Rhodosperma, Melanosperma, or Chlorosperma) were best adapted for this purpose.

So, too, Mrs. Thynne need not have sent from London to the ocean for sea-weeds to revivify the water for her flagging corals, even though she thus for the first time intelligently applied the purpose of the vegetation in a marine aquarium; for, had she but exposed the water long enough to light, seaweeds would inevitably have come, even in London, without their having been consciously put in—and they doubtlessly did come without being recognized, in her case. It was the same with Mr. Gosse, and with every other writer, who recommended the putting masses of grown-up or even young plants into tanks. Such vegetation is very elegant, often as much so, and as interesting, as the animals themselves, but with the exception of the knowledge taught by Warington and Gosse, namely, that a few of the red algae can be grown in captivity in darkness or in much shade, or by the interposition of coloured media, the means of systematically cultivating seaweeds of my kind—whether green, red, or brown—is as yet hardly known to us,* and especially with regard to the green ones, as *Ulva, Enteromorpha,* and *Porphyra.* By chance, indeed, sometimes one here and there (and even difficult kinds occasionally, as *Delesseria, Laminaria,* and others) may be grown more or less well; but as the reason is unknown, a repetition of success can seldom be obtained - and, in fact, so uncertain are these algae, and so easily are they killed from a slight disturbance of condition, that sometimes an alteration of position in a tank of even a few inches in extent, without the attachment or any other part being disturbed or injured, will cause a growing plant to die.

* Since this passage was written, however, several of the red algæ have grown luxuriantly in this aquarium, chiefly in the dark corners of the north and south rooms. The species are *Phyllophora, Gymnogongrus Griffithsiea, Polyides rotundus, Iridia edulis, Chondrus crispus, Gelidium corneum, Rytiphlaea pinastroides, Corallina officinalis*, and several others. (April 1870.)

It may be that some algae need the alternate exposure and submersion of tides, or the successive periods of rest and growth afforded by the cold and warmth of actual nature; or possibly some require tidal actions, or the influence of the rain they occasionally get when the tide is out. Be that as it may, it is certain that with our present knowledge, the putting into an aquarium of masses of already grown sea-weed, especially the green kinds, whether they be young or old, or attached to stones or not, or of any ready grown fresh-water plant, is not only very seldom attended with a successful result, but so much positive harm is done by the decomposition arising from their decay, that it is better to avoid them altogether, and to depend only upon that which gradually and naturally appears upon the rocks of the aquarium by the action of light, and which answers every chemical purpose. The amount of growth of such vegetation can always be precisely regulated by the amount of light given to it—indeed so vigorously does it flourish on places of its own choice, that its tendency is to increase too much when the light cannot be sufficiently diminished without making an aquarium too dark for objects in it to be distinctly seen—and in such cases some animals, as mollusks, the ormer (*Haliotis*), or fishes, as the grey mullet (*Mugil*) are employed to eat it down to the very small quantity required to decompose the carbonic acid gas of even the largest aquarium. If all the *necessary* vegetation of the Crystal Palace aquarium could be gathered together in one mass, it would, when deprived of its water, probably not weigh one ounce. This better mode of producing and keeping-up the vegetable element of the system, combined with the use of the new tank ("the dark chamber slope back") gave to domestic and public aquaria a new impulse; but only a temporary one, for the great want felt was *constant motion*, like that of nature, by which the water may be continually turned over and over, presenting successive and multitudinous surfaces to the surrounding atmosphere, and may by contact with it incessantly absorb the large quantities of oxygen necessary for the sufficiently rapid decomposition of organic matters given off by the animals, with sufficient rapidity to keep the aquarium clear of putrescence.

It will be seen by this, that motion in aquaria is merely the increase, frequently to an enormous extent, and of commensurate value, of the air-absorbing surfaces of the water. It then became more and more apparent that the oxygenation obtained by such motion should not be used merely as an auxiliary to the oxygen obtained from growing vegetation, combined with the surface absorption of oxygen effected by even motionless water, but that the *chief* means of aerating and purifying should be motion, or, in other words, the increase of air-absorbing surfaces, and that the plants should he used merely to do what motion will not do, that is, to decompose the carbonic acid gas. It was felt to be an error, and a fruitful source of failure, to so far stimulate the growth of plants with light, that dependence had to be placed in them for nearly all the oxygen needed for aquaria. Accordingly, early in the history of the subject, the writers of aquarium books, without seeing the matter quite as here stated recommended such aeration as could be got by occasionally drawing off some of the water into a separate vessel, and allowing it to drip back into the aquarium; or by forcibly injecting water through a small orifice with a hand syringe, so that a strong stream, mechanically entangling atmospheric air at the moment of its impinging on the surface of the water in the aquarium, should carry down into the latter great quantities of minute bubbles of air, so that the air being thus as it were, pulverized, is, by reason of its largely increased surface, in the fittest state to be easily absorbed by the water. In Ball's system, the air is driven into the tank at the bottom, and it *quickly* rises to the surface in huge

bubbles which effect but little service, and still less so because they rise in one straight column, and therefore are only of local benefit, but when driven down through the surface of the water, the bubbles ale so diffused everywhere, and are so very minute, that their smallness causes them to rise *slowly*, and thus time is afforded for the water to absorb as much as possible of the air in such bubbles.

In Mr. Gosse's book, ''The Aquarium," 1854, there is described and figured an arrangement termed "A fountain Aquarium,'' where water is pumped, or otherwise lifted, to a cistern above the aquarium, into which the stream runs and overflows the aquarium into another cistern below it, whence it is again periodically raised to the upper cistern. This plan, which is still a convenient one for small aquaria, is not only valuable in its aerating effects, but also by it the whole quantity of water can be largely increased, to the great benefit of the animals; and in the Regents Park aquarium, this system was adopted from the beginning. But when used for a large arrangement, the streams so produced, which depend on when the water is pumped up by manual power, are insufficient, or inconstant.

In 1859, Mr. George Hurwood, of Ipswich, contrived an arrangement whereby the pressure of a stream of fresh-water, such as exists in the pipes of waterworks of towns, or such as can be got from a high cistern already existing in a dwelling-house, may be employed to compress air, which compressed air in turn forces a current of sea-water into an aquarium; and this plan is perhaps the best that can be adopted for small aquaria where hand labour is undesirable, though the motion is of necessity intermittent unless the apparatus be in part doubled, and though, too, there is a small waste of power each time the air-vessel is charged. [The details of this pump can be found in my essay, "The Early History of Aquarium Aeration," in *Essays on Aquarium Hobby History*, p. 240.] This arrangement was adopted in several private aquaria in England, but afterwards on a much larger scale in the first public aquarium erected in Paris, in the Acclimatation Garden in 1859. This aquarium was very successful, the sea-water not being once changed during its thirteen years of existence, and in 1862 it stimulated the Zoological Society of Hamburg, then in the first year of its life, to have an aquarium in its gardens. This aquarium was opened in the spring of 1864. It is much larger and better than the one at Paris, and became speedily very popular and successful in every way, and is still the best, though not the largest, aquarium open on the Continent, thanks to the early influence of Dr. H. A. Meyer, Professor Mobius, and the late Baron Ernst von Merck. The sea-water is circulated partly by a water-pressure engine set in motion by the town waterworks, which drive a pair of water-pumps (instead of compressing air, as was done in Paris), and partly by a steam-engine which drives two other pumps.

The great pecuniary success of the Hamburg aquarium caused other public aquaria to be erected in various parts of the Continent, namely, in Hanover in 1866; in the Boulevard Montmartre, in Paris, in 1867; in the reserved Park of the Paris International Exhibition in the same year in two places; at Boulogne-sur-Mer in 1866; twice at Havre, in 1867 and 1869; in the Zoological Gardens of Brussels, in 1868; in the Flora Gardens of Cologne, in 1869; and in Berlin, in 1869. The money capital embarked in these Continental aquaria has amounted to about £180,000, but this large sum in the case of ten of them has not produced either scientific or commercial results in proportion to its amount. The chief cause of this failure may be traced to the neglect of one apparently small matter: this was a principle of aesthetics, the connection of which with the natural history scientific success of the entire project is not obvious at first sight, though it led gradually to the neglect of other principles, not merely of art, but of physics. As these two matters are subtly but intimately connected together, it will be of interest to explain how, thus:—the early experimenters, when they wished to introduce a plant (as *Valisneria*) into a fresh-water aquarium, embedded it among the sand and shingle forming the bottom, and then placed a somewhat heavy stone

or a few lighter ones over the root to hold it down more firmly and keep it in its place. For the same reason the first workers at marine aquaria, when they introduced sea-weeds, always procured them attached to stones, often of rather large size, which, therefore, became conspicuous features in aquaria; but it will he seen that they were essential to a stated purpose, however unnecessary it may have been to introduce plants at all in such a manner.

After a while it was found that such stones had a further use, since fishes liked to rub themselves against them, or to hide under their edges, or among their crevices; or worms crept beneath them, and sea-anemones clung to their welcome surfaces. This evidence of the use of such stones caused their increase in number and dimensions, till at length they were disposed in a somewhat decorative form, and built up as miniature columns and arches, or sometimes even as small cromlechs, that is to say, with two upright pieces supporting a third piece on their tops. This latter device was not in the best possible taste, as a cromlech is a mode of enclosing a space not needed beneath the surface of water; but so long as this grotto building was confined to the interior of tanks— where it incidentally afforded the creatures the shelter they needed, and supplied places on which vegetation might grow by the action of light—no great objection could be urged against it, even if sometimes the form of such grottoes was fantastic rather than fanciful. Still less could anything he said to their prejudice when occasionally some unassuming rock-work in fresh-water aquaria was carried above the surface of the water, and used for the growth of ferns and other plants overshadowing the water below.

But the thing did not stop here, for in an evil hour someone proposed to construct an entire aquarium like one big grotto, and accordingly two public aquaria, one in Hanover, and one in the Boulevard Montmartre, Paris, were so made, and in such manner that not only was there rock-work inside the tanks, where it was of course essential to the use and comfort of the creatures, but there was rock-work outside the tanks also, projecting from walls, suspended from ceilings and rising from floors; in which places it was improper and most objectionable, because unnecessary for the use and comfort of visitors, and in fact, tending to their discomfort by reason of the sharp and ragged edges and surfaces it presented, and the dirt it harboured. Still, the public admired, and could neither perceive nor he induced to understand that a thing, which only serves to gratify inartistically educated eyes, is not merely valueless, but is actually wrong - wrong because devoid of purpose. However, the new fashion was approved, and every Continental aquarium made after that period (1866) was constructed on this erroneous principle. Perhaps none of them have been seen and admired by so large a number of persons of all nations as the two, one fresh-water and one marine, in the International Exhibition of Paris in 1867; although both were utter failures in every way, and one of them (the marine one) displayed the crowning absurdity of making the ceiling of the aquarium the transparent base of a tank over the spectator’s head, in addition to having its side -walls composed, and properly, of glass forming the fronts of tanks. But it was not generally remarked that no good zoological result proceeded from such puerilities, and the materials of this Paris Exhibition aquaria were in fact re-erected in Brussels in the following year, where of course no better scientific result ensued. In the first Havre aquarium, set up in 1867, the rock-work building was modified into an imitation of the Cave of Fingal in Scotland, and it is almost needless to say that as an exhibition of living aquatic animals (the sole purpose for which an aquarium is intended) it was very poor. The same may be said of the second Havre aquarium, one-half of the interior of which is apparently constructed to imitate the Israelitish passage of the Red Sea on dry land, the ceiling being modelled to resemble high over-arching waves suddenly arrested in their progress and walled up on each side; while the other half is an imitation of a stalactitic cave, the stalactites (composed of long conical bundles of straw bound with string, and covered with cal-

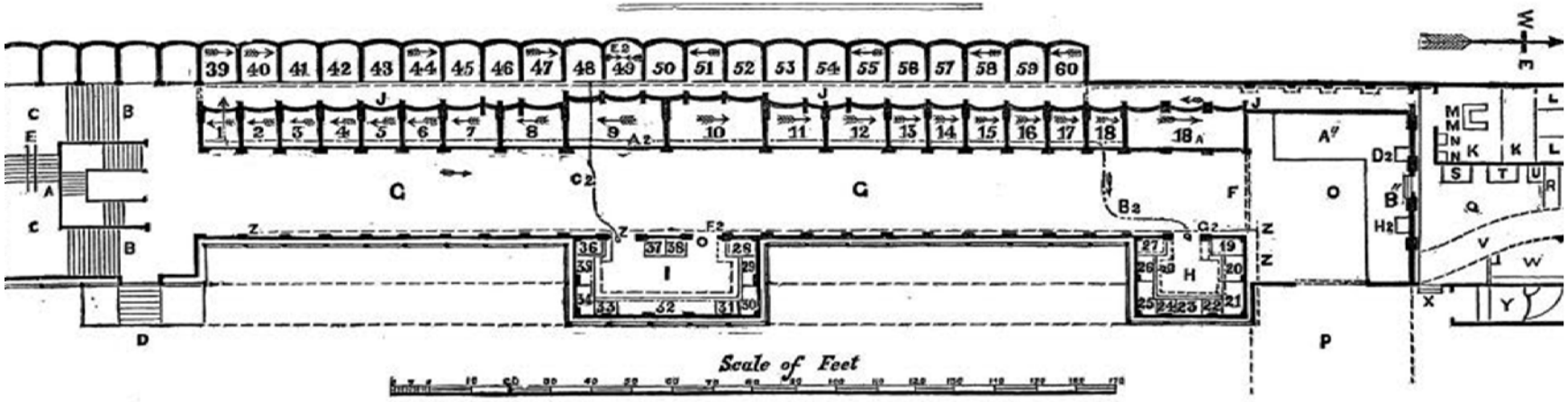
careous cement) hanging in masses from the ceiling. Between them rises what seems to be, but is not, a mass of coal left to support the ceiling of an imaginary mine, and externally the building is made to look like a great stratified rock. So also in the Berlin aquarium there are everywhere huge masses of rock imported from great distances at a great cost, but answering no real constructive purpose whatever, or supporting merely that which could be supported by iron columns of one-tenth the diameter of the piles of stone. The frames of the glasses of the tanks are made of irregular angles, with about as much reason as if the frame of a picture of a rough and broken landscape should likewise be made of irregular outline to correspond.

There are also there a “geological grotto,” can teach no geology, a blue grotto of Capri, illuminated at a wrong place and with spectators at the wrong end, stalactites lighted with coloured flames, ruined Gothic arches, and many other conceits. The object sought in all this and in much more of the same kind, is to make all look “natural “and in a sort of fancied “keeping “with the interior of the tanks. In fact, the error consists in the quite futile endeavour, as far as artistic result is concerned, to model instead of to draw a picture. When an artist makes a drawing of a rocky scene, he does not imply that his work is really the rocky scene, hat merely that he reproduces the idea left on his mind by the scene. He does not *imitate* what he saw, he only represents it; and in making that representation he employs only just as much material as is necessary, and is very careful not to use any of the materials of the things represented. Consequently, whenever, as in making an aquarium, an idea is sought to be suggested by the use of imitative means, a sense of incongruity is at once produced by the incompatibility of the ideal to be suggested with the reality which everywhere makes itself manifest, and contradicts the attempted ideal.

For example, if it be intended by making an aquarium in the semblance of a submarine grotto, to give visitors the impression that they are in a veritable cave beneath the surface of the sea, they at tuna' meet with things which could not there exist, as dry and smooth floors to walk on and plate glass through which the animals are seen, and thus the intended deception never deceives. Then comes the sense of waste at so much material having been used to do so little. In nature there is no waste. Natural rocks, mountains, and eaves may he, and are picturesque and beautiful; but they were not made only to be so. They are so merely because they are the result of some cause which had a use in the first place, and admiration of such things proceeds (often insensibly) from a recognition of that usefulness, and of a general fitness for a definite purpose. With regard to stalactites, too, they derive their peculiar shape and pendent position from the mode of their general formation; and to reproduce them in a manner which in any way permits the supposition that they have been made by nature, while they have not been so constructed, is wrong, because untruthful, and for this reason cultivated persons dislike such things, especially when they are associated with real objects having the gravity of a natura1 collection. They are accepted as illustrations in theatrical scenery, because there, usage and necessity allow an incongruous mixture of painting and modelling allied to what is of but a temporary character. Waste is also committed in the constant employment of disguise which the practice of imitation instead of representation gives rise to; for example, if in these objectionably-built aquaria, a flat or smooth surface presents itself as a pilaster or jamb, instead of being honestly displayed as being constructurally necessary, it is carefully concealed by having some rock-work cemented to it.

Waste, in the same way, is shown in the making of mock ruins, which in effect proclaim falsely that time has ruined them; and as the interest of an actual ruin is due only to a knowledge of such effects of time it is wasteful to make that which can have no other interest than the single one which has been thus carefully eliminated. Other contrary elements are set up by the primary error

PLAN OF CRYSTAL PALACE AQUARIUM.



KEY TO PLAN.

A Staircase from Palace.
BB Staircase to Palace.
CC Storerooms below Staircases.
D Communication with Palace Grounds (public).
E Turnstiles.
F Screen at north end of Saloon.
GG Saloon, containing Marine Tanks 1 to 18A.
H North Room, containing Marine Tanks 19 to 27.
I South Room, containing Marine Tanks 28 to 38.
JJJ Attendants' Gallery, containing reserved Marine Tanks 39 to 60. (Private.)

KK Room, containing as follows :—
LL Two Steam Boilers, and
MM Two Steam Engines, and
NN Two Steam Pumps.
O Junction, with Conservatory, to contain Fresh-water Tanks. A" B".
P Part of Conservatory (upper end).
Q Workroom.
R Slab for preparing Food for Animals.
S Store Cupboard.
T Slab.
U Sink.
V Flue.

W Office.
X Communication with Palace Grounds (private).
Y Heating Apparatus room.
ZZ Heating Pipes.
A2 Sea-water Pipes supplying Tanks 1 to 18.
B2 Sea-water Pipe supplying Tanks 19 to 27.
C2 Sea-water Pipe supplying Tanks 28 to 38.
D2 Point of issue of Sea-water from Reservoir to circulating system.
E2 F2 G2 Three points of entrance of Sea-water from circulating system to Reservoir.
H2 Float showing height of Sea-water in Reservoir.

The direction of flow of Sea-water in the Tanks is shown by arrows, which for want of space are omitted in Tanks 19 *to* 38, 41 *to* 43, 45, 46, 48, 50, 52 *to* 54, 56, 57, *and* 59.

referred to—such as the introduction of empty shells and corals into aquaria for decorative purposes, especially when placed in water (even when they are marine shells in sea-water tanks), inasmuch as an aquarium is a place for the exhibition of living animals, not for the houses of dead ones. Shells and corals are made to render certain services to animals inhabiting them, and they should not be placed in situations, especially in water, where it is implied even, without being directly stated, that they fulfil their legitimate and useful purpose. They are allowable only in museums, in illustration of natural history, or as articles of manufacture, as they are then employed usefully. It may be urged, on the contrary, that shells and corals are found dead and empty in the sea; but they are not placed there decoratively, and they are even then of probable service in restoring to the water some of its solid matters, which in aquaria can be more conveniently supplied by other means.

It may be and has been said in reply to all this, that mere decoration is a matter of fancy, and that even if ornamentation is incorrect in principle, it need not interfere injuriously with the practical working of an aquarium. But in every known case it has so interfered, and in a direct manner, for if such objectionable work is planned by a naturalist, it is impossible that he can have in him the true spirit which observes that nature never decorates merely for the sake of decorating, but, on the contrary, first makes a useful work, and then enriches its surfaces. Nature never introduces any member of a construction unless it has some real working necessity; and never, except in cases of deformity, which are accidental, gives anything the character of an excrescence or a deprivation. A naturalist knowing this, and being always impressed by it, will in his own work endeavour to imitate the same general principles. If he does not, the probability, or rather the certainty, is, that all will be wrong, not only in the decorative, but also in the mechanical arrangements and in the appliances generally for the maintenance of the animals—as the want of this spirit of following nature affects every part of his work.

One error leads to another, and many of these Continental aquaria have violated all the three fundamental rules laid down at the commencement of this pamphlet for the arrangement of aquaria, particularly the one against the introduction of animals which breathe air by lungs. When this rule is once overstepped, it immediately opens the door, not to the overcoming, but to the evasion, of the difficulties attending the management of aquaria, and at once converts an aquarium (then one only in name) into a heterogeneous assemblage, comprising every animal that can be maintained in captivity at all. Tint an aquarium, properly so called, has the one great advantage that all the animals can be maintained, at all seasons, within a covered building, without any ill smell arising from them or inconvenience to themselves; this cannot be the case with any animals, with but two or three small exceptions, which rank higher than tidies, and, moreover, when that is the case, the peculiar charm derived from seeing animals living immersed in an element so essentially differing from air, as water is, is at once done- away-with.

Professor Ruskin has well said that “buildings for scientific purposes should be plain and useful in all things, in appearance as is in fact," but in a building where the science is essentially popular, a little decoration is allowable, so long as it is in good taste and is unobtrusive, such as, for example, on the fronts of Tanks 19 to 38, where the ornaments are incised in the material decorated, and not applied or stuck on to it.

When any designs derived from the forms of plants or animals are used *decoratively* in any building used to contain such objects, they should be always conventionalized, or deprived of their naturalness, so that they may not come into imitative competition with the actual objects shown, they being not required as pictorial representations of them.

The difficulties generally of an aquarium, however, whether inland or by the sea, are so great, and

so much need all the money capital that can be spared for the surmounting of them, that but very little remains that can be honestly spared for mere ornamentation.

Since the opening of the Crystal Palace aquarium, two other public ones have been opened, one at Copenhagen, and one at Brighton. Five more are now in course of construction, namely, at. Vienna, Manchester, Southport, San Francisco, and Naples. Of these, the first should do much for the Adriatic fauna, and the last-named one, under the management of Dr. Anton Dohrn, will, it may be anticipated, be one of the most important, both as to the results to be obtained on the spot, and as to the obtaining of desirable Mediterranean animals from thence for British aquaria. Already, through the kindness of Messrs. Pickernell Brothers, and Messrs. A. Laming & Co. in painstaking transmission, some valuable specimens have been safely received. Messrs. Pearson and Langnese, of Hamburg, and Messrs. Drolenvanx and Bremner, of London, have also for several years greatly aided in this good work. Four other public aquaria are in contemplation, at Jersey, at Yarmouth, at Ramsgate, and at Torquay.

The building undertaken by the Crystal Palace Aquarium Company was commenced in July 1870, much too late, therefore, to be opened when at first contemplated (April 1871) though at Faster of that year half a dozen of the marine tanks were temporarily converted into freshwater ones, and some pike, tench, carp, eels, and other fishes were shown therein for three days, after which the place was closed, and the progress of the works continued; until the establishment was finally opened on August 22nd, 1871. It would have been well if the sea-water had been in good condition in the early part of the summer, so that advantage might have been taken of the then exceptionally cool weather to transport some of the great abundance of animals at that time on the coasts of England; but that was not possible; and when the water *was* fit, the weather became very hot, and the sending of many animals was thereby prevented. At first, and for many weeks after its introduction, the sea-water was much discoloured, unclean, and not fit to support life, in consequence partly of its being disassociated from growing vegetation in the sea, but chiefly because it took up such free lime as was used in the cement employed in making the reservoir and tanks, and in building the rock-work in the latter. Consequently, it became alkaline and poisonous, and continued so till the carbon of the atmosphere united with the lime and formed a harmless deposit of hydrate of lime; as this process went on, the water became clear, and vegetation formed, and animals were gradually introduced.

The accompanying plan on a folding plate, drawn to a scale of about fifty feet to one inch, shows the ground occupied by the Crystal Palace aquarium and its adjuncts to be nearly 400 feet long and 70 feet broad, and it is situated at the northern end of the Palace on part of the site of the portion which was burnt in 1806. It is of but one story high, and therefore this ground-plan shows everything, except the sea-water reservoir beneath the saloon G G, extending under its whole width, and running below Tanks 9 and 10, and going lengthwise from E to H 2. This reservoir contains 100,000 gallons of sea-water, while the tanks above contain 20,000 gallons, in all 120,000 gallons, weighing over a million pounds, supplied by Mr. Hudson, and brought from the coast by the Brighton Railway Company, at favourable rates of carriage, through the kindness of its manager, Mr. Knight. Contrary to what used to be supposed, shore-water, when purified, is perfectly fit for the maintenance of deep-sea and open-sea animals in health. The fact of the aggregate contents of the tanks being only one-fifth of the contents of the reservoir is extremely serviceable in keeping the water clear, as supposing the water in Tank 18a, holding 6,000 gallons, became turbid from any cause, it could be emptied by syphons in less than an hour into the reservoir, where so comparatively small a quantity of fluid would not appreciably disturb the purity of so great a mass, from which, in less than half an hour, No. 18a can

again be filled. Thus all the tanks where animals exist are always kept in good order by being constantly pumped into, day and night, from the large clear and cool reservoir below, where there are 110 animals.

The main aeration which is thus depended on for their health is thus produced by mechanical agitation, and the small quantity of sea-weed necessary to decompose the poisonous carbonic acid gas evolved from the animals, which could not be effected by mechanical agitation, is grown upon the rocks of the aquarium by the action of light on the spores of the algae existing invisibly in the water. As the motion of the water needs to be incessant, in the same manner that the motion of the sea is unceasing, all the machinery by Messrs. Leete, Edwards, Norman and Co. is in duplicate; there being each of four-horse power, two steam engines, each of three-horse power, and two of Forbes's patent pumps one of which is kept always in action, the other being in reserve in case of accident. Even in winter, when the lower temperature of the water enables it to absorb and retain more oxygen than in summer, the occasional stoppage of the streams for a few hours, to ascertain the rate of the evaporation of the water, occasions evident discomfort to some of the animals. Indeed, the creatures in especially in the taller tanks must be considered to some extent in the light of persons in a diving-bell, whose existence depends on the continuous pumping and injection of air. In this respect they are strikingly different from terrestrial animals living in captivity in cages or dens, in an atmosphere the same as that which is around them, in free and easy contact with it, and therefore not necessarily requiring as in an aquarium the mechanical injection into it of another third of a widely-different density. The sea-water issues from the pumps at the rate indicated by a counter while a tell-tale clock furnishes evidence of the attention of three engine-men, each working consecutively for eight hours; of from 5,000 to 7,000,gallons an hour, and passes in the first place into the two highest tanks, 9 and 10, half into each, from whence it runs, diverging north and south, through channels cut in the upper part of the walls dividing tank from tank, as far as Tanks l8a and 1. It is not possible for any poisoning or other deterioration to happen to the water in its passage, as the continuous aeration it receives in so many places causes it to be as pure at the end as at the beginning of its circuit. From 18a the water flows into 90, and from 1 into 39), in each case passing below the floor of the gallery JJJ, and then the two currents converge centrally through the series of reserve tanks, and fall together into the reservoir at Tank 49.

A portion of the water, however, is arrested above Tanks 9 and 18, and is by separate pipes conveyed into the rooms H and I, where after circulating in the Tanks 19 to 38, it finds its way into the reservoir below at F 2 and G 2. Independently, however, of the simple fall of water from one tank to another, in steps of from three to six inches in height in the series 1 to 18a (Tanks 9 and 10 being six feet high, while 1 and 18 are three feet high, internal measurement), other streams of water mixed with great quantities of air in minute babbles are driven from the main pipe into all the tanks with force through jets, so that myriads of such bubbles, controlled by stop-cocks, are forced in a state of fine division (resembling steam, or falling sand) nearly or quite down to the bottom of each tank; and thus the fluid is charged with as much atmospheric air as it will take up in open vessels. (See page 19.) This forcing in of air as nearly as possible resembles that which takes place in the ocean by rushing waves, especially when by their fall they drive much air into the depths below. It is possible that if an aquarium were arranged so as to resemble the ebb and flow of tides every six hours, some important results would be gained with some animals, and probably with such plants as grow in the sea between tide marks; but the complication and cost of such an arrangement would be great, and it would cause much inconvenience to some of the animals, as fishes, which in the sea escape beyond the tide at its ebb, but in a tank have no such means of escape, and would die if the water were

removed, or even much diminished in bulk. Then there would be also the unsightliness to visitors of having the tanks, or some of them, occasionally empty of water, and with the anemones and some other specimens closed, flaccid, and uninteresting.

Therefore, conventionally, tides can be considered as useful only as contributing by their means additional air, and as laying bare decaying substances and so more quickly hastening their destruction, by intimate contact with the atmosphere and its oxygen, and by afterwards washing them away. And these effects, for aquarium purposes at any rate, are otherwise attained with nearly the same end, though in a more limited degree. The amount of aeration (which depends much on the amount of water entering, as well as on the manner of its entrance) varies greatly according to the dimensions of the tanks—thus Tank 10 holds 4,000 gallons, and Tank 1 holds 400 gallons; and as Tank 10 has a stream equal to its own bulk running through it once an hour, it necessarily follows that as the same current flows through Tank No. 1 (of only one-tenth the capacity of Tank 10), then Tank 1 has a stream equal to its bulk ten times as often as Tank 10, that is to say once every six minutes; and as these grades of aeration vary in all the tanks, they can be chosen according to the varying requirements of different kinds of animals.

There is no intention to change the sea-water, but only to make up for accidental waste, as the breakage of pipes, &c., or to introduce from time to time a requisite quantity of distilled water to compensate for evaporation, and also to add whatever constituents the animals may eliminate from the seawater. For example, lobsters, craw-fish, crabs, oysters, worms with calcareous tubes, and many other animals, arc constantly making new shells, or adding to their old ones, and the solid matter necessary for their formation is derived from the seawater, and must he replaced. This is a direct representation on a small scale of what takes place in the actual sea, where the evaporation of fresh water ascends and forms clouds, and thence descends as rain and in rivers. In like manner, solid matters in solution are being constantly washed down rivers into the sea, to be there used, and they are also furnished from some unknown sources.

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The material used for the pumps, strainers, cocks, and jets, and for nearly all the pipes (the exceptions being the stoneware pipes connecting Tanks 39 to 60), is vulcanite, or hard india-rubber. This was recommended by the late Professor Faraday for the purpose in 1857, as being practically unaffected by sea-water. But it is likely to be now superseded by a preparation of collodion patented by Mr. D. Spill of Homerton.

In Tanks 1 to 18a, the animals can be viewed only through the plate-glasses forming the fronts of the tanks, but in the twenty tanks of the rooms 11 and I (Nos. 19 to 38), which are made to contain small specimens, the view is through the surface of the water, as well as through the glasses of the fronts, as in the table-cases of a museum. The shallowness of these twenty tanks, varying in water capacity from 40 to 270 gallons each, much increases the accessibility of the objects they contain, as well as their aeration, inasmuch as, independently of the streams, the absorption of atmospheric air by water depends on its being exposed to the air in masses having large surfaces, and small thicknesses, as has been before slated. Thus in tanks 9 and 10, every column of water measuring six feet in vertical height and one foot square, has only one superficial foot of surface at the top exposed to the atmosphere; while in Tanks 28 to 38, every column of water measuring one foot high vertically, and one foot square, has also one foot superficial at the top in contact with the external air; and in Tanks 19 to 27, every column of water measuring half a foot of vertical height, and one foot square, has still as much as a superficial foot in contact with the surrounding atmosphere. It follows, then, that the passive surface absorption of air in the south room of this aquarium, is six times as much, and in the north room twelve times as much, as in the two great Tanks, Nos. 9 and 10. In the small tanks the much shaded position of some of them, as Nos. 19, 21, 25, 27, 28,

30, 34, and 30, also affords means of maintaining some organisms, both animal and vegetable, needing an unusual amount of darkness.

For example, it is unlikely that any green algae (*Chlorosperma*) will grow in the gloom of these tanks, while they are admirably suited for the *Rhodosperma* (or red algae), which always flourish best in much obscurity,*—not only because, contrary to the rule which obtains among most terrestrial plants, the deeper-coloured marine plants or sea-weeds grow best in the least light, and fade when exposed to much illumination,—but also when so exposed they become densely covered with, and have their form and character concealed by, various green or purple filamentous weeds, which, under the stimulus of light, tend to grow upon everything. Even when by chance some of the higher green algae, as *Ulva* and *Bryopsis*, have sprung up in aquaria, the lower insidious silky green kinds (as *Conferva*, *Spirulina*, and *Oscillatoria*) have appeared oftener than not, unbidden and unwelcome, and have concealed and spoilt those whose cultivation is desired. It is true that there are some vegetable-eating mollusks, and some fishes, which may be advantageously introduced to consume these growths, but they exercise no discretion, and eat that which should be saved, as well as that which needs removal. Therefore in the culture of all such sea-weeds as can be grown in aquaria, the management of light is the principal thing to be attended to. In the Regent's Park aquarium, from time to time, some growths of the higher and more beautiful sea-weeds have occurred, probably through some accidentally presented circumstances of light; but succeeding seasons of great illumination and warmth have destroyed them. At present, however, in March 1873, in one of the central tanks is a copious growth of a red weed (*Chondrus crispus*), the "Carrageen," or "Irish moss," of the shops, which, by reason of the much more darkened con-

TOP: Front view of Tank No. 10 (18 feet long). BOTTOM: Front view of Tank No. 9 (18 feet long).

dition of the building of late years, has continued for a long time.

* Since this passage was written, however, several of the red algae have grown luxuriantly in this aquarium, chiefly in the dark corners of the north and south rooms. The species are *Phyllophora rubens, Gymnocongrus Griffithsea, Polyides rotundus, Iridaea edulis, Chrondrus crispus, Gelidlium corneum, Rytiphlaea pinastroides, Corallaea officialis*, and others. (April 1873.)

The colours of some animals are also affected by light, and therefore no direct sunlight can enter Tank No. 1; and as it contains only sea- anemones, it may be expected that this intentional arrangement will somewhat retard the usual fading of the hues of these animals when in aquaria. Some of them are diurnal in their habits, however—notably *Anthea*, which likes much exposure to light, and does not fade, and has a tendency to close at night. It will be noticed throughout the whole of this aquarium, indeed, that the principle followed is to give the animals the very smallest amount of light consistently with their being seen at all by visitors. In the sea many of them are always in more or less darkness, and this shade they often seek in aquaria by hiding in crevices of rock-work, or by burrowing in the sand and shingle, many of them coming out of their retreats only at night.

The difference between the amount of light in the sea and in aquaria is shown strikingly by such creatures as lobsters *Homaras* and craw-fish (*Palinurus*), as these, when freshly caught, have their shells usually clean and bright, or at any rate free from the green weeds which come spontaneously from the influence of light. But after they have been in even an obscurely lighted aquarium fur a few weeks especially in summer, when heat and warmth are at their maximum, and stimulate vegetable growth, they gradually become more or less covered by such growths. Other animals, as the slow moving crabs, *Maja, Pisa, Stenorhychus* and others, sometimes arrive in the aquarium much covered with the higher red sea-weeds which grow upon them because in the sea they hide much among the concealing fronts of these algae; but after a sojourn in the tanks for a period, these red forms of vegetation often decay and disappear, mainly because they are exposed to too much light, and then the green minds take their place and grow, especially in warm weather, with much rapidity—the speed being assisted by the rough surface of the shells of animals—and it is owing to the necessity of keeping in check this green vegetation, which, if uncontrolled, will grow so fact as to cover and obliterate everything, choking up pipes and gratings, and doing much other mischief, that a properly constructed aquarium, with its shade and coolness, presents such a marked contrast with the light and heat of a conservatory for terrestrial plants.

Tanks 1 to 18a are lighted from a source not seen by spectators in front of the glasses, and persons standing there cannot by looking upward obliquely, or in any other way, see through the surface of the water, the surfaces of which have the appearance of mirrors horizontally laid on the top of the water, and reflecting all objects below them, when the fluid is not too much agitated by the currents. This is because the vision is at what is termed “the angle of total reflection”; and it is incidentally of value because it tends to confine the attention of spectators to what is contained in the tanks, and prevents distraction by the sight of whatever is above them.

In Tanks 39 to 60 the view is only through the surface of the water. These twenty-two receptacles, each holding about 300 gallons of seawater, contain animals which are at intervals drafted into the show tanks (1 to 38). Acting as reserves and not for public inspection, they enable large numbers of animals to be purchased when they are to be cheaply and easily got; and thus these store-places in part remove the uncertainty of supply which hitherto has attended inland marine aquaria. They are also used as stores for living food, as mussels and shrimps, for the other animals.

For the general supply of the aquarium the Company possesses a large marine pond in communication with the sea at every tide, and serving as a store for animals, with a resident agent at Plymouth. This pond is capacious enough to furnish many animals otherwise difficult to procure, to all the public aquaria in Europe. The Company has another agent and a store-place at Southend, Essex, and supplies are obtained also from Weymouth; from Menai and elsewhere in North Wales; from Tenby, in South Wales; from Ilfracombe; together with other contributions from North and South Devon and the Channel Islands.

The difficulty of procuring animals in good health, of sufficient variety, and of suitable size, is very great; so great, indeed, on account of periods of excessive heat or cold, or of rough weather, that there are probably not more than a dozen or fifteen weeks of any average year (with seldom a couple of weeks consecutively) in which animals can be most advantageously got; and this applies especially to fishes. The specimens are conveyed from the sea by fast trains, and by the facilities kindly given by railway companies, some of the cost ordinarily attending the transmission of goods by such a mode is much lessened. There are two modes of packing, namely:—firstly in a moist atmosphere; and, secondly, in actual bulks of water. The first method is adopted for such animals as sea-anemones and corals, with a few exceptions; some of the tube worms and other annelids; many of the echinoderms; a large number of crustaceans; nearly all the mollusks having a hard shell, and an operculum, or lid, to close it; and a few of which have no such provision. Those which form exceptions to this rule, together with all the fishes, must be conveyed immersed in a sufficient quantity of water, save about two species of the fish (eels and blennies), and these only when the time of the travelling does not exceed about six to ten hours, and the weather is favourable. In the moist system the animals are usually placed in layers of wet seaweed, contained in large cans or baskets, with ready access to air through their interstices; and, so long as the moisture from the weed is sufficient to keep wet the bodies of the anemones and corals, and the skin (and particularly the breathing organs) of the other creatures, this plan is a good one, inasmuch as not only is a considerable expense saved by avoiding the carrying of a heavy weight of water, but, as the moisture produced by the sea-weed in contact with the creatures (on their external and in their internal parts) is necessarily in very thin films, these, by reason of their thinness, art more rapidly oxygenated by the atmospheric air in contact with them, on the same principle as the shallowness of water in Tanks Nos. 19t to 38 has been described as being so advantageous.

But when animals are obliged to be transmitted in actual masses of water, the process of due aeration on a journey, notwithstanding the agitation the water then receives, is more difficult (as well as more costly, owing to its greater weight) because of its greater bulk, or, more exactly, of its greater thickness. The difficulty is in both methods much increased at periods of great heat, when the films of water are liable to be dried up, or the mass of fluid to be unduly warmed. The effects of such drying is that the gills of the creatures become desiccated, and the blood then not flowing through them to be aerated, death quickly follows. The result of the warming is, that the water then not retaining sufficient oxygen for the animals, death likewise ensues. So, too, is the difficulty increased, when, in a season of much cold, the films of fluid become dried up by frost, when the animals also die; or when, if conveyed in a bulk of water, it becomes cooled below that which the creatures live in in the sea, even if they are coldblooded organisms. It is this liability of comparatively small masses of fluid to become too much warmed or cooled on a journey which makes the transit of aquarium animals so trying to them; for it must be remembered that if attention to light, to vegetation, to temperature, and to other points, is so necessary for them when deposited in an aquarium, so it is necessary to be observed in travelling, where, however, such attention can be but very imperfectly given, and the hin-

drances to success increase in proportion to the length of duration of the journey.

These considerations account for the very few non-lung-breathing aquatic animals imported from abroad, in comparison to the lung-breathing creatures so imported. Of the crustaceans (to name only one class) obtained in Europe alive from non-European countries, there are only *Sesarma* from the Navigator Islands, (*Gecarcinus* and *Coenobita* from the West India Islands, and ***Lineatus*** **from** America; and these four, though provided gills for respiration, are so modified in structure that they can pass much of their time out of water, and thus survive a long voyage. *Proteus*, a creature sometimes kept in aquaria, and of great interest because of its anatomical peculiarities, and its position in the scale of beings, has been repeatedly brought to England from the south of Europe; but though in captivity it lives wholly under water, yet its reptilian character, and its possession of gills as well as lungs during its whole life, undoubtedly aid largely its transit, though how is not quite clear. The same may be said of two other members of the same family, *Siredon* and *Siren* of South America, both of which have been brought alive to England and to the continent of Europe. Another nearly-allied form, *Lepidosiren annectans* (the Mud-fish), has often been imported into England, France, and Germany from Africa; and. notably, in the warm waters of the tropical end of the Crystal Palace has thriven well. But its successful transport is owing to its organization, which permits it to be brought over in the state in which it is found in tropical dry seasons—contained in a case of hardened mud or clay, within which, and protected from evaporation by the dry envelope, is the small quantity of well-oxygenated moisture necessary to preserve its existence when no food is taken, and the heart pulsates very slowly, and therefore very little oxygen is needed. It was also owing to the ease with which their films of fluid can be aerated, that eggs of salmon and trout, in a cold and moist atmosphere, were conveyed to Australia and there hatched-out. They could not have been conveyed immersed in water.

All the animals in this aquarium have to be fed constantly; and as for the sea-anemones, of which there are in the aquarium over 5,000 individuals, every one of them has a morsel of food proportioned to its size, and according to the condition of the water, given it at frequent intervals with a pair of wooden forceps by an attendant who makes this his sole occupation; as these flower-like creatures being so non-locomotive as to be almost absolutely fixed, cannot pursue their food, or in an aquarium obtain it in any other manner. They are here deprived of the action of the waves which in the actual ocean brings them nutriment, which is arrested by their outspread and waving tentacles.

The food consumed by a few of the animals now present in the aquarium is vegetable, consisting of green weeds (*Ulva, Porphyra, Enteromorpha,* &c.), but by far the greater number have animal food given them. This consists of shrimps, alive or dead, crabs, mussels, oysters, and fish, but they are never fed on “butcher’s meat.” The large amount of organic substance thus continually placed in the water, and the correspondingly great quantity of excrementitious matter resulting from it is nearly all rendered harmless by being decomposed chemically by the oxygenation of the streams of water, and by the growing vegetation, without the use of any filter, and without the water being made turbid. In fact, the circulating system of the water in this aquarium is similar to, and avowedly made on the general model of, the circulating system of the blood of the animals which the aquarium itself maintains in life and health. Thus, the steam-engine represents a heart; the coals consumed by the boilers are the food; the pipes are the veins and arteries; the sea-water is the blood; and the wide-spreading air-charged streams discharged at the jets are the lungs.

Filtering arrangements, contrary to the usage obtained in most other large aquaria, are here omitted, as it is evident that if filters are necessary at all, some part of the tanks or reservoir must be in a turbid state; and to clear it mechanically

(otherwise than by the mechanical displacement of floating substances by the ever-entering current of water), so as to be absolutely trails parent when seen horizontally in masses of nine feet thick, and as rapidly as the circulation demands, would need a filter of enormous and impracticable size, and the constant renewal of its contents oi surfaces. Besides, it is necessary that the water should contain some organic matters or minute organisms (of which a filter would deprive it), and which serve as food for some animals which cannot be artificially fed, as the *Serpulae*, *Sabellae*, and others. Consequently, with the exception of the use of perforated strainers to arrest the grosser impurities, the purification is a chemical one—that is to say, the large quantities of oxygen constantly thrown in with the atmospheric air decompose the injurious dead organic matters present, present, both animal and vegetable, and consume them, resolving them into their harmless constituents, by a process exactly analogous to a consumption by fire, which is merely a decomposition at a high temperature and with the aid of oxygen, while the decomposition alluded to in an aquarium is one conducted at a low temperature and without the assistance of fire, but with the aid of oxygen. This latter form of decomposition or consuming is termed by the late Baron Liebig *oremacaus*, and the rate at which it is made to proceed in an aquarium depends on circumstances. Thus, when in summer the increased temperature of the water causes it to retain in solution a diminished quantity of ab. more air has to be injected by the machinery in compensation, especially as at such periods any annual or vegetable substances accidentally present have a tendency to rapid decomposition and quick dissemination of their particles through the fluid.

Consequently, the circulating apparatus is driven faster in warm than in cold seasons, and also at all times when the water is made turbid through accidentally giving the animals too much food, which is either left uneaten, or rejected as decaying matter; the feeding is then fur a time suspended, and the circulation of water made more vigorous, so as to bring the tanks into rapid contact with the large and clear mass of water in the reservoir, and thus to take all the advantage possible of this excellent system of counteraction; while at the same time any solid or semi-solid unconsumed substances are carefully removed by nets, forceps, or dipping tubes.

A blacksmith's forge fire in operation well illustrates what is here said respecting the similarity between the two modes of consuming by the aid of oxygen; thus, when the forge fire is being blown into, the coals become a clear white incandescent mass, because the fuel is having a large quantity of oxygen (contained in the atmospheric air, and urged by the bellows) driven into it; or, in other words, because the fuel is being rapidly consumed by being made to combine with the oxygen more quickly than if there were no stream of air; when more coals are added, the flame is for a time less bright and clear, but the blowing of air being continued, it soon regains its former incandescence; and again, when the blowing has ceased, the fire becomes red, dull, and smoky, because the union of coals with oxygen is then less rapid.

So it is with this aquarium: as it is constructed to maintain a certain number and kind of animals by the aid of a stream of oxygenized water constantly driven into every tank, the water is in a bright and sparkling condition so long as the stream is kept going, but when more organic matter is added in the form of food or fresh animals (both being carbonaceous matter answering to the supposed addition of coal or carbon to the forge fire), or when from excessive light there is a superabundance of floating plant spores, the water becomes slightly dull, till the continually entering and aerating current (increased to meet such a contingency) clears it in a short time. And when on rare occasions the current is stopped entirely for a few hours, the water in the tanks loses its transparent clearness for precisely the same reason that the forge fire becomes dull when its supply of oxygen ceases. The entering currents are not made to fall through a considerable height of

air in order to absorb more of it, as was formerly deemed necessary, and the points of the delivery tubes are therefore only between a quarter of an inch and an inch above the water surfaces of the tanks; and the force of the entering stream of water carries with it a current of air, so that both air and water are forced in together at the moment they impinge on the surface of that which is already in the tank: and it is to the force with which the mingled stream is dashed in, that the greatly comminuted state of the air is due.

Very few deaths occur, and the condition of the animals is being further improved as the vegetation grows. There are, however, reasons for supposing that in no aquarium yet devised can any pelagic animals be permanently kept, and that therefore the bulk of specimens must be littoral. But there are many marine animals, not only of the deep sea, but of the shore, which at present cannot be kept in captivity at all. The reason of this is in some cases known; but in others there is not the slightest clue us to the means to be adopted for their successful maintenance.

In front of Tanks 1 to 18 are placed obliquely, and over Tanks 19 to 38 are suspended vertically, glazed frames to contain drawings of animals; which when finished will be numbered to correspond with numbered descriptive paragraphs of future editions of this guide-book, so that any animals can be readily found. Although Tank No. 1 contains exclusively sea-anemones, and thus properly commences with the lower animals, yet the classification of the specimens throughout the building is not made with reference to any acknowledged system founded on organization; but they are, so far as the limits of tin place permit, arranged with reference to *habits* rather than *structure*, and in such manner that as much as possible one animal shall not interfere injuriously with another.

The building is very cool in summer, and during the hottest part of 1871, when the true temperature of the general atmosphere in the shade was 88°, that of the air in the aquarium was only 68°, and the sea-water never rose higher than 63° Fahrenheit. In winter, hot-water pipes are arranged to maintain the temperature of the air at from 60° to 65°, and the water at about 63° Fahrenheit. The ventilation everywhere is remarkably good, and there is no tank in any of the entire series of sixty which cannot be brought, when required, into free contact with the open air. The amount of daylight can be aim very exactly regulated. On winter evenings the tanks are illuminated with gas, and many nocturnal animals not visible by day are then seen. Indeed, in an aquarium, the difficulty always is to show animals which endeavour to avoid being seen.

The architect, Mr. C. H. Driver, of Victoria Street (the builders being Messrs. Jackson and Shaw), has shown much ingenuity in turning to good account every part of the space placed at his disposal; and in his simplicity of design he has not in any ease disobeyed any law of service in construction. Everything is done with a meaning, and with a definite and obvious purpose; thus, as animals cannot exist with comfort without rock-work in the tanks, it has been plentifully introduced; but whatever picturesqueness of form such rock-work possesses is merely a consequence of its being in the first place useful. And so strictly and severely is this principle carried out, that the rock-work does not project anywhere even an inch above the water level, instead of being employed (as already stated of most Continental aquaria, that of Berlin in particular) in the spectator's part of the building, where it is not wanted, and where, being perfectly useless, it is therefore ugly, and merely an expensive excrescence. Everything is made to look like what it is, and not like something else; not even to emulate some other and more expensive material.

Thus, if it is necessary to paint deal wood for its preservation, it is not also grained to look like oak or walnut-wood; nor is cement squared with imitation masonry joints, or otherwise treated to look like stone. Nor is there any use of sham marble. It

was certainly deemed advisable to make the building correspond externally with the arched iron framings which compose the Crystal Palace adjoining, and in which the gloss of that edifice is set; but even this frame on the outside of the aquarium walls is employed usefully to strengthen those walls, which are purposely made insufficiently strong if such framing were absent. And whenever, either inside or out-side the walls, a little enrichment has been indulged in, it properly consists only in the decoration of construction, and not in the construction of decoration.

Indeed, in this aquarium the strictest economy is throughout observed so that the largest number and variety of animals may be preserved in the best condition in the smallest space.

Site workers from the Crystal Palace Foundation have been involved with the excavation of the Aquarium since the early 1980s. Much about the history of the site and its significance in the world of aquaria has been gleaned in this time, and the learning process continues. The palace may have been gone for many years but there are still many reminders of the halcyon days.

THE LLOYD-KENT CONTROVERSY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 9, 2016)

Based on the success and attraction generated by the fish tanks in the Zoological Gardens in London in 1853, other public aquariums were established in Great Britain, including The Crystal Palace Aquarium in Sydenham (1871), The Brighton Aquarium (1873), The Manchester Aquarium (1874), The Southport Aquarium (1874), Dr. Cocker's Menagerie in Blackpool (1875), The Rothesay Aquarium (1875), The Royal Aquarium in Westminster (1876), The Scarborough Aquarium (1877), The Yarmouth Aquarium (1877), The Rhyl Aquarium (1878), The Tynemouth Aquarium and Winter Garden (1878), The Edinburgh Aquarium (1878), The Aston Aquarium in Birmingham (1879) and the Plymouth Aquarium (1888).

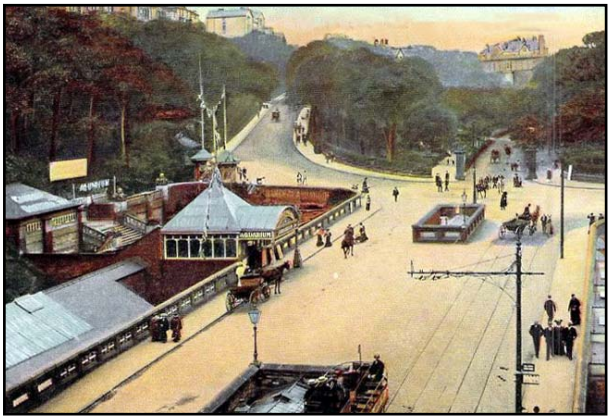
These aquariums used the system devised either by William Alford Lloyd or by William Saville-Kent. Lloyd's plan was to keep a large underground, dark reservoir for storage, removal of confervae and other small plants (they die without light), and temperature control purposes. The aggregate contents of the tanks at the Crystal Palace, for example, were only one-fifth of the contents of the reservoir. After circulating throughout the show tanks, the water ran into the reservoir, from which it started again on its circulatory rounds. Should something go wrong, any tank could immediately be emptied into it, and the slight admixture of any turbid water would be unable to significantly affect the condition of the reservoir. The main aeration was produced by the mechanical agitation caused by the circulation of the water and the constant injection of sprays of salt water that entangled air into them, into each tank.

Kent's plan was to aerate the tanks by jets of air, injected into the water in its simple form; thus the mechanical arrangements were less complicated than those in the Lloyd system. Also, a much smaller storage reservoir was required. The circulation of the sea water in the tanks was carried out individually by means of compressed air, which was supplied to their lower parts. By directly injecting air into the bottom of each tank, it ascended through the entire volume of water, first coming into contact with any organic substances lying at the bottom which was then oxidized. Although Kent referred to Lloyd's system as the "circulating system," and to his as the "aerating system," both are circulating, and both are aerating plans.

WILLIAM SAVILLE-KENT

William Saville Kent (1845-1908) was born in Devon, England, the youngest of ten children of Samuel Saville Kent, sub-inspector of factories. William was educated in boarding schools at Bath, Worcester and Gloucester. After study at King's College (University of London) and at the Royal School of Mines under Thomas H. Huxley, William became a naturalist and from 1868 worked at the British Museum. Later he became an accomplished marine biologist.

He married in 1872, but his wife died three years later. After marrying his second wife in 1876, he added a hyphen to his name, i.e., William Saville-Kent. A fellow (1869) of the Royal Zoological



The Scarborough Aquarium (1877).

Society, London, in 1873 he was also elected a fellow of the Linnean Society of London. At various times he used the nom-de-plume William Saville-Kent, and in early correspondence with the British Museum in London, as well as in his scientific correspondence, he signed himself William S. Kent, and occasionally W. S. Kent. In November 1870, in a personal letter concerning his engagement, he used his second name (i.e. W. Saville Kent) for the first time, perhaps in an effort to distance himself from the 'horrific events of the past' (see Addendum II). Note: I use "Kent," rather than "Saville-Kent" in the remainder of this essay since he did not use the hyphen until after the controversy between himself and Lloyd surfaced.

In 1870 he received a grant from the Royal Society to conduct a dredging survey off Portugal. Recognizing the potential for experimental marine biology of the public aquaria then being constructed in a number of British cities, in 1872-73 he was the resident naturalist at the Brighton Aquarium where his ambition was to establish a national marine research laboratory. Later, at the Manchester Aquarium (1873-76), he developed an interest in aquaculture. in March 1877, he took up a temporary position at the Zoological Society in Regent's Park (London) in order to restore their Aquarium and Fish House.

1877 he acquired a site on Jersey – partly because of its proximity to France (and hence with the potential to attract French visitors) but also be cause of the abundant local stocks of lobster (and the possibility of developing lobster culture), which were fetching high prices. He founded a registered company with shareholders, and the construction of a temporary building commenced in 1878. But the Government declined him a £ 250 grant and the fledgling project of establishing a national marine aquarium and laboratory, collapsed.

He hoped to make a further attempt a few years later - perhaps with the cheaper option of using an existing facility rather than building a new one, and he published the idea in a letter to Nature in 1883. It appears that the 'existing facility' he had in mind was none other than the Brighton Aquarium he knew so well. But Saville-Kent's personal interest in running a national marine laboratory was also shared by others, including some of the leading lights of the Victorian scientific establishment (e.g. Huxley's protégé, Lankester) and Saville-Kent was effectively excluded from the group who eventually drove the project through to fruition. The Marine Biological Asso-ciation was founded in 1884 and the Plymouth laboratory building was completed in 1888.

Following his work at the Great International Fisheries Exhibition in London in 1883, Huxley recommended him to the Tasmanian government to restore badly depleted oyster beds. Appointed superintendent and inspector of fisheries, in the following decade he produced the first comprehensive and scientific surveys of Australian fisheries and

William Saville-Kent (1845-1908).

their potential for development, covering not only the biological aspects of the stocks but also fisheries laws, the economics of the industry and the marketing of the catch. He fell out with members of a commission charged with acclimatizing salmon and trout in Tasmania's rivers and when his Tasmanian appointment was not renewed, he applied the same techniques in Victoria (1887-88), Queensland (commissioner of fisheries, 1889 -92) and Western Australia (commissioner of fisheries, 1893-95) for both edible and pearl oyster fisheries. He also examined and reported on fish, sea cucumbers, corals, sponges, dugong and turtles during this period.

In 1904 he worked for Lever Bros in a pearl culture experiment based in the Cook Islands. Forming a company back in England in 1905, the next year he began to culture pearls in tropical Australia, at Somerset, Torres Strait. He was probably the first to succeed in producing both blister and spherical pearls of commercial quality - a necklace believed to have been made with his pearls has recently attracted specialist attention. In poor health in 1908, he returned to England and, following surgery, he died. In his private research, Kent devoted much attention to corals, sponges and lizards, and these objects of his interest shared his residences. His grave in All Saints' churchyard, Milford-on-Sea, Hampshire, is decorated with corals.

He was the author of many scientific papers and reports and wrote three major books: "A Manual of the Infusoria" (three volumes, London, 1880-82), "The Great Barrier Reef" (London, 1893) and "The Naturalist in Australia" (London, 1897).

Clearly Kent was a scientist of the first order but he was not an engineer; but then Lloyd was not a scientist of the first order. Although Lloyd was not as educated as Saville-Kent (he left school at the age of 14), he was self-taught in both engineering and mathematics. He was also self-taught in natural history and in 1856, at the age of 31, he had two articles published in *The Zoologist*: "Occurrence in Britain of *Edwardsia vestita*," and "Note on a Sea-cucumber in Confinement." In his latter life Lloyd was often acknowledged as "the pioneer of aquarium science." The following is from Ray Ingle's 2013 article on Lloyd:

THE FIRST AQUARIST

Lloyd was the first aquarist to develop the 'closed systems methods' for successfully maintaining multiple aquariums and the first to recognize the importance of large settlement reservoirs, aeration, temperature control and filters for achieving water quality. He would not have been aware of detailed biological aspects of the water chemistry of his systems (most of this information became available only during the following century). However, he recognized the importance of vegetation in the aquarium and tried to culture seaweeds. He was an avid experimenter and intelligent observer, quickly learning from mistakes and, above all, highly capable of visualizing, calculating the requirements of, and successfully designing, large-scale aquatic closed systems.

THE CRYSTAL PALACE AQUARIUM

Since Lloyd was most closely associated with the Crystal Palace Aquarium and Kent with the Brighton Aquarium, I'll briefly summarize them, starting with Crystal Palace.

An oil painting of the interior of the Scarborough Aquarium.

In 1854 the Crystal Palace, a cast-iron and plate-glass structure originally built in Hyde Park, London, to house the Great Exhibition of 1851, moved from its temporary site in Hyde Park to its more permanent location at Sydenham, an affluent south London suburb of large villas. It had only been on the site for twelve years when in 1866 it experienced the first of a number of fires, which destroyed the North Transept. The fire left a large desolate area which had become a charred eyesore. There were insufficient funds to reconstruct the north end and it was not until 1870 that a plan was put before the directors to construct a marine aquarium.

What made the Crystal Palace Aquarium special was the fact that it was a marine and not a freshwater exhibit. No one before had created a working marine aquarium of this scale and diversity. The Crystal Palace secured the services of Lloyd, the leading aquarist of his day, who developed a system of continuous circulation of the water, which was kept in the dark as much as possible and at strictly governed temperatures. The Aquarium consisted of a building of one story high, measuring altogether about 400 ft. long and 70 ft. broad. There were 100,000 gallons of sea-water, of which 80,000 gallons were below the floor of the saloon, and 20,000 gallons in the tanks where the animals were shown. The water for the tanks was brought by train from the sea at Brighton, and briefly the aquarium was the largest of its type in the world.

The Crystal Palace Aquarium.

These tanks were sixty in number, and varied in capacity from forty to 4000 gallons each. Thirty-eight of the tanks were for the public exhibition of marine animals and plants, and were contained in a large room and two smaller rooms, but the remaining twenty-two tanks, for the storage of surplus animals, were in a gallery behind the large show tanks, and were not shown to the public (see the layout on page 8). All of the public tanks were fitted with plate glass, varying in thickness from three eighths of an inch to one inch. The sea-water was constantly pumped by steam power from the great reservoir below to the tanks above, day and night, at the rate of from 5000 to 10,000 gallons an hour; and, after it had traveled from tank to tank through the entire series, it disappeared below to be again pumped up Thus the same seawater was used continuously, without change, except for the occasional addition of fresh water to make up for the loss by evaporation.

To guard against the chance of a stoppage of the streams, all parts of the machinery in motion or liable to get out of order were duplicated. Thus there were two steam-engines, two pumps, and two boilers. Furthermore, all the pipes, strainers, stopcock and jets were made of vulcanite and stoneware to minimize corrosion by the sea water, and consequent injury to the marine plants and animals.

THE BRIGHTON AQUARIUM

It is a bit of irony to note that William Kent was not the first manager of the Brighton Aquarium. In the early summer of 1869 the newly formed Brighton Aquarium Company issued its Share Prospectus in which William Alford was listed as the Aquarium Manager. However, due to problems in obtaining the necessary permits for the construction - a new road and sea wall had to be built and securing the Royal approvals took time -

Lloyd, who needed an immediate salary, took the position of Manager of the Crystal Palace aquarium when it was offered. After Kent resigned his position at the British Museum, The Brighton Aquarium gave him the job. Kent was Curator and Resident Naturalist of the Brighton Aquarium from 1872 to 1873 but was forced to resign his post owing to some disagreements between himself and the management. In 1873 he accepted the positon of manager at the Manchester Aquarium. He left the Manchester Aquarium in 1876, working for other aquariums before entering his new career as a marine biologist.

The Brighton Aquarium was the brainchild of Eugenius Birch, the famous pier engineer and designer of Brighton's West Pier, who conceived the idea following a visit to the Boulogne Aquarium. Erected on the approach roadway to the Chain Pier, the Aquarium necessitated the construction of a new sea-wall and promenade, which was began in 1869. The whole project was completed in 1872 at a cost of £130,000, and the Aquarium was inaugurated by Prince Arthur at Easter although there were no exhibits at the time. It was formally opened to the public on August 10, 1872 by the mayor, Cordy Burrows.

The Italianate building extended for about 700 feet along the base of the cliff. The entrance was at the western end where a wide flight of steps descended into a large courtyard formed by five red-brick arches and terracotta columns. Here was located a restaurant and dining hall. From the entrance hall the visitor proceeded to what ☺ be termed the Aquarium proper, a corridor two hundred and twenty feet long and twenty-three wide, divided in the center by handsome columns, constructed alternately of Bath stone, serpentine, and polished granite. On the caps of the columns were carved designs of shells, fish, sea-birds, and other marine subjects, while the corresponding corbels from the piers were enriched in a similar manner.

The large tanks in this corridor were lit from behind to add to the air of mystery. On each side of the corridor the tanks were arranged for the exhibition of the specimens, varying in size from eleven feet six inches by twenty feet, to one hundred and three feet by forty. The center of this corridor housed a hundred-foot tank to Birch's unique design. Holding 110,000 gallons, it was the largest display tank in the world at that time.

The central square had a groined vaulted roof on each side, forming a sort of cloister, while the middle was covered with an elaborately ornamented iron roof, part of the covering being antique colored glass.

Passing through the principal corridor, which ran nearly from west to east, the visitor had access to another corridor at right angles to the one just described, running directly north and south. There were no tanks in this part of the building, its chief use being a communication between the two main corridors.

There was a conservatory opposite the second corridor at the end of the building. Its extreme length was one hundred and sixty feet, and its width forty feet, the eastern end being designed to form a rockwork waterfall, with ledges, dropping well, small aquaria and ferns. The conservatory proper was seventy feet long and twenty-three feet wide, the entrance facing the main corridor from the entrance hall. On each side were lofty arches forming arcades, having a tier of windows overlooking the terraces. The roof was in cast iron, resembling the iron roof already mentioned.

The Brighton Aquarium, 1873

The Grand Restaurant at the Brighton Aquarium.

The other main corridor, which was approached from the one running from north to south, corresponded in length to the conservatory, its width being the same as that of the principal one. It had twenty tanks, part for the exhibition of freshwater specimens, and part for tropical specimens requiring a higher temperature. The conservatory communicated on the south side to a part of this corridor, which was arranged for small table aquaria requiring minute inspection. The vaulting, lighting, glazing, and roofing of this corridor were similar to those of the first, and at the end were the engine rooms for pumps, machinery and boilers, and also naturalists' rooms.

THE ROYAL AQUARIUM IN WESTMINSTER

Since the Royal Aquarium was mentioned a number of times in the dispute between Kent and Lloyd that ultimately wound up in print, a few words will be said about that institution here. The Royal Aquarium and Winter Garden was a place of amusement in Westminster, London, opened in January of 1876. The board of directors included Henry Labouchère, the financier and journalist; William Whiteley the retailer; and Arthur Sullivan, the composer. It was intended to offer art exhibitions, concerts and plays, among other intellectual entertainments, like The Crystal Palace.

The main hall was 340 feet long by 160 feet wide. It was covered with a roof of glass and iron and decorated with palm trees, fountains, pieces of original sculpture, thirteen large tanks meant to be filled with curious sea creatures and an orchestra capable of accommodating 400 performers. Around the main hall were rooms for eating, smoking, reading and playing chess, as well as an art gallery, a skating rink and a theatre. The following is description of the aquarium proper:

The main avenue is 80ft. wide, being 8ft wider than that of the Crystal Palace. For the supply of salt water nine long tanks are constructed under the promenade floor, and occupy a rectangular area of about 260ft. long by 53ft. They are placed lengthwise, 3 in length and 3 in width. In section they are semi-cylindrical vaults, shown in our small section, with segmental inverts resting on a bed of concrete, and are faced with concrete. The arches are in three rings. These reservoirs or tanks are capable of holding over 800,000 gals. of water, one-fourth of which will be fresh and the remainder salt. The asphalting of the arches was a difficult operation.

The iron pipes and valves through which the water circulates are also coated with vulcanite, to prevent the action of the iron on the salt water. Wells, 15ft. deep and 8ft. square, at the west end communicate with the reservoirs, one with the fresh and the other with the salt water. The water will be pumped up from the reservoirs through these wells by two engines of 20-horse power (nominal) into the various tanks. The same water will serve for many years, as it undergoes a process of oxygenising, the "continuous circulating" system of Mr. W. A. Lloyd being adopted. The water will have to circulate 3-1/2 miles, and will thus be maintained in a state of clearness and healthfulness. The larger show tanks on each side of avenue have sills of polished granite, and are lighted by large semicircular lights from the outside and also from the top. The fronts are

of plate glass, having cast-iron mullions with slate fillets behind the rebates as security against leakage. There will be 9 fresh-water and 22 sea-water slate show tanks, and some reserved as a hospital for sick animals.

The all-day variety entertainments at the Aquarium turned less respectable, including billiards matches, novelty acts and side-shows of all kinds, and commercial stalls offering perfumery and gloves. The comedian Arthur Roberts (1853-1933) sang the following song about the Aquarium:

I strolled one day to Westminster,
The Royal Aquarium to see;
But I had to stand a bottle
just to lubricate the throttle
Of a lady who was forty-three.

The Royal Aquarium had its own tame royal in the shape of the Duke of Edinburgh to cut the ribbon and in addition, the organizers had roped in some other big names, with Sir Arthur Sullivan in charge of the music. What could possibly go wrong? Well, the Aquarium opened with magniloquent addresses from and to the Duke, but was found to be a hollow sham. It was then discovered that the building was still in a very unfinished state, that the tanks for the much-boasted aquarium contained neither water nor fishes, and that the general emptiness of the place was weakly disguised with colored calico and shrubs. The following is from the February1, 1876 issue of *The Musical Times*:

An Aquarium without fish can scarcely be said to offer a legitimate attraction to the public, and it is not surprising, therefore, that on Saturday, the 22nd ult., when the "Royal Aquarium, Summer and Winter Garden" opened its doors for the first time, the programme of entertainment provided for the visitors should include such items as Arrival of Lord Mayor and Lady Mayoress," "Arrival of H.R.H. The Duke of Edinburgh and Suite," and that military bands should relieve the monotony of staring at the gorgeously fitted up royal box, which was, however, placed in such a position that the occupants of the reserved seats in the gallery could only guess what was going on during the reading of the address and the reply thereto. But our business is only with the music; and here it must be said that, whatever deficiency may have been observed in other departments, no fault could be found with the band which Mr. Arthur Sullivan has formed, nor with the programme exclusively selected from the works of English composers, which had been drawn up for the opening concert.

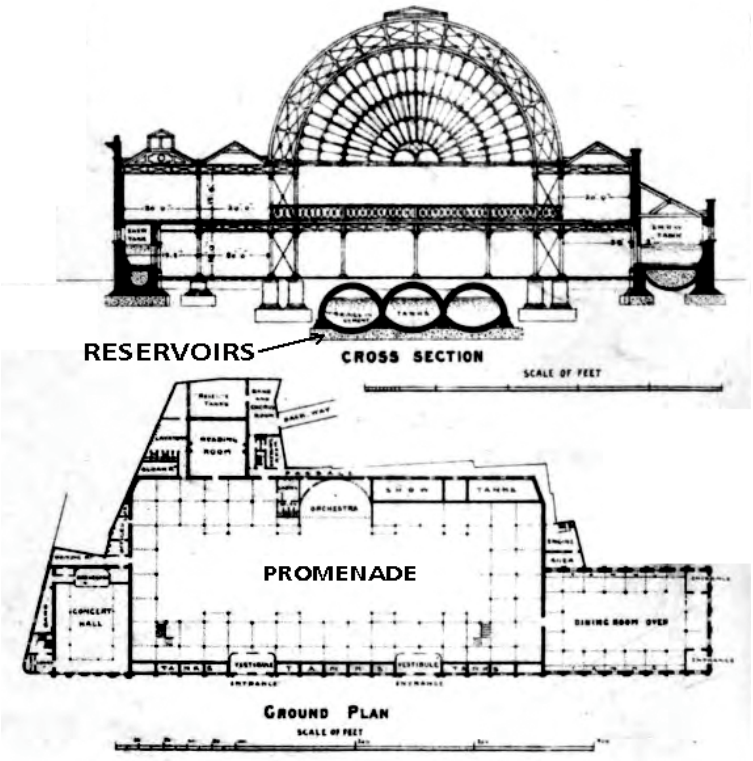
As it turns out, The Royal Aquarium had nothing to do with fish and not much to do with royalty, either. On the basis of his managing the Aquarium at Brighton, Kent was hired as the Aquarium's manager and, on the basis of his managing the Crystal Aquarium, Lloyd was a paid advisor

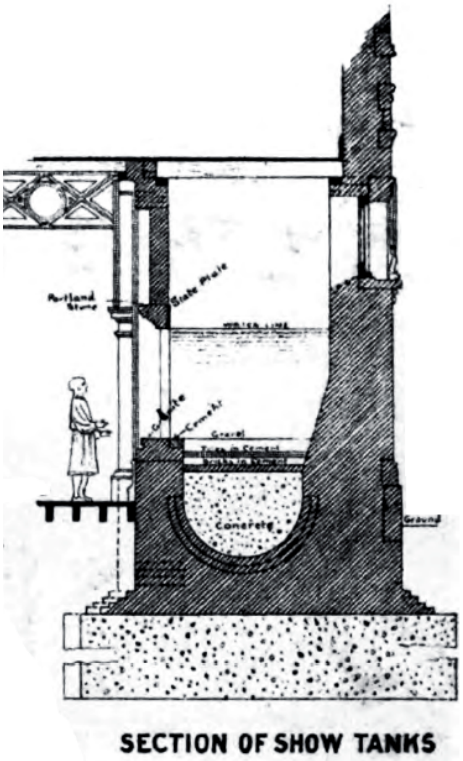
Entertainments at the Royal Aquarium.

with the aim of designing the Aquarium. It was his circulating system that was chosen but the huge hall at Westminster unfortunately allowed direct sunlight to fall upon the aquariums. If the aquariums were to maintain a constant temperature between the summer heat and the winter cold, Lloyd calculated that large reservoirs were essential and so he supervised the installation of three of them under the visitor's promenade.

However, because of the time it took to fill the reservoirs and then start the three and a half mile trip the water would take to fill the show tanks, plus the difficulty in making the large reservoirs waterproof, the stocking of fishes was delayed. Kent suggested that a temporary small cistern be built for the reception of the water flowing over the show tanks and the feeding of the pumps. This idea was rejected because of its impracticality and the unscientific character of the idea. The disagreement between them soon became public when Lloyd voluntarily resigned soon after the aquarium opened on January 22, 1876, leaving Kent to do the job he was hired for, i.e., running the Aquarium. As Charles Dickens junior put it in his *Dickens' Dictionary of London* in 1879:

Unfortunately the desire of the directors to obtain an immediate return for the large sums invested in the undertaking unduly precipitated the beginning of the campaign. Not only were the plans of the managers in an inchoate state, but the tanks without fish became a standing joke, and the dissension which arose among the discontented proprietors further tended to create distrust of the enterprise in the public mind. After some time, the tanks were filled and energetic management provided attractive entertainments of a superior music hall type.





The design of the Royal Aquarium. The three large reservoirs under the promenade are indicated by the arrow. The room on the left, bottom is concert hall; the one on the right is a dining room. The rooms at the top left include lavatories and a reading room. The rounded area seats an orchestra and to the right are two large marine tanks. There are thirteen small freshwater tanks at the bottom.

***Mrs. Jones*. "And pray, Mr. Jones, What is the matter now!"**
***Jones*. "I was only wondering, my dear, where you might have bought this fish."**
***Mrs*. Jones. "At the fishmonger's. Where do you suppose I bought it?"**
***Jones*. "Well, I thought that, perhaps, there might have been a remnant sale at the Royal Aquarium!"**

In March of 1877, the following notice appeared in a number of newspapers and journals:

Mr. John T. Carrington has been appointed "Resident Naturalist" to the Royal Aquarium Society, Westminster, in place of Mr. W. Saville Kent. Mr. Carrington has for the last year been studying aquarium management with Mr. W. Alford Lloyd, at the Crystal Palace Aquarium. Mr. C. P. Ogilvie, formerly a pupil of Dr. J. E. Taylor, F.L.S., and who studied aquarium management under Mr. W. S. Kent, at Westminster, has been appointed Curator to the Great Yarmouth Aquarium.

THE KENT ATTACK

The main portion of Kent's attack on Lloyd's system was on the grounds of its great expense and also that so extensive a store of salt water was not required. At the time of the dispute (1876), both Lloyd and Saville-Kent were in the employ of Yarmouth aquarium, Lloyd as paid advisor and Saville-Kent as manager; as I have mentioned, both briefly had worked together in the same capacities in 1875 at the Royal Aquarium. The following are excerpts from a paper by Kent that was that was read before *The Society of Arts* on March 3, 1876:

In addition to being the then largest undertaking of its kind in this country, though since greatly eclipsed in size, the Crystal Palace Aquarium prominent for the large space devoted to the stowage of reserve water, kept apart in the dark and uninhabited by the animals, and so corresponding with the spare cisterns, already mentioned in association with the aquarium at the Regent's-park. These spare cisterns, or reservoirs as they are now more generally termed, were constructed to contain no less than five times more water than did the show-tanks inhabited by the fish, the whole mass being circulated over and over again by powerful steam pumps. The entire series of tanks, both for exhibition purposes and for the storage of duplicate specimens in reserve, at the Crystal Palace Aquarium, contains 20,000 gallons of sea water; the longest single tank of these, about 18 feet in length, holding 6,000. Compared with these the reservoirs are constructed to contain no less than 100,000 gallons, making a total, with the tanks, of 120,000.

Large as those proportions seemed in comparison with its predecessors in this country, they were and are of a very puny size contrasted with the magnificent aquarium at Brighton, completed in the succeeding year, that of 1872. In this fine building the tanks alone were constructed to hold over 300,000 gallons of water, while the largest single one, more than 100 feet in length, could accommodate the whole contents of both tanks and reservoirs at Sydenham, allowing space, indeed, for the evolutions of porpoises, full-grown sturgeons, and other monsters of the deep never previously displayed to the public under similar advantages.

As already remarked, the Brighton Aquarium is conspicuous as representing that system of maintenance characterised by the injection into the tanks of air in its simple form, and which system was distinguished as the aerating one. With the exception of the fine aquarium now building at Scarborough, which will be associated with the same system, being indeed planned by the same architect, all the other aquaria here enumerated are already, or will be, maintained on the circulating system first typified at the Regent's-park, and recently in its more perfected stage at the Crystal Palace. In certain important details, however, several of these aquaria depart widely from the Crystal Palace type. Foremost in this respect must be mentioned the vast bulk of water stored in reservoirs in comparison with that held by the tanks containing animals which obtains at that institution, and which is asserted by the superintendent, Mr. Lloyd, to be absolutely essential to maintain the fish in health and the water clear.

Until experiments were instituted and contrary results arrived at, this dictum was implicitly accepted by the recent advocates of the circulating system, and in all aquaria undertaken with the assistance of Mr. Lloyd, reservoirs of these greatly preponderating proportions were insisted on as the *sine qua non* of success. The greatest length to which this fancy for reservoirs of such excessive size has been, and probably is likely to be, carried, is exemplified at Westminster—where, with water in the show tanks to the amount of under 150,000 gallons, or less than the contents of the two largest tanks in the Brighton Aquarium, accommodation has been made for storing no less than 600,000 in enormous reservoirs, which, to use the designer's own words, resemble "three railway tunnels placed side by side" occupying the whole space underneath the grand promenade. How many thousands of pounds have been spent, and must yet he spent, upon these reservoirs before they fulfil the purpose for which they were devised—that of holding water —it is impossible at present to estimate, though the filling of them with seawater alone, at the same rate paid at Sydenham, i.e., one penny per gallon, would amount to no less than £2,500.

To illustrate that this provision for reserve water, at both the Westminster and Crystal Palace aquaria, is altogether excessive and unreasonable, it may be stated that the Manchester Aquarium, adjacent to a densely-populated manufacturing centre, and with tank accommodation closely approximating that provided for at Westminster, has been, and is still, most successfully maintained with reservoirs constructed to hold a supply of water only equal to that contained in the show-tanks. Practically, however, it has been kept in the highest state of efficiency, that is, with the water clear, and an abundant supply of fish of the largest size, with less than one-half of this full complement in the reservoir.

The superintendent of the Crystal Palace Aquarium has thought fit to question the truth of this assertion in print, but if more substantial proof is needed, it may be remarked that the promoters of both the Yarmouth and Westminster Aquaria, who visited the Manchester undertaking while under my charge, were so satisfied with the results there obtained, that in the latter case it was recognised that a most needless expenditure

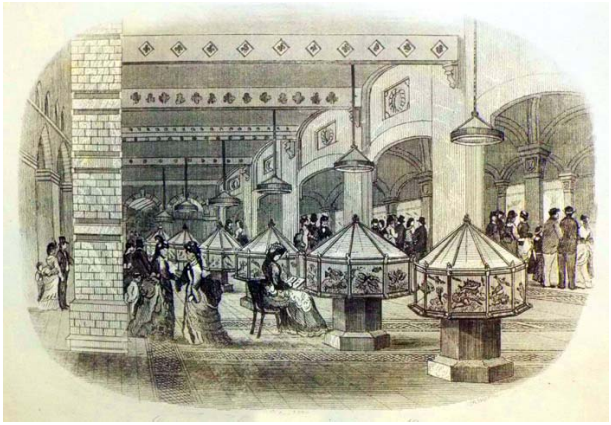


Table-top aquariums at the Brighton Aquarium.

upon the reservoirs had been made; while in the case of Yarmouth, then uncommenced, and with the construction of which I am now associated, it was at once decided to alter the previous plans, embodying huge reservoirs of enormous coat, and to substitute in their place others corresponding only in capacity with the tanks above, as at Manchester. In fact, the show-tanks of the Yarmouth Aquarium being designed to hold an aggregate of 200,000 gallons of water, it would be necessary, in order to maintain the same ratio in the reservoirs as obtains at Westminster and the Crystal Palace, to construct reservoirs large enough to hold no less a quantity than 1,000,000 gallons.

It is, in fact, this great primary expense of reservoir construction, usually incited, on as on altogether indispensable necessity, that has in many instances proved an insuperable bar to the carrying out of large public aquaria that have been proposed, and has certainly seriously hindered the more general establishment of these institutions throughout the country. As an argument in defense of reservoirs corresponding in proportional size with those of Sydenham and Westminster, it has been urged that the greater proportional amount of water in the reservoirs must necessarily carry with it greater clearness of water in the show-tanks. Surely, however, there is a limit to even the transparency of water, and when that is gained, such an argument becomes surely a *reductio ad absurdum*, involving a lamentable waste of time and money, when reservoirs and bulk of water in reserve ore insisted on over and above what is proved to be all-sufficient for the purposes they are required to fulfil.

It has been already intimated that at Manchester the reservoirs correspond with the tanks in their cubical contents, and that the same proportions will be maintained at Yarmouth. It is not inferred by this, however, that the limit in the reduction of their size has been marked by the equalising of their respective bulks. Experience at Manchester has, on the contrary, illustrated that successful results may be obtained with a considerably less amount of water in the reservoirs; and, although it might be a bold experiment to attempt for the first time in some new aquarium, it is an open question whether, by a trifling increase of the pumping power, and acceleration of the circulating stream, reservoirs might not be done away with altogether, substituting in their place a mere well or cistern, for the reception of the water flowing over from the tanks and feeding of the pumps. This suggestion has been already made by me to the authorities temporary arrangement for the working of their aquarium, pending the removal of the chief obstacle which has delayed the stocking of the various tanks with fish—that obstacle being the unmanageable size of the reservoirs, involving a "three miles" circuit before the water returns to its starting point, and the difficulties associated with rendering such enormous reservoirs watertight. If here or anywhere else it could be shown that large aquaria can be efficiently maintained without the aid of reservoirs, the saving of one-half of their present cost as aquaria *per se* will he accomplished.

Lloyd claimed the following in favor of his system: (1) Because they need light to survive, Confervae and other minute plants that make the water cloudy in an aquarium are killed off in his large, dark reservoirs; (2) The reservoirs afforded a means of controlling the temperature, both dur-

The interior of the Brighton Aquarium.

ing the summer heat and the winter cold. The following were Kent's views on these subjects:

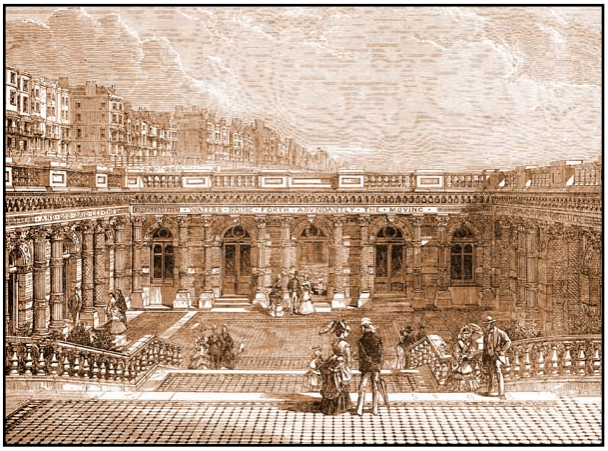
It has been further represented by Mr. Lloyd that large dark reservoirs are indispensable to prevent the appearance of the multitude of vegetable-spores, which occasionally multiply in aquaria to such an extent as to render the water turbid. This, however, may always be prevented by judiciously screening the tanks from undue access of the sun, and the Brighton Aquarium affords a practical illustration of water constantly exposed to the light, but where, through such judicious screening, these spores are not harmfully developed. It has also been asserted by the same writer that reservoirs of preponderating size are necessary to equalise the temperature of the water, which, he argues, would otherwise become too hot in summer and too cold in winter for the well-being of the animals; but the Brighton and Manchester Aquaria are again cases in point, to prove the fallacy of this argument, which, however, might be of some value if associated with an aquarium at Calcutta, or other tropical station. Under any other circumstances, the construction of these comparatively enormous reservoirs is an undoubted misapplication of capital.

Light being a problem in any aquarium, Kent suggested the following solution:

A circumstance frequently drawn attention to in relation to the growth of seaweeds in aquaria is the tendency of the finer silkweeds, or confervoid *algae*, to spread themselves over the larger kinds, until, like the insidious mycelium of some parasitic fungus, they completely choke off and destroy the higher form. Such mishaps do not occur under the ordinary conditions of their growth, and, on inquiry into the matter, an explanation is readily afforded. These low conferva, in fact, do not naturally grow in association with the more highly organised varieties we want to cultivate, but rather in those localities where the tide is sluggish, and more especially in pools, where they are undisturbed by the waves, except at only the highest tides. It would seem, indeed, that where a strong current prevails, such as the higher seaweeds luxuriate in, the conferva are unable to obtain a foothold. This explanation still further recommends the adoption of a more rapid rate of circulation in our tanks. At the Yarmouth aquarium, as soon as it is opened this coming summer, this question of seaweed culture will be especially attended to.

Lloyd's answer appeared in *The Society of Arts* on March 3, 1876 and the following are extracts from that article:

Mr. Kent's chief point seems to be his objection to the plan of aquarium construction which I have successfully pursued for many years, and which consists in using unchanged sea and fresh water, kept in constant circulation, between a series of show tanks containing animals and plants exposed to light, and an underground dark cool reservoir, containing several times as much water as the collective capacity of the show tanks, Mr. Kent maintaining that large dimensions in the reservoir are unnecessary, for reasons which he does not set forth. I therefore have now to describe why I believe and know they are requisite.



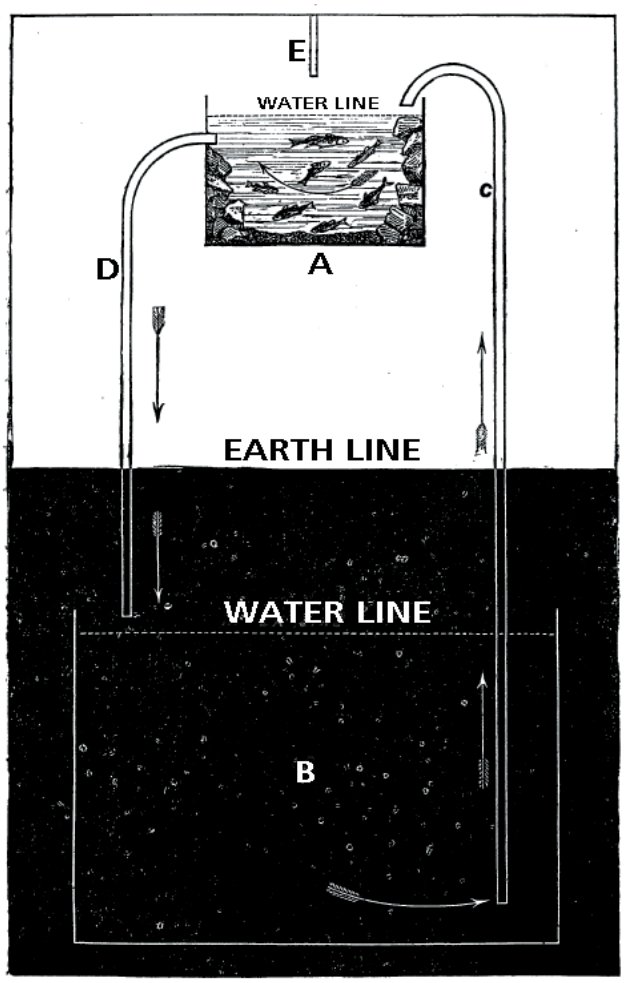
The entrance court of the Brighton Aquarium.

At or near the surface of the seas of our islands, where aquarium animals came from, the range, however, is very much less, the water being neither so hot nor so cold as the air, especially of the air in inland places, the temperature of our sea water being from 45° F. to 65° F., and having an average of about 60° F. This tolerably uniform temperature of the sea water tends to give a similar uniformity to the air immediately in contact with it, which accounts for the mildness of the climate at seaside places in winter.

The main principles involved in the water circulating system in all public aquaria constructed under my supervision, turn on the law governing the following facts: If a quart of water at 100° F. be added to a quart at 60° F., the mixture of the two will be 75° F. If one at l00°F. be added to two at 50°F., the result will be 66.6°F. If one at 100° F. be added to three at 50° F., the mean will be 62.5°F. If one at 100°F. be added to five at 50°F., the result will be 58.3°F.; and if the proportions be one to twenty, the mixture will be 52.3°F., and so on; the larger the proportion of the colder mass being to the warmer, the nearer the mean of the two masses will approach to the temperature of the larger mass. The entire thing is shown in the accompanying diagram, where B is a large underground, cool, dark, reservoir, C is a pipe conveying water from B to the show tank A, containing fishes, or other animals, and D is a pipe conveying water from A to B. The six arrows indicate the direction in which the water flows. E is a pipe to re-supply the water which evaporates. As this is an ideal representation, showing only results, all the machinery (as engines and pumps) giving these results, by moving the water, are omitted.

Now let it be supposed that—which really would be the case in an English summer, without any circulation going on between A and B—the tank B would have its water at about 60° F., and A would have its water at about 75° F. On the circulation being established, and continued for some time, the water in A would become cooler, and that in B warmer, than before, and the mean temperatures of the two, varying according to the proportionate quantity of water in B., would be according to the seven following formulas:

No. 1. A2, B1; result, 70°F.
No. 2. A1, B1; result, 67.5° F.
No. 3. A1; B2; result, 65° F.
No. 4. A1; B3; result, 63.7° F.
No. 5. A1; B4; result, 63° F.
No. 6. A1; B5; result, 62.5° F.
No. 7. A1; B20; result, 60.7° F.



Lloyd's geothermal system for maintaining show tank temperatures in both winter and summer.

So that by increasing the quantity of water in B, that in a is made to approach very near to the temperature of B, whether the surrounding atmosphere tends to increase or decrease the temperature of A. The water rises through C at an even temperature, exactly as it would if rising from a natural well, or spring, whether the spring be cold or hot, as in nature, and we can so increase the speed of the flow through C that the fluid is not allowed time to become unduly warm or cold in A We know, by many years of observation in the Observatory at Greenwich, that at a depth of six feet below the ground there, the mean daily range of the thermometer is less than one degree, while at the surface it is often twenty degrees. These facts, and the results to be deduced from them, are alike incontrovertible.

We also know, from Bunsen's tables, how much atmospheric air in solution water will retain when not under pressure at varying temperatures, and it is also known that it is upon the presence of such air in solution that the value of the water for aquarium animals proper mainly depends. It is true that, as Mr. Kent states, the quantity of air injected into a under the conditions No. 1, may be increased by accelerating the flow, but that does not diminish or increase the temperature, and *that* is the primary thing. It is also true that some local circumstances may affect these results, such as a very equable and mild climate, or an aquarium building of extreme temperatures either way, or the use of tanks which are very shallow or very high, which increase or diminish the surface absorption of air, but, as giving general and broad results, the figures just quoted may be depended upon, and they were true in their results at the Manchester Aquarium, Mr. Kent cites as a contradiction to my theory.

In all aquaria, the work to be done is the oxygenation of certain organic matters, so that the animals may be healthy and the water clear, and if sufficient means he not used to do this work, the water must he more or less turbid, or the amount of organic matter must he proportionately lessened. Now, at Manchester this was the case, for the water, when I saw it, was not sparklingly bright, nor was the amount of organic matter to be oxygenated, i.e., the animals and their food, adequately large in comparison to the size of the place. Once I remember, on a very hot day in July, I telegraphed to Manchester that our Crystal Palace temperature was as follows:—

Maximum external air at Sydenham and Greenwich	92° F
Maximum air in shade in Crystal Palace	84° F
Maximum air in shade in Crystal Palace Aquarium	77° F
Maximum in water in Crystal Palace Aquarium, everywhere	61° F

and I asked for similar information about the Manchester, but it refused me.

L'aquarium du Jardin d'Acclimatation de Paris, designed by Lloyd. The building was 130 feet long and 33 feet wide, containing 14 show tanks. He was its Director from 1860 to 1861.

This brings me to explain why I chose the formula No 6—five to one—for the great London aquarium now preparing to be opened at Westminster, where the circumstances are quite different to those at Manchester, and where the aquarium is not, as at Westminster, placed in the very midst of a great city, with a soot-laden atmosphere. Moreover, in this latter aquarium, some of the tanks measure twenty feet wide from back to front being more than in any other aquarium where the water is maintained in so clear a condition as to satisfy my fastidiousness. When this width is so great, the size of reservoirs must be relatively increased, because a very small addition of foreign matter in suspension or solution then increases the apparent turbidity. Moreover, the Westminster building itself is not exactly such a one as should prefer for an aquarium, if I could have controlled it, with reference to all things, but as it has to be used for many other purposes I must make the best use of it that I can for my purpose. It is, in effect, a huge conservatory of glass and iron, supported on brick walls and, in spite of much good ventilation, it will be very hot in summer. Yesterday, for example, was a cold and blowing March day—the 9th—with strong sunshine and at noon the temperatures were thus:—

External air,	
Maximum	55° F.
Minimum	35° F.
Internal air in Westminster	
Aquarium building	61° F.
Water in reservoir of Aquarium	
at bottom	49° F
at top	50.5° F.
Water in Crystal Palace Aquarium	
Everywhere	54° F.

(It will be seen that the Crystal Palace Water is higher than that in the Westminster reservoir, because the show tanks above are exposed to warmth, while at Westminster there are at present no show tanks to raise the temperature of the reservoir.)

This water at Westminster was fresh water, used to test the soundness of the reservoir, and as it had been in for ten. days, it had had time to assume its normal temperature, and it was ton feet deep vertically. No water was in the show tanks, and no circulation was going on. This indicates, clearly, that a valuable equalising effect will be gained by the reservoir, which these figures show, is not at all too large; in fact, I tried to get it made to hold a million gallons instead of only about 600,000 gallons. Really, such a reservoir cannot be too great for the general purposes of an aquarium, the goodness of which a naturalist, if he be true to his cause, will only regard, and for such excellence, and for the animals it contains, he will alone care. He will, if he be genuine and zealous, regard the creatures he has to keep, not as unfortunate prisoners for whom it is policy to do as little as possible for their comfort, but as friends and guests, for whom he cannot do too much.

Therefore, the only limits to the dimensions of aquarium reservoirs are considerations of cost and space. But long experience points out that for all general purposes the proportion of formula No. 6 is an excellent one as a minimum, and to gain this, or better, a much larger proportion, as even ten or twenty to one, as being, in the end, an excellent invest-

The Crystal Palace at Sydenham.

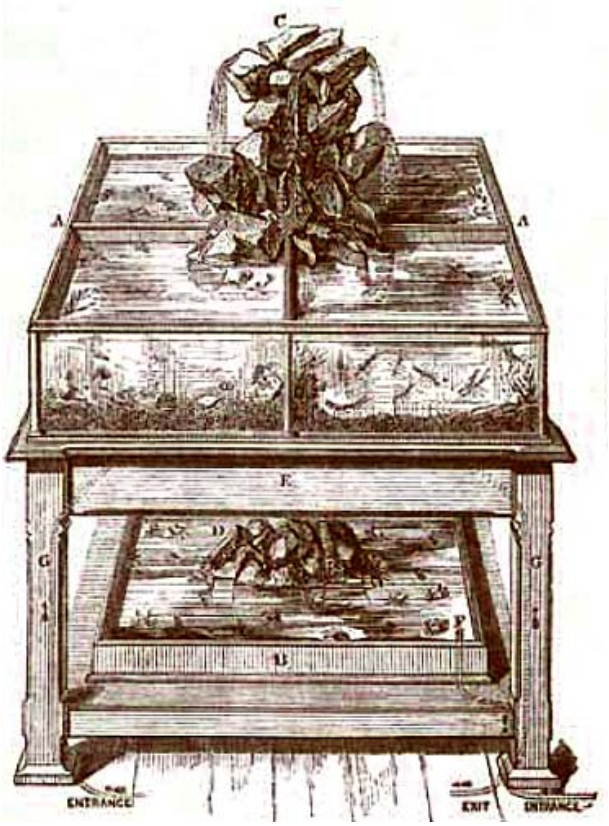
Is this the wildest or is it the best design for an aquarium in history? It was built for the Paris L'exposition universelle de 1867.

ment of capital, a right-minded naturalist will do much, even to the extent of recommending the sacrificing of the features of building which are not constructurally necessary, but merely decorative. The slight enrichment of surfaces of necessarily constructive parts is all which a well-educated man will aim at. He cares only for the decoration of construction, and is content to leave the construction of decoration to the ignorant and vulgar.

Lloyd then passed on to other matters brought up by Kent:

With reference to the curious circumstance of sea and fresh water becoming greenly opaque from an excess of light, Mr. Kent is in error in saying that at the Brighton Aquarium the water is constantly exposed to light, and does not, therefore, become green. The water in that establishment is periodically changed, wholly or in part, and allowed to run into the sea, and therefore the ocean itself is the dark and great reservoir of the Brighton Aquarium. This arrangement would he an excellent one if the water could be drawn from so great a distance from the polluting land that the incoming current of sea water would be pure and constant. But as it is impure and inconstant, the result is biologically most unsatisfactory compared with the large money expenditure on this Aquarium, as Mr. Kent well knows, and as he has stated in print, in *Nature* for October 23, 1873.

All that Mr. Kent has said on the maintenance of the higher marine algae in aquaria has been better said by Mr. Warington a quarter of a century ago. But it is a positive error to state that the silk weeds (confervae), marine and fresh water, do not grow in fast running currents. What affects them is light more than motion, for I have known these plants to be developed and to grow freely, attached to the polished interior surfaces of glass tubes through which water was flowing rapidly, with exposure to light. And it is a most astounding mistake to compare these chlorosperms to the infinitely lower fungoid forms of vegetation, when both grow on other and higher plants.



Lloyd's 'Compound Aquarium'. This shows all the concepts of his marine circulating closed systems sold for private residences, which later formed the basis of the public aquariums he designed.

A fungus does, or may, destroy another plant, or an animal, upon or in which it grows, as e.g., the "smut" in wheat, or the "ergot" of rye, or the "potato disease," or the fungus which appears on some fishes or insects, but a conferva which attaches itself to a red seaweed, or to the shell of a crab or lobster, or to oysters, or to the hard parts of other plants and animals, does not destroy the plant or animal upon which it is parasitic. Thus, Warington has shown that when a conferva has grown upon and obscured some rhodosperm, as *Ghondrus* or *Iridcea*, because of excess of light, yet that when that light is artificially coloured by the interposition of glass of a particular hue, the chlorosperm dies, and leaves the rhodosperm as fresh and beautiful and uninjured as before it was grown over.

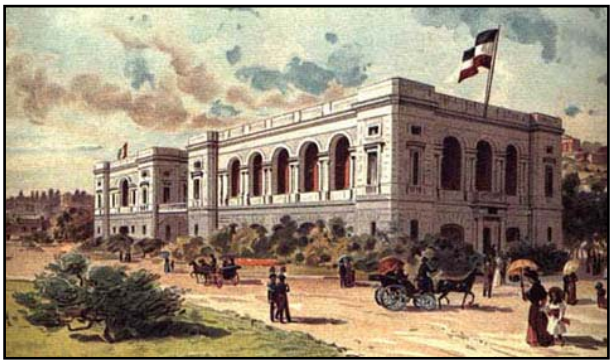
Mr. Henry Law (an engineer whom, from his great knowledge, I should choose by preference to all others to be associated with in aquarium construction), in stating that large underground reservoirs are valuable in preventing a large growth of conferva, stated that which is just possible, but which is not proved. What they do prove is that they prevent the multiplication of what are called "zoospores," which cause turbidity, but Professor Ferdinand Cohn, as an authority on these excessively minute bodies (they being but 1/2000 of an inch in diameter) is not certain if they are ultimate forms of plants or not.

He [Kent] mentions Mr. C. L. Jackson, of the Southport Aquarium. When that establishment was commenced I was consulted, and I gave the best advice I could; but the architect, being no physicist, determined to make one-half of the place on the Crystal Palace system, and one-half on the erroneous Brighton plan. The whole is, however, now being changed into the former system (as I advised at first), under the direction of Mr. Jackson. If I had had him to deal with at the beginning, he being an engineer, some thousands of pounds would have been saved, and I have his fullest written permission to say that he believes in the large reservoir system, and not at all in Mr. Kent's unreasoning crotchet of small reservoirs.

Mr. W. B. Woodward, the proprietor of a large aquarium at San Francisco, has just been to Europe to examine all public aquaria, and he is convinced that the turbidness he is troubled with is due to his having a too small reservoir, and he intends enlarging it. As to saying that a large reservoir is necessary at Calcutta, but not in England, I possess the sea and air temperatures of Calcutta, and find they have the same relations, nearly, as in Britain. The isothermal charts of Professor Dove and others may be consulted in proof of these points. So [it is] with three places in Australia, respecting which I am being consulted for great public aquaria.

Lloyd goes on to correct Kent's many errors in aquarium history as, for example, Kent's statement that Dr. Ball's air-blowing in the first Dublin aquarium was effected by their feet in walking to and fro when in reality it was effected by having visitors working bellows with their hands. If Kent had known anything about engineering he would have realized that constructing such a floor would have been expensive, not to mention almost impossible with the technology of the day.

Finally, Lloyd's following comment addresses Kent's ungentlemanly behavior. It would not be



The Stazione Zoologica at Napoli, 1873, designed and built under Lloyd's supervision.

too far afield to suggest that much of it was due to jealousy:

Mr. Kent, in referring to the Yarmouth Aquarium Society, where he is now engaged, does not state that I, too, am officially employed there, and that I seriously disagree with much which he is there doing, as being contrary to the interests of our mutual employers, and as to having the Yarmouth Aquarium open in this coming summer of 1876, it is quite impossible. He is not only ungenerous in thus omitting my name in reference to the Yarmouth, Paris, Crystal Palace, Naples, Frankfort, Rhyl, Teignmouth, Rothesay, and other Aquaria, but he does not even mention the one at Hamburg, I being more or less intimately connected with all of these.

Lloyd was not hard-nosed in favor of his system when it was not the optimal solution. One of the problems in the water supply system used in Brighton was that the tanks were not connected to each other, thus minimizing any circulation of water. A well-functioning system of permanent water exchange, resulting from an interconnecting pipe system for all the tanks (i.e., an "open circulation system," where the water was directly circulated to refresh the aquariums and then discharged back into the sea, thus negating the need for the large reservoirs required by an inland marine closed circulating system) was the invention of Lloyd; he used it first in Hamburg (1868), and then in London (Crystal Palace, 1871) and Naples (1872). Kent did not comment on any of this. Ironically, while the London aquarium in the end had cost £12,000, building costs for Brighton amounted to £100,000.

Naples, at that time, was still recently the capital of the Kingdom of the Two Sicily's and was a sufficiently important center of tourism and commerce to ensure keen interest and support for such a novelty. Taking advantage of the site of the new Naples aquarium, Lloyd designed a system for pumping water into the cisterns directly from the sea. Although supplied with them, the Aquarium experienced good results without any need of filtering. Such a method of circulation was an immediate success and was imitated in many other aquariums, including the one in Monte Carlo.

The Naples aquarium still uses this open circulation system, in which the water is pumped from two large underground cisterns into the tanks and then flows back down, during which time about one third of the volume of water is renewed. The water is drawn from the Bay of Naples at a point 300 yards offshore and 12 yards deep, and is left to decant in a large tank before going into the ciscterns. The twenty three tanks on display, ranging in capacity from 66 gallons to 18,000 gallons, use volcanic rocks to create a natural setting and are chiefly illuminated by daylight from the skylights in the roof. All the specimens come from the Bay of Naples, which in spite of pollution, is still one of the richest breeding grounds of marine life.

A much larger problem that neither Lloyd nor Kent addressed, was the rapidly diminishing interest of the paying public, confirmed by the falling revenues of most town and city aquariums, something that would be soon affect both of them. A good example is the Margate Aquarium that Kent mentioned as one of those being contemplated. On July 25, 1874 The Margate Aquarium, Limited, announced the following:

The Southport Aquarium, 1874.

Capital, £50,000, in £10 shares. The undertaking is formed to establish an aquarium at Margate, for which purpose a lease has been acquired of the foreshore from the Pier Hotel and Fort Point to the Second Point.

Due to the declining attendance at public aquaria throughout Britain, investors were not interested. Only half the amount was raised, the company went bankrupt in December of 1877 and the Margate Aquarium was not built.

With regard to the technical issues involved in this dispute - and not the personal ones - as technology has moved on they have become moot. Advanced filtration, better aeration, more efficient equipment and improved materials of construction have resulted in public aquaria today that resemble neither the Lloyd or the Kent systems. *Fugit inreparabile tempus*.

THE BIRMINGHAM (ASTON) AQUARIUM

In 1874 the Birmingham Natural History and Microscopical Society appointed a committee to obtain information with the view towards promoting a marine aquarium in Birmingham, the subject having been introduced by its President, Mr. William Richard Hughes - a friend of both Gosse and Lloyd - in an address at the annual soiree of the Society. This Committee, after procuring information from various aquariums in England and on the continent, sent a deputation to visit and examine the Crystal Palace Aquarium and the Brighton Aquarium for the purpose of obtaining practical information about the requirements needed to be provided for, and especially to enquire into the two different systems of circulation and aeration of the water that were used and the results of their implementation. As has been examined here in detail, the Crystal Palace Aquarium used the system advocated by William Alford Lloyd and the Brighton Aquarium used the one advocated by William Kent.

The result of the examination and enquiry of the Committee was a recommendation for the Crystal Palace system, in consequence of their finding the Brighton Aquarium not so successful with regard to the health and condition of the animals and the clearness of the water in the tanks. The Crystal Palace Aquarium was found by the Committee to be eminently successful in these respects, the most delicate animals being maintained in perfect health and almost free from those parasitic growths to which they were so subject in confinement, whilst the water in the tanks was beautifully transparent and brilliant.

The action of the Committee resulted in a proposal to construct an Aquarium in the basement story of the Midland Institute Building, facing the Town Hall, and plans were prepared by W.P. Marshall for this purpose under the advice of Mr. Lloyd, who was called in to examine and report upon the proposal. That proposal, however, had ultimately to be given up, in consequence of it being found impracticable to adapt the existing building satisfactorily for the desired object. The idea had been to establish a public aquarium pure and simple, with appliances for scientific study and instruction, in close connection with the Public Library and Art Gallery, and supported only by a small admission charge. The original cost of construction was intended to be materially reduced by the circumstance of adapting a portion of an existing building and thus avoiding the cost of erecting a new building.

The idea of the Birmingham Aquarium was ultimately revived in a definite form by Mr. Arthur

The Yarmouth Aquarium, 1877.

Ryland (1807-1877), founder of the Birmingham and Midland Institute), and he succeeded in enlisting the support and cooperation of a number of influential gentlemen to a proposal that led to the formation in 1877 of a Limited Company for the construction of the Birmingham Aquarium. It was felt that an aquarium alone could not be made to succeed financially, and it would require to be combined with some other attraction, such as first -class music, and must consequently involve the erection of a large building in some central situation. The great difficulty experienced was the obtaining a suitable site in a sufficiently central situation, but this was overcome in a highly satisfactory manner by obtaining the site of the old Hen and Chickens Hotel, in New Street, a classic ground of the old coaching days. This site was a remarkably favorable situation for the ready access of the public in the principal thoroughfare of the town, and in close proximity to the two railway stations. The hotel would be converted into a first-class restaurant, the largest in the town, and in the rear would be built the Aquarium, with a spacious and convenient Concert Room above it, affording facilities for concerts that had been long felt to be much needed in the town.

The Aquarium would consist of a large, handsome Hall, upwards of 100 feet in length, with a series of tanks extending along each side and forming the sides of the Hall, amounting in total extent to about as much as those of the Crystal Palace Aquarium. There would also be an extensive series of table tanks and in the rear there would be a large and commodious space for the food and store tanks, the machinery, and the general working purposes of the Aquarium. The public approach would be through a large Entrance Hall from New Street, from which a handsome flight of steps would lead down to the Aquarium, which would be constructed of red terra-cotta, with the ceiling supported by arches resting on ornamental pillars.

The large Assembly Room, on a level with the New Street entrance and over the Aquarium, would be 165 feet long and would consist of three divisions, the first portion being appropriated to the table tanks, the central transept for a similar purpose, and at the end would be the large Concert or Lecture Room. This would be surrounded by galleries, and capable of holding 1,000 persons. The block of the present building facing New Street would be retained, and converted into a large Restaurant on the first floor, 70 feet long; and the kitchens would be at the top of the building. Large shops and sets of retiring rooms would be arranged on each side of the New Street entrance, and means of exit in the rear into Worcester Street would be provided for the Aquarium and Concert Room.

One might wonder why these public aquariums were such a small part of something called "The Aquarium." The following extract is taken from a paper, "Notes on the Construction of Aquaria," read before the London Architectural Association in 1879 by John Norton (1823-1904), a famous architect of the time:

As no aquarium in its present highly developed form is supposed to contain sufficient interest to secure permanent success, it is now considered necessary to supplement its attractions by subsidiary features; and hence

The Laboratory of the Marine Biological Association at Plymouth, 1888. Kent had been trying to establish an aquarium for scientific purposes for years but was unsuccessful. The Plymouth Aquarium was built shortly after he left for Australia.

the necessity to provide music and concert halls, winter gardens, skating-rink, club-rooms, restaurants, baths, and pleasure-grounds.

CONCLUSION

I'll finish with the following extract from Lloyd's reply to Kent:

Rightly considered, an aquarium is a beautiful philosophical contrivance for illustrating the manner in which the various forces of nature harmoniously balance each other. Thus, cold balances heat, and produces a certain mean temperature, while darkness balances light, and represses an excess of vegetation which is so constantly being urged into existence by that light, in order to decompose the poisonous carbonic acid gas which animals evolve. Then, motion, gained from whatever source, balances the quiescence which water is ever desirous of attaining, and without such motion vegetation would be useless, just the same that motion would be useless without the vegetation. And, if these things are rightly understood, and applied skillfully by thoughtful mechanical adjustments, there can be attained a tolerably accurate control over the growth and decay of organic matters, both vegetable and animal, to suit named and definite circumstances.

It is impossible for mere human beings to refine too much on the means by which these ends are endeavoured to be secured, seeing that nature herself is most infinitely painstaking in the construction of the objects which are wished to be maintained in life and health in aquaria. The only limits to such refinements are such great money costs as may be plainly and evidently prohibitory. Thus, by endeavouring to follow Nature in a humble and inquiring spirit, we succeed in our trials to a certain extent, and we are thankful, but are always trying to do more and more; and, to attain the highest excellence, we do not adopt the motto of "rest, and be thankful." To a real and earnest seeker after knowledge there can be no rest, and no contentment to do anything but his very best.

The Tynemouth Aquarium, 1878.

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ADDENDUM I:
THE FIRST USE OF ARTIFICIAL SEAWATER IN A PUBLIC AQUARIUM IN ENGLAND

Since the Aston Aquarium site was far from the coast where seawater is easily obtained and transportation of the water from the coast would be expensive, Lloyd decided that the use of artificial seawater was justified. Thus was the first use of artificial seawater in a public aquarium in England. The following is an extract from an article by Lloyd titled, "The Birmingham Aquarium" (Lloyd, 1878):

A large aquarium is being built in a flourishing pleasure garden—Aston Lower Grounds, Birmingham. The range of larger tanks measure in their aggregate over three hundred feet long, seven feet broad, and from four to five feet high internally, and there are ranges of smaller tanks for lesser marine species of animals, and for salmon and trout breeding, &c. In addition there is a series of reserve tanks to contain living food till wanted, and to accommodate sickly creatures, &c.

Being in the centre of England, it is the place where sea water, brought from any coast, will be dearest, and consequently it is intended to compound the water artificially, and thus save many hundreds of pounds—remembering that in every 1030 lb weight of sea water only the odd 30 lb weight consist of sea salts and other solid constituents, all of which are soluble in water, and can be

The Ashton Aquarium, Birmingham, 1879.

added to it in such manner that alter a while it cannot be told from real sea water; and, moreover, it improves by keeping and using, and such of the subtle elements which are found in the actual ocean are conveyed to the compounded water by the small but inevitable quantities of real sea water brought with each consignment of animals.

All sea water has been compounded gradually, and artificially, so to speak, since the beginning of time, by the rains falling on to the land, and washing down into rivers, and thence into seas, the salts of the land, and especially of the salts of its rocks, which are gradually disintegrated. But it is quite easy and practicable to mix together, in a short time, and in inland receptacles, that which has taken an enormous lapse of. time (uncountable ages) to mix together and gather from all parts of the universe, yet without paying large sums for the conveyance from a long distance of the mere fresh water which forms so large a part of the bulk of the whole, and which can be found sufficiently pure, or made nearly so, everywhere.

Consequently, reservoirs of large dimensions relatively to the exhibition tanks in this Aston aquarium are being prepared for the getting ready of this water, and from these receptacles it will be afterwards continuously pumped into the tanks, overflowing which, it will return to the reservoirs, and so maintain an incessant circulation, without any change being ever needed, and without any manual cleaning or filtering of any kind, all decaying organic matters being decomposed by the action of the oxygen in the atmospheric air, which, with water, and as a consequence of the circulation which is ever presenting new air-absorbing surfaces, will be thrown in or injected ceaselessly, day and night.

I have to add that the large public aquaria at Berlin and Hanover have been successfully conducted for the last eleven or twelve years with "factitious sea water," made at my suggestion—if "factitious" is a right term for a compound which, as far as ultimates are concerned, is a precise representation or what is done by Nature. I used successfully such artificial sea water so long ago as the summer of 1865.

The details of the artificial seawater itself were supplied in an article titled, "The Artificial Sea-Water at the Aston Aquarium" (Southall, 1879):

To Philip Henry Gosse, the eminently well-known Naturalist, who, with his pen and pencil, has made so many of us familiar with the wondrous beauty of the inhabitants of the sea, belongs the credit of the introduction of the Marine Aquarium. In the second edition of his excellent book, "The Aquarium," published in 1856, he gave the world the benefit of his thoughts and experiments, by publishing a formula for producing easily and cheaply a supply of artificial sea-water such as had been found sufficient for the purposes of small aquaria.

Many other formulas have since been suggested, and nearly all, like that of Gosse, have been based on the analysis of Brighton sea-water, published by Dr. Schweitzer in the "Philosophical Magazine" for July, 1839. However much such made-up water has answered the purposes required, theoretically it has been at fault, inasmuch as in chemical composition it has not been identical with real sea-water, and on this account, perhaps,

The Margate Aquarium, 1877.

many Naturalists have been unable to keep certain animals alive in such water, and have affirmed that made-up sea-water is so lacking in certain elements or properties as to be unfit for the maintenance of marine animals in a state of health.

Opinions being thus divided, the boldness of the directors of the Aston Lower Grounds Company, in deciding to use none other than artificial sea-water in their magnificent Aquarium, is to be admired; and Naturalists all over the country are looking with interest upon the scheme new carried out for the first time in England on a really great scale. The following tabular statement of the composition of the concocted sea-water may, therefore, be deemed interesting. In the first place, it may be stated that the fine series of tanks and the underground reservoirs are capable of holding, in the aggregate, 300,000 gallons, and sufficient water has been made to fill the whole of the show and reserved tanks, and to nearly fill the reservoirs, enough space only being left to accommodate the contents of a few tanks in case leakages should occur.

My firm (Southall Bros. and Barclay) was appointed to manufacture the water, and about fifty tons of chemical substances have been used. Each ingredient was subjected to analysis, and allowance made in every case for water of crystallization, hygroscopic moisture and impurities, and the various constituents of the well-water used were also allowed for in calculating the working formula. The analysis of Dr. Schweitzer was taken as a basis, supplemented by our own analysis of water recently taken near Brighton, a mile from the shore; and from the latter the data necessary for the required amounts of iodine, &c., were obtained. As a result, the water in use in the Aquarium contains the following compounds in solution, and in the proportions given, from which it will be seen to completely represent chemically real sea-water (amounts are in grains per gallon):

Sodium chloride 1894.1
Potassium chloride 53.6
Magnesium chloride 256.6
Magnesium bromide2.0
Magnesium sulphate 160.7
Calcium sulphate 98.4
Calcium carbonate 5.8
Magnesium carbonate 1.5
Magnesium citrate 0.3
Sodium nitrate 0.2
Oxide of Iron 0.1
Silica 1.0
Iodide of Sodium - traces
Ammoniacal salts
and organics matter - slight traces

For the thorough admixture of the water in the various tanks, and the preparation and filtration of solutions, a considerable length of time was required; and it is only at the present date that the water is assuming what may be termed its permanent and representative character. Time will prove how far the sanguine anticipations of its promoters will be realised; so far it is certain that all animals hitherto placed in the tanks, under fair conditions, have done exceedingly well.

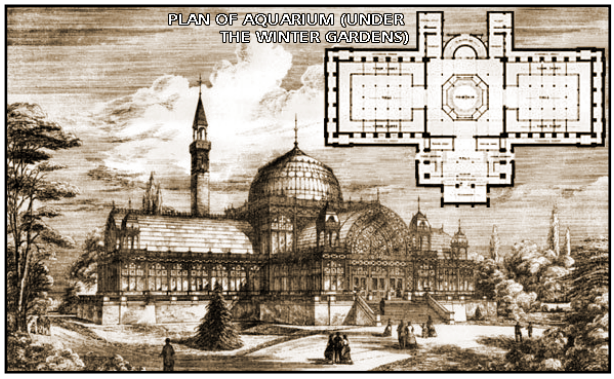
When Gosse published his formula for artificial seawater in 1854 (Gosse, 1854), it only had four constituents (not counting water) and some took exception to his removing three from Schweitzer's formula . Lloyd, however, was very sup-

Dr. Cocker's Menagerie in Blackpool (1875).

portive. The following is from a letter Lloyd sent to Gosse in 1854:

P.S. Some letters which have been lately published by Mr. W. A. Lloyd in the 'Athenaeum' confirm my experience. Perhaps I may be excused for citing a few words contained in a private letter from the same gentleman to myself:— "In reference to what has recently been published on an improvement (or a supposed improvement) on your receipt for the manufacture of sea water, a friend of mine took me by the button and said, 'My dear Sir, Mr. Gosse is altogether wrong; he has not salt enough; he has no—.' To which I replied, pointing to two fine *Actinia dianthus* in full blow in one of my vessels,— 'But if Mr. Gosse is altogether wrong, why do these *Actiniae* flourish.' This was unanswerable."

Neither Gosse nor Lloyd, however, attempted to keep vertebrates - fish in particular - using Gosse's formula. Over time, Lloyd experimented and modified the formula, ultimately using the one devised by Southall that used fifteen constituents. Lloyd, by the way, found a way to deal with those constituents that were very difficult to dissolve, such as silica and calcium sulphate.



The Proposed Llandudno Aquarium
Quite a few public aquaria in Britain were proposed but never built. This is one of them, in Llandudno, a seaside resort in Wales. the building contained a Winter Garden constructed of iron and glass on its upper floor, with a large Aquarium constructed of brick and slate in the basement below. At the center of the building was a 60ft high Dome.

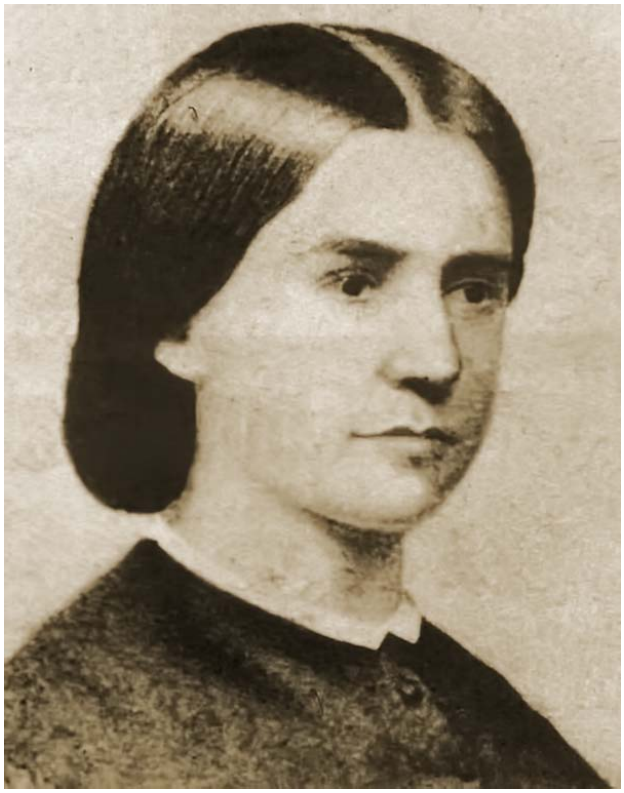
In an article titled "Artificial Sea-Water After Six Month's Use" by Henry William Jones (Jones, 1880), Jones found that the artificial seawater maintained its sea-like condition after six months. Jones examined the growth and reproduction of small invertebrates over a six-month time and found that,

"It may be taken for granted, however, that not only has the water been favourable to the two forms of the same animal [referring here to the zooplankton, *Coryne eximia*]**, but that it has gone through the entire "alternation of generations."**

ADDENDUM II:
A CHILDHOOD TRAGEDY

Sometime during the night of June 29th and the morning of June 30, 1860, Francis Kent, William's half-bother, disappeared from his home. Almost four years old, the child's body was found in the vault of an outhouse on the property. The child, still dressed in his nightshirt and wrapped in a blanket, had knife wounds on his chest and hands, and his throat was slashed so deeply that the body was almost decapitated. The boy's nursemaid, Elizabeth Gough, was initially arrested.

Elizabeth was released when the suspicions of Detective Inspector Jack Whicher of Scotland Yard moved to the boy's 16-year-old half-sister, Constance, William's sister. William was 17 years old at the time. She was arrested on July 16th but released without trial owing to public opinion against the accusations of a working class detective against a young lady of breeding. This difference in class was used as subplot by Wilkie Collins in his detective novel "The Moonstone" (1868). After the investigation collapsed, the Kent family moved to Wrexham in the north of Wales and sent Constance to a finishing school in Dinan, France.



Constance Emily Kent (1844-1944).

Constance Kent was prosecuted for the murder five years later. In 1865 she made a statement confessing her guilt to an Anglo-Catholic clergyman, the Rev. Arthur Wagner, and expressed to him her resolution to give herself up to justice. He assisted her in carrying out this resolution, and he gave evidence of this statement before the magistrates. The substance of the confession was that she had waited until the family and servants were asleep, had gone down to the drawing room and opened the shutters and window, had then taken the child from his room wrapped in a blanket that she had taken from between sheet and counterpane in his cot (leaving both these undisturbed or readjusted), left the house, and killed him in the privy with a razor stolen from her father. Her movements before the killing had been conducted with the child in her arms. It had been necessary to hide matches in the privy beforehand for a light to see by during the act of murder. The murder was not a spontaneous act, it seems, but one of revenge – and it was even suggested that Constance had, at certain times, been mentally unbalanced.

There was much speculation at the time that Constance Kent's confession was false. Many supposed that her father, Samuel Kent, a known adulterer, was having an affair with the toddler's nursemaid and, in a fit of rage, murdered the child after coitus interruptus. It fitted a pattern with the senior Kent, who had romanced the family nanny Mary Drewe Pratt while his first wife Mary Ann Kent, née Windus, (Constance's mother) was dying, and subsequently married Pratt (who was Francis' mother). Many were suspicious of Samuel Kent from the start, including the novelist Charles Dickens.

The substance of the Constance's confession was that she had waited until the family and servants were asleep, had gone down to the drawing-room and opened the shutters and window, had then taken the child from his room wrapped in a blanket that she had taken from between sheet and counterpane in his cot (leaving both these undisturbed or readjusted), left the house and killed him in the privy with a razor stolen from her father.

However, in her book, “The Suspicions of Mr. Whicher or The Murder at Road Hill House” (2008), author Kate Summerscale comes to the conclusion that Constance Kent's confession omitted facts to shield another person, not for the benefit of her father but for her brother, William Saville-Kent, with whom she shared a very close sibling relationship that was even deepened by her father turning his paternal attentions away from the children from his first marriage to the children he had with his second wife. William was indeed suspected during the investigations but was never charged. Summerscale suggests that if William was not the actual murderer, he was at least an accomplice to Constance and, after reviewing all the evidence, I tend to agree with her.

Constance Kent never recanted her confession, neither after her father’s nor her brother's deaths. She also kept her silence about the motive for the murder. In all of her statements, she emphasized and insisted that she bore no hatred nor jealousy toward her half-brother.

Constance Kent was sentenced to death, but this was commuted to life in prison owing to her youth at the time and her confession. She served twenty years in a number of jails and was released in 1885, at the age of 41. Kent emigrated to Australia early in 1886 and joined her brother William in Tasmania, where he worked as a government adviser on fisheries. She changed her name to Ruth Emilie Kaye and trained as a nurse at The Alfred Hospital in Prahran, Melbourne, before being appointed sister-in-charge of the Female Lazaret at the Coast Hospital, Little Bay, in Sydney. From 1898 to 1909, she worked at the Parramatta Industrial School for Girls. She was then made matron of the Pierce Memorial Nurses' Home at East Maitland, New South Wales, serving there from 1911 until she retired in 1932. Kent died on April 10, 1944, aged 100, in a private hospital in the Sydney suburb of Strathfield.

The Brighton Aquarium at night.

THE ROTHESAY ROYAL AQUARIUM

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 23, 2016)

The following excerpts are from an article that appeared (the author is unknown) in the January 9, 1875 issue of *The Spectator*, a weekly British conservative magazine first published on July 6, 1828, making it the oldest continuously published magazine in the English language; its principal subject areas were and are politics and culture. In addition to some interesting information as to those pubic aquaria that were successful and that were not, Lloyd's discouraging economic analysis shows why public aquaria were not profitable or long-lasting.

FISH SHOWS AS PECUNIARY SPECULATIONS.

The great public aquaria of to-day are giants when compared with the toy aquariums of the drawing-room which were a fashion some twenty years ago. One of the tanks at Brighton is quite as large as some, and much larger than many of the drawing-rooms of which little glass fish-prisons used to be an ornament. As a matter of course, the great aquaria of to-day are simply commercial speculations, money-making shows originated by joint- stock companies with a view to profit only. Scientific instruction or popular information are with their projectors only incidental considerations, and hold no part, or only a very small part, in their inception. But we should not look down upon them in consequence. Although they are only the product of breeches-pocket enthusiasm, they will in spite of that defect afford us much information that we are much in want of, and aid in developing that accurate knowledge of fish-life of which at present we are singularly ignorant.

Before, however, entering upon speculations as to what may be incidentally achieved in the way of gaining knowledge of the life and habits of our food fishes, it may be interesting to state that Mr. W. A. Lloyd, of the Crystal Palace Aquarium, who is an excellent authority, asserts that no Aquarium pure and simple will pay its way, even in a very large town or city, unless its cost be limited to £3,000, and its annual expenses be restricted to £500! Allowing a sum of £150 as interest on the capital sum, the total receipts would require to be £650 per Annum, or about two guineas a day, which would represent forty - two persons at a shilling each, or double that number if the charge for admission should be fixed at sixpence for each person. Sunday admissions are not counted upon. This presents

Figure 1: The locations of the Island of Bute and of Rothesay.

a rather dark aspect of the question to enthusiasts in Natural History, for at the present prices of building materials and the high rate of wages now paid, only a very indifferent aquarium could be erected for the sum named. At Rothesay, a small pleasure town on the river Clyde, it was found that the five thousand pounds subscribed for the erection of an aquarium was an insufficient sum, and the capital has in consequence been more than doubled.

A really great Aquarium, to "pay," must be something more than an aquarium; or, if not that in itself, it would require to form a portion of some greater exhibition, as in the case of the Crystal Palace, where the Aquarium is a parasite of the larger building. The Brighton Aquarium is both a fish-show, concert-room, and general lounge; and the suite of buildings recently erected at Southport, in Lancashire, is extensive. Several acres of ground are occupied altogether, the place being a winter garden as well as an aquarium. The Aquarium at Hamburg has been very successful, so much so, that the whole of the sum expended in its construction, £3,000, was recouped in six years. The current expenditure involved in keeping up the fish-show is £600 per annum. The success of the Aquarium at Hamburg has been in part owing to the popularity of the gardens in which it is situated; as many as 250,000 persons (a number equal to the population of the city) have been known to enter these gardens in the period of a week. Mr. Lloyd, who presided at the furnishing of the Hamburg Aquarium, and who has revised his estimates with special relation to the facts of the Hamburg case, nevertheless holds and appears to prove that no fish-show will pay of itself unless the expenditure be restricted to the sum named. The Aquarium attached to the Crystal Palace cost about £12,000, exclusive of the ground on which it is erected, and Mr. Lloyd feels sure that it never would have been remunerative, but for its being an accessory of the greater building. The cost of erecting the Aquarium in the Jar-

**Figure 2: Rothesay Bay during the time of the Aquarium.
The Aquarium was situated so that it overlooked the Bay.**

din d'Acclimatisation in Paris was 100,000 francs, or £4,166. It contains only fourteen tanks of small size, and is entirely thrown into the shade by our Brighton Aquarium. The average number of visitors to the Parisian institution is about 450,000 annually, but it has never yet paid any dividend!

These figures are exceedingly interesting, although they do not, if we are to accept the opinion of Mr. Lloyd, say much for the national love of scientific inquiry. The capital invested in the Brighton Aquarium is about £100,000, and at present an excellent dividend is paid to the shareholders. The Southport Aquarium, which was opened in the autumn, is yet too much of an experiment to enable us to say how far it will prove remunerative. The capital invested amounts to £60,000. An Aquarium Company is at present being started in Liverpool, under the auspices of Mr. Willert Beale, also with a capital of £60,000. Great Yarmouth, Ramsgate, and Margate are each to have an aquarium, and for these a sum of £140,000 will be required, whilst the Rothesay Fish Show already alluded to requires for its completion £12,000, instead of the £5,000 originally contemplated.

Counting the Winter Garden and Aquarium lately projected in London, and that meditated for Dublin, we are safe in assuming that as much as £700,000 is either invested or about to be invested in Fish Shows in England, Ireland, and Scotland. There can be no question that the creation of numerous other buildings of the kind will speedily be designed. Such towns and cities as Birmingham, Bradford, Glasgow, and Edinburgh are sure, sooner or later, to have their grand Aquarium. In large towns where there is a paucity of picture-galleries, museums, and kindred exhibitions, an aquarium forms a welcome place of resort, especially for ladies and children. There is no practical difficulty in constructing and maintaining an aquarium, even in cases where its site may be a hundred miles from the sea. It is important to state this fact, as many persons suppose that an aquarium cannot be properly organised in an inland town. The sea-water at the Crystal Palace is brought by railway from the Coast, and the animals are always in excellent health.

Even, however, when a large sum of money is subscribed for the erection of an aquarium, it may not all at once become a success. The Berlin Aquarium, for instance, has proved almost a failure, whilst the Brighton Aquarium is not a great success, considered zoologically, though, as a show, it is entirely successful. The organisation and working of such an institution is attended by much worry and anxiety. It was a long time before the Aquarium at Hamburg could be got into working order. To ensure good health for the fish and crustaceans, and provide suitable food as well as keep up the supply of both, is a work that requires considerable organisation and not a

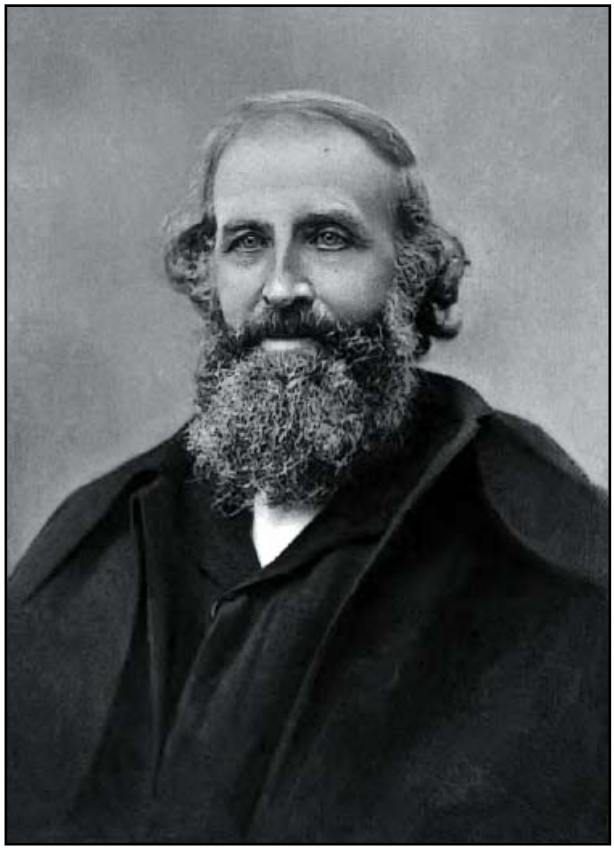


Figure 3: Reverend William Ross (1836-1904)

The Rothesay Aquarium Company, Limited.

FIFTH DIVIDEND, YEAR ENDING 31ST DECEMBER, 1876.

No. 35

ROTHESAY, 31st January 1877.

Mr. John Wallace.

The Directors having, with the sanction of the Shareholders at the Annual Meeting held on the 24th Inst., declared a Dividend of One per cent. per annum, free of income-tax, for the year ended 31st December, 1876, the amount payable on 10 shares held by you is £1-10-0

I annex a draft for this amount, payable at the Royal Bank of Scotland here, on and after 1st March next.

I am,

Your obdt. servant,

JOHN T. WILSON, Secretary.

Figure 4: A ten-share note issued by the Rothesay Aquarium Company.

little scientific knowledge. The mortality of some aquariums is very great indeed, although, we daresay, it will not be observable to the ordinary run of visitors.

Lloyd remarks that the £5,000 subscribed at Rothesay for the erection of an aquarium was an insufficient sum, and the capital in consequence had been more than doubled. Actually, the final cost for the Rothesay Aquarium was £15,000.

ROTHESAY

Rothesay (from the Gaelic *Reogh-siudh*, "King's seat") is the capital of the Island of Bute, on the Firth of Clyde just off Scotland's Ayrshire coast and less than two hours from Glasgow some 40 miles to the north-east (Figure 1). From reliable evidence it would appear that the town has Viking origins. From the late 8th century onwards, Vikings raided and settled much of Scotland's western seaboard. This culminated in an all-out invasion of the Scottish islands by Magnus Barfod in 1098. He claimed Bute as his own and is credited with building the first castle at Rothesay.

The old town centered around the Castle and, long-ruinous, it is nevertheless picturesque, and formed a focal point for tourists from the beginning of its evolution into a seaside resort. During the Victorian era, Rothesay developed as a popular tourist destination. It became hugely popular with Glaswegians going "doon the watter" (literally down the water, where the 'water' in question is the Firth of Clyde), and its wooden

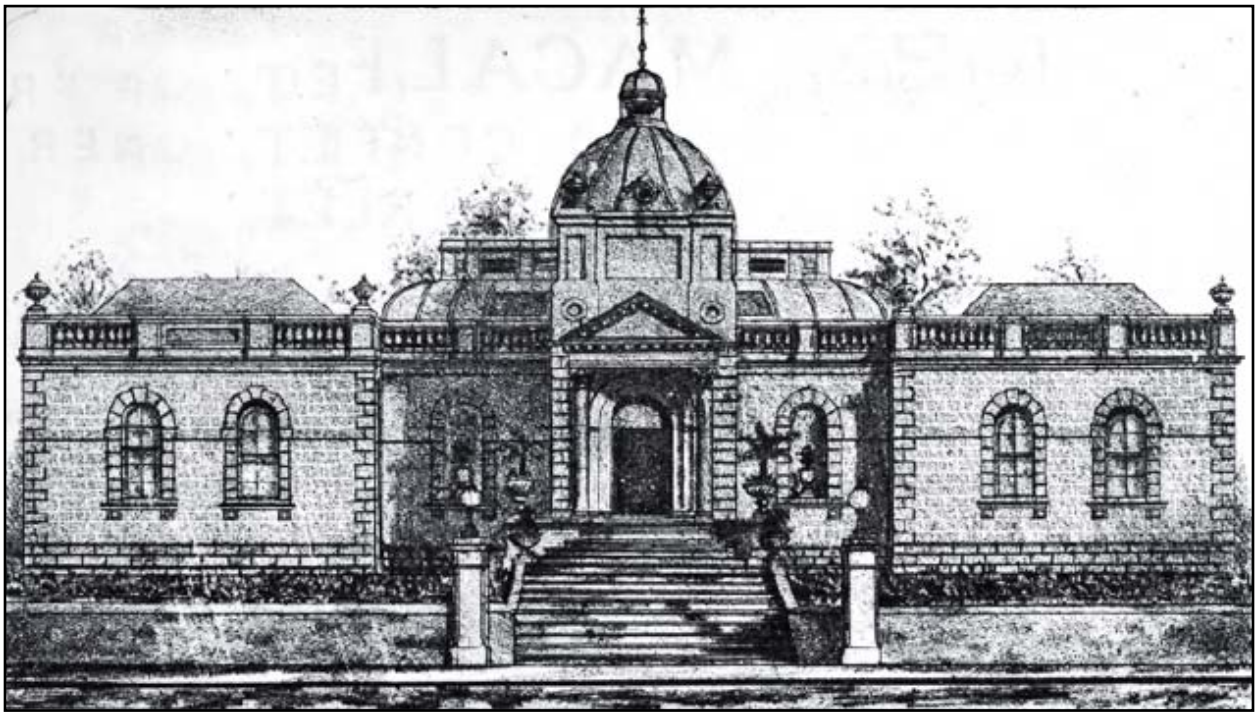


Figure 5: The architect's rendition of the Rothesay Aquarium.

pier was once much busier with steamer traffic than it is today. The situation of the town is both beautiful and sheltered, being finely situated. It enjoys a mild climate, and was and still is a favorite watering-place and a center for visiting places on the River Clyde at the head of Rothesay Bay (Figure 2).

THE ROTHESAY AQUARIUM GETS STARTED

The idea of The Rothesay Aquarium - known later after the visit to it of Prince Leopold as the Rothesay Royal Aquarium - had been in the air for some time, and the Archaeological and Physical Society of Bute took it up and formed a company to float the scheme. The Reverend William Ross, a prominent member of the Rothesay clergy (Minister of the Chapelhill Gaelic Church) and one of the founders of the Society, was first a member of the committee of investigation and then a Director for several years of the company. It was he, for example, who traveled to London to consult the Engineer of the Crystal Palace Aquarium with regard to the details of designing and running a system for the proposed Aquarium. The Aquarium was opened in June 1870 and, at the opening ceremonies, the Rev. Ross gave an address on the uses and purposes of such an institution. The following is an extract of an announcement that appeared in *The Freemason* in June 1875:

Laying Memorial Stone of
The Rothesay Aquarium

To Rothesay belongs the honour of giving to Scotian its first public Aquarium, the memorial stone of which was on Saturday, the 5th inst., laid with full Masonic honours by Bro. Charles Dalrymple, M.P. for Buteshire and Provincial Grand Master of Argyle and the Isles. The Aquarium occupies an excellent site on the Ascog shore, at the spot occupied by the old battery. When completed the building will have an imposing appearance. Externally it has a frontage of 102 feet, is graced below with a rusticated basement and cornice, is surmounted by a chaste open balustrade, and rising from the centre there will be an ornamental tower 47 feet in height. A short flight of circular steps leads from the outside to a

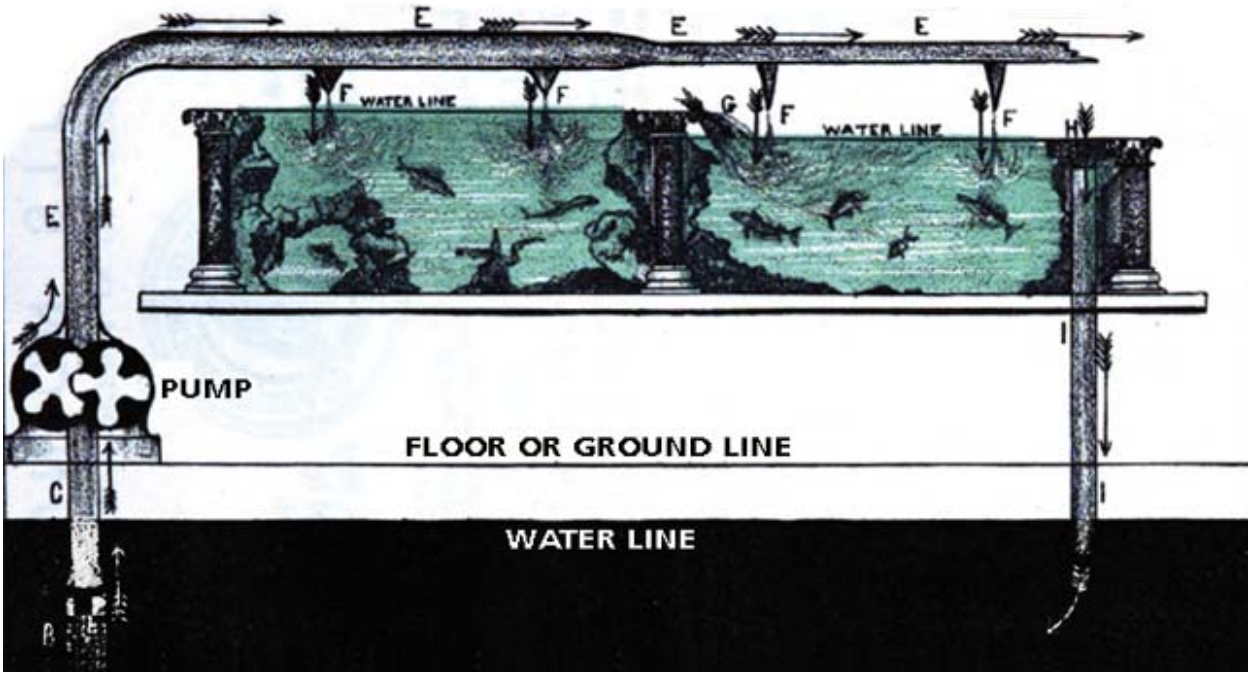


Figure 6: The system used by the Rothesay Aquarium was modeled after Lloyd's design that he used in the Crystal Palace Aquarium.

commodious vestibule which communicates with a promenade hall, lighted by a dome, and intended for concerts social gatherings, and the like. [Note: The architect's drawing of the front of the Aquarium is shown in Figure 5.] **Adjoining the hall are smaller rooms as suitable accessories, and also rooms it which will be fitted table tanks. Entering from the promenade hall is a magnificent corridor, forming the main portion of the building, and measuring 90 feet by 15 feet Ranged on each side of it will be sixteen tanks, while in two adjacent rooms are to be placed twenty others, for the reception of the smaller species of salt and fresh water animals. Besides those mentioned there will be nine tanks to be used chiefly for experiments.**

For the tanks 20,000 gallons of sea water and 12,000 gallons of fresh water will be required; but it has been considered necessary to have to supply reservoirs beneath the building capable of containing 100,000 and 40,000 gallons respectively, the extra quantity being indispensable in having the water thoroughly aerated. [Note: The Rothesay Aquarium was modeled on William Alford Lloyd's design, rather than on William Saville-Kent's. See Figure 6.] **A water engine pumps the water into pipes from which it is sent in a spray from jets in the roof, and in the event of an accident to this engine, a supplementary one, worked by steam, is to be provided. The tanks in which the animals are to be placed will be similar to those in the English Aquaria, three sides being of slate, and the front of one-inch plate glass. Artificial rock work is to be placed inside, and the bottom will be covered with shingle. It is not yet known from what source the sea water will be drawn, fears being entertained that the water in the vicinity of the Aquarium may prove unsuitable.**

the reservoirs are filled there will be little need of replenishing, the sweetness of the fluid being maintained by machinery, and as each tank is placed in a lower level than the one

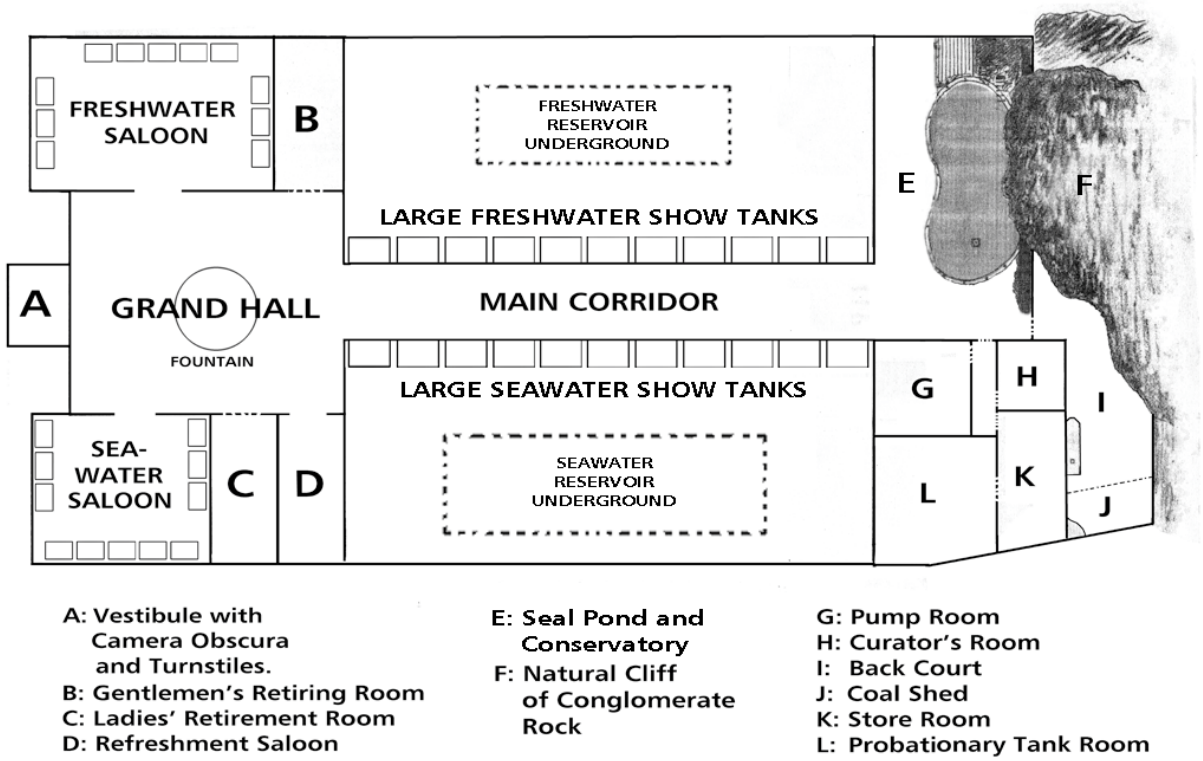


Figure 7: The layout of the Rothesay Aquarium.

next it, the water, by an overflow pipe, finds its way back to the reservoirs. To maintain an equal temperature of water, and in the building, hot water pipes are to be brought into requisition. It is proposed to use several tanks in promoting scientific research, more particularly in the department of embryology, and after the Aquarium has been fairly started the directors hope to be able to add a seal ground, and also a home for porpoises. The total cost is estimated at £10,000, and of this £1,000 has been contributed by the Marquis of Bute, who, in addition, gave a free site for the building, and £1,000 by the Corporation of Rothesay, the remainder being made up by shares of £5 each.

A DESCRIPTION OF THE AQUARIUM

It is helpful to refer to Figure 7 as one proceeds through this description. The building, which faces Rothesay Bay, is approached by a broad circular flight of stone steps, leading from an Esplanade or long, open level area (see Figure 8). About the close of the 1700's, when the stirring events in France led Great Britain to fear an invasion, a battery of several 18-pounders was placed on the east side of the Bay of Rothesay, some of the guns being set beside the aquarium on each side of the stairs.

Ascending the stairs one reached the Vestibule, the left of which led to the Camera Obscura (Figure 9). At the top of the dome there was a lens and a mirror in a revolving turret, the latter being protected by a hood and a pane of glass. The mirror was angled so that natural light reflected downwards into the camera obscura room. The light passed through the lens, which enabled it to focus onto the table, projecting a moving picture of the surrounding area. The lens also switched the image so that it appeared the right way up on the viewing table. When the room was darkened, the visitors' eyes adjusted to the light and they could then see the

Figure 8: The Rothesay Aquarium as it looked after its construction.

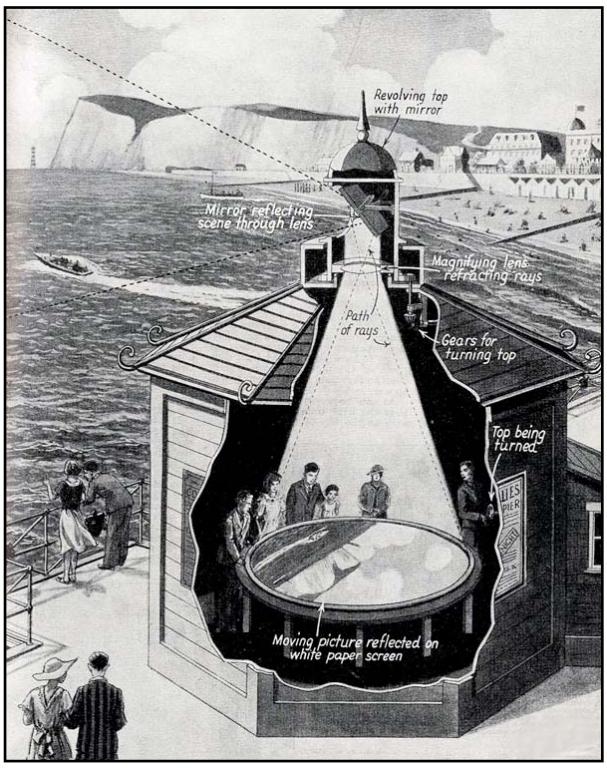


Figure 9: An example of a Victorian seaside camera obscura.

reflected, moving image. In Victorian times, camera obscuras became popular seaside attractions, offering a unique way to see the surrounding area and an opportunity to spy on courting couples.

After passing through the turnstiles in the Vestibule one then entered the 45 feet x 48 feet Grand Hall (Figure 10). Visitors were struck with admiration at the artistic elegance of this spacious room. Its beautiful tessellated pavement of mosaic tilework and the elaborate Corinthian enrichments of its walls and ceiling were toned by the tinted light transmitted through the enameled windows of the roof. In the center of the Grand Hall a bronze fountain threw its refreshing spray into a large marble basin. Round the walls were a handsome set of meteorological instruments and a valuable clock, the timepiece being a marvel of ingenuity and delicate mechanism. It represented birds of the most brilliant plumage, and of the smallest size, flitting from twig to twig, warbling their sweetest songs and fluttering their resplendent wings with all the appearance of animation.

To the right of the Grand Hall was the Freshwater Saloon and forming the left wing of the building was the Seawater Saloon. In each of these side saloons there were eleven table tanks, which, with the four in the Grand Hall, totaled twenty-six. Their average size was five feet long, three feet six inches wide, and two feet high, with an average capacity of two hundred and twenty gallons each. The contents of these tanks could be viewed either through the glass fronts or from the top by the open surface of the water, and from this latter circumstance they were called Table Tanks. The bottoms, backs, and ends of these tanks were of white polished marble slabs two inches thick, the first tanks constructed of this material in any public aquarium. Not only were the polished surfaces kindly to the touch and pleasing to the eye, but they were capable of being tightly joined so there was not even the least sign of leakage. Each of the Saloons had Retirement Rooms - what we would nowadays call fancy toilets with tables and chairs - and on the Seawater side was a “Refreshment Room.”

The Grand Room opened up to the 90 by 15 feet Main Corridor. Here the large show tanks were arranged along both sides, forming a double wall of water between which the visitor passed. There were sixteen seawater tanks and 7 freshwater tanks. The main internal framework of these tanks was of slate slabs, nine feet long, five feet high, and two inches thick; these were dovetailed together and further secured with bolts and clamps. The sides that faced the Corridor were of polished plate glass one and an eighth inch in thickness. In front of each tank, and supporting the arc stretched above it, were two pillars of polished St. Ann’s marble, and these were based upon a broad slab of the same material, which stretched across the front of the tank, as would the sill of a window (Figure 11). In front of this sill was placed the case containing the names of the various creatures in the tanks, and before this was a handsome mahogany rail, which formed a rest for the visitor and a protection for the tank.

Passing through the central door of the Main Corridor the visitor entered the Seal House and Conservatory. The rustic style of the Conservatory contrasted pleasingly with the Corinthian style of the main building. The pond was surrounded on three sides by a rustic walk, and on the other was a perpendicular cliff of conglomerate rock. This cliff had been utilized to form one of the retaining walls of the Conservatory, and it, consequently, supported one side of the arched glass roof. At the east end of the Conservatory was a rustic grotto and stairway. This was formed of the famous columnar sandstone obtained from the south end of Bute. This formation of rock was most remarkable, for its shape was the columnar of the igneous rocks of Staffa and the Giant's Causeway, while its consistency was sedimentary sandstone, the columns being transversely stratified. This rare geological formation is only known to exist in three or four places on the globe, of which Bute is one. The walls were treated with rustic cork and trellis work, in which flourished British and exotic ferns, and various creeping plants. Two large New Zealand Tree-ferns (*Dicksortia medullaris* and *D. squarrosa*) also spread their luxuriant fronds overhead.

From the Seal House private access was obtained to the Engine House, the Probationary Tank-Room (used to quarantine new arrivals or as a piscatorial hospital; there were six seawater reserve tanks and three freshwater reserve tanks), a store room, the Curator's Room and other private offices. Unlike the Crystal Palace Aquarium and the Royal Westminster Aquarium with their music and concert halls, winter gardens, skating rinks, clubrooms, restaurants, baths, and pleasure grounds, the Rothesay Aquarium was an aquarium in the full sense of the word (save for the camera obscura) in that it was dedicated to an aquatic biota.

THE PROBLEM OF LEAKAGE

In July of 1876, thirteen months after the opening of the Rothesay Aquarium, John T. Carrington, who was working under William Alford Lloyd at the Crystal Palace Aquarium (Carrington was to replace William Saville-Kent at the Royal Westminster Aquarium eight months later), wrote the following:

Scotland, so far from being behindhand, has, within the last few days already opened its first, at that charming little place, Rothesay, so much frequented by the people of Glasgow. There, through the influence of its patron, the Marquis of Bute, has been established an aquarium, which, when quite complete and in working order, will not only be an ornament and attraction to the town, but I have every reason to believe will be of great scientific value, for on this rock-bound rock-bound northwest coast of Scotland is a grand marine fauna. This, without some aid and central base for

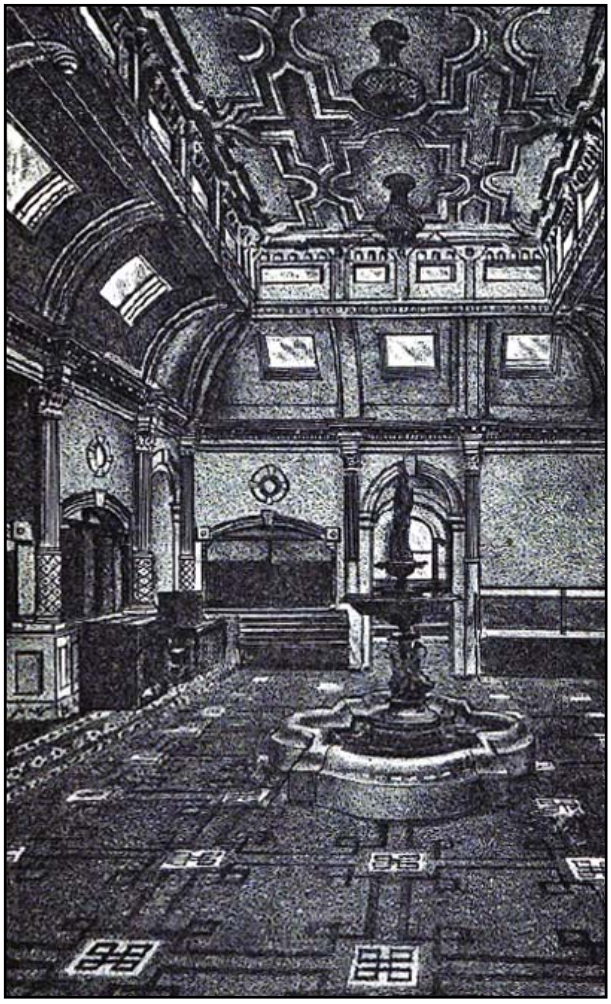


Figure 10: The Great Hall.

operations, such as this aquarium will afford, could hardly ever be worked out satisfactorily.

Rothesay will I hope prove to be a famous place in future aquarium reports, especially in its record of rarities and new species discovered in Britain. It is fortunate in having a curator, Mr. Barker, who has his "heart and soul in the cause," and from whom we hope much. Already he reports to me that the northern stone crab (*Lithodes arctica*), which, up to the present lime, has only been reported as British from one or two isolated captures by the trawlers of Yorkshire and Lincolnshire, has been discovered in some numbers by the collectors sent out on behalf of this aquarium. Large *Nephrops Norvegicus* also have been found abundantly by them: this species, although known by the name of the " Norway lobster," has hitherto been found in Britain most commonly on the eastern Irish coast, from whence the English, and even some of the continental, aquaria have been supplied. In Dublin I have often seen this species sold in the streets, after being boiled, as "prawns," at a few pence per dozen ; they are a very great delicacy, and quite equal to the common lobster (*Homarus vulgaris*) as an article of food. As an aquarian animal they are very attractive; their bright colour, their dignity of bearing, their habit of throwing up great earthworks for the protection of their hiding-places—make them great objects of attraction to visitors.

At the Rothesay Aquarium marble has been greatly used, for the first time, in the construction of the tanks. This I believe is a very important application, one which will be largely adopted in place of slate, as at present used for smaller tanks. Slate, from its laminated structure, is liable to split when any lateral pressure is put upon it, while marble remains intact. Again, though slate is somewhat unsightly unless enameled, it unfortunately happens that this so-called "enamel" chips or peels off under the action of any sea-water with which it may come in contact; and the tanks then become unsightly and untidy in appearance. My readers will naturally say that

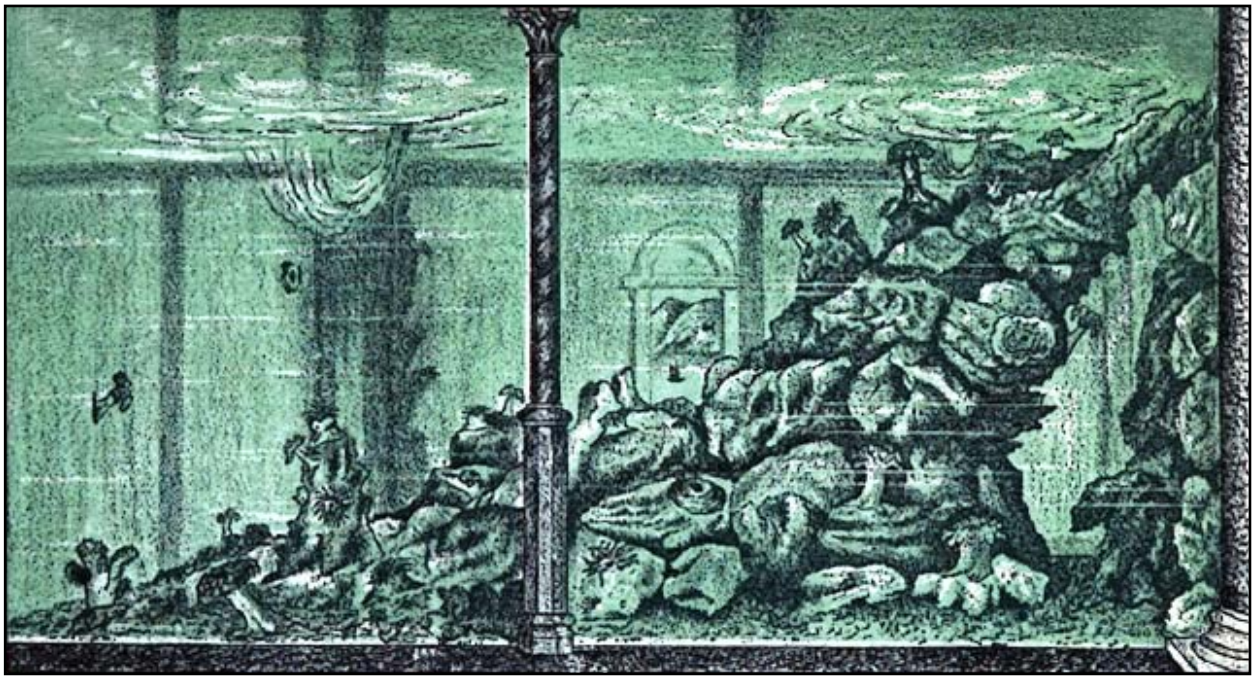


Figure 11: Sea anemone tank no.3 as seen through from the corridor.

the enamel being outside the tanks, it should not come in contact with the sea-water; but all who know the great difficulty of making large show-tanks absolutely water-tight will see the inadvisability of using a material which, in the present immature stage of aquarium construction, adds greatly to the first cost, and then afterwards only adds to the many complications of management.

Carrington continues, talking now about leaks and laying the blame upon the architects:

Unfortunately the aquarium at Rothesay suffers from the same failing as every other aquarium yet constructed—namely, the miserable leakage of water from reservoirs and tanks. It seems such a pity that, for the sake of a comparatively small fee, Aquarium Companies have hitherto persistently refused to engage a really competent engineer to superintend the earlier stages of construction. Had this been done there is little doubt that much anxiety in the management would have been saved, besides the disastrous consequences of the wear from leakage, which, from its very insidiousness, is a dreadful enemy to cope with. Aquarium construction has so far been treated entirely from an architectural standpoint, whereas it is eminently engineering, and large sums of money have been spent upon external decorations, which earn nothing, while tanks, pipes, and especially reservoirs, being out of sight, are neglected, to the infinite damage of future dividends. In fact, it amounts to this, that a well-constructed aquarium is a most valuable property, which, with little outlay after first cost, will earn large results, both biologically and financially; while a badly constructed one is a veritable "white elephant."

The leaks however, were in the large reservoir, not in the small one or in the show tanks. The following is from *The American Architect and Building News* of February 1878:

Rendering Portland Cement Concrete Water-Tight

With reference to the discussion in recent issues of the Journal on the question of Portland cement concrete, our Glasgow correspondent quotes the experience gained by the practice at the Rothesay Aquarium. He says : "Concrete tanks can be made practically water-tight by first using a good stiffish body of concrete, composed of just such proportions as should be used in order to make a good job, judging by the quality of the cement. Use clean sand, thoroughly free from soil, and then give a coat, one inch in thickness, of pure cement, finished and polished as hard as possible. By adopting such a course of procedure the tank is practically water-tight. This is what was done in the large reservoir-tank at the Rothesay Aquarium, and it succeeded famously, whereas under the ordinary method it leaked like a basket." —*Journal of Gas-Lighting*.

The slate tanks at the Rothesay Aquarium were the first that differed from those in any public aquarium. The adoption of slate slabs was highly preferable to the previously used bricks and mortar, not only on account of their thinness, providing a great economy of space, but they required no calcareous

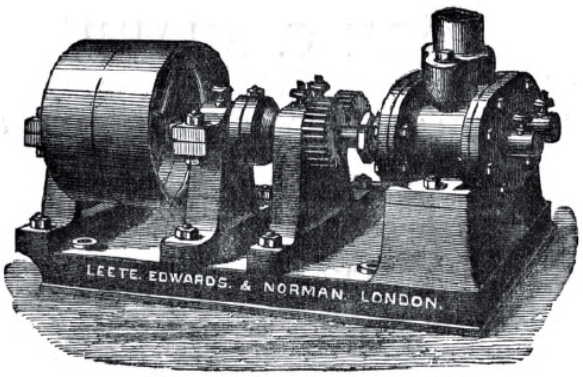


Figure 12:
The Forbes & Edwards rotary pump, adapted by the Leete, Edwards & Norman Aquarium Engineers for the Rothesay Aquarium. These pumps were made with vulcanite, a hard black insulating material made by the vulcanization of rubber with a high proportion of sulfur (up to 30%). The pump was driven by an 8 HP motor.

cementing as was the case with a construction of masonry, which rarely, if ever, proved watertight. Each side of the tank being of one piece - the only fissures in it were at the four corners and round the edges of the bottom - it was a simple matter to make a perfectly watertight tank which in reality was a huge box composed of seven pieces, including the two plates of glass forming the front, when compared to the difficulty attending the multiplicity of jointing necessary in the construction of a tank of bricks. The tanks being therefore made perfectly secure and tight before the rockwork was put in, it was not necessary to construct a rockery of such artificial materials. The Curator, Ernest E. Barker, has this to say about leakages:

Leakages are the Aquarium manager's bugbear, his nightmare in fact. When these occur in accessible places they sometimes may with great difficulty be overcome; but when they are known to exist out of sight and out of reach, they prey upon his mind continually. In some inland aquaria the loss of seawater by leakage through the intricacies of the rockwork, is so great, that large sums of money are annually expended to keep up the supply. In others the leakage has been so great, in spite of every effort, that the whole of the rock-work had to be completely taken out of every tank, and replaced by enormous quantities of cement which was fashioned to imitate rocks, at exceeding great cost. Hence we find it officially set forth in the records of one Aquarium, that "the loss of seawater through inaccessible leaks is continually going on at the money rate of over £200 per annum!' Another records, "Unfortunately the cementing at the back (of the tanks) had been so imperfectly performed, that water was running to waste through the walls of every tank, to an extent that involved the loss of many hundred pounds." I am happy to announce that the introduction of the slate slabs has relieved us of the loss and annoyance which otherwise might have attended the construction of the tanks: and as each one is independent of the fixing of the rock-work, "as sound as a bottle," it has left us free to use the natural rocks, and to represent them in their natural formations.

THE AQUARIUM COMES TO AN END

To begin with, the Aquarium was a prodigious success. It was the first in Scotland and therefore a novelty. It had an almost unlimited constituency in the summer visitors from Glasgow and all parts of the world. And Royalty set the example of paying it a visit. In the first four weeks of its history 25,000 people visited it, and in the first year nearly 100,000. The Aquarium also worked closely with the Fishery Board of Scotland, hatching herring eggs and lobster roe, spawning codfish and providing the Board with tank space for their experiments. Thus it partially fulfilled the hopes of Wil-

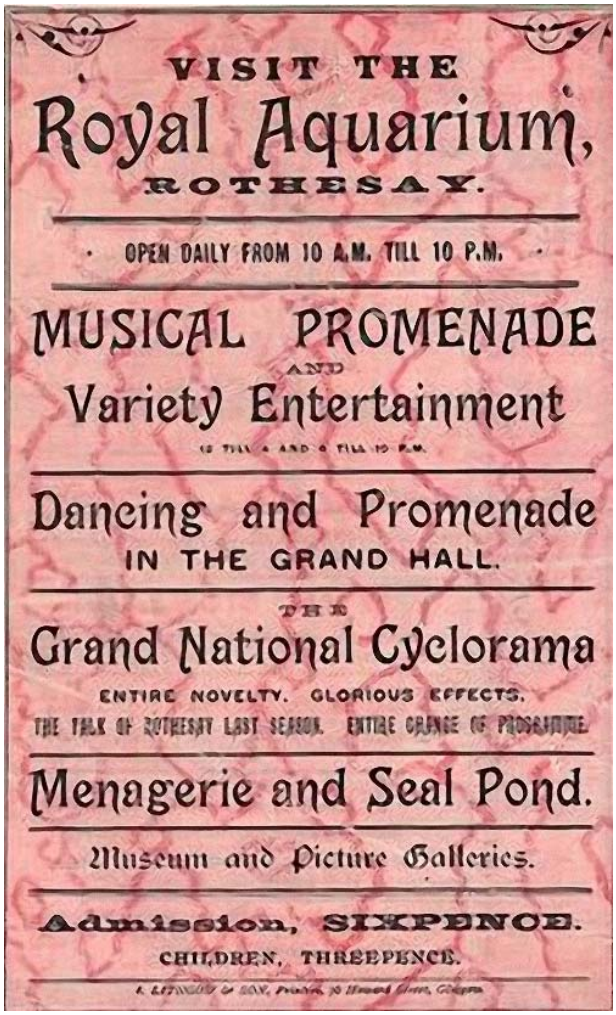


Figure 13: A flier for the Rothesay Aquarium.

liam Saville-Kent to establish a national marine aquarium and laboratory using the Brighton Aquarium, an idea that never came into being, and it predated the establishment of the laboratory of the Marine Biological Association at Plymouth by four years.

But after a time the Aquarium fell on evil days. It was no longer a novelty and there was much competition. The interest of the public gradually fell off, and the Company had to be wound up. The following appeared in the Edinburgh Gazette on November 27, 1908:

The New Rothesay Aquarium Company Limited, in Liquidation.

A General Meeting of the New Rothesay Aquarium Company Limited (in Liquidation) will be held within No. 14 Hart Street, Edinburgh, on Wednesday, 13th January 1909, at five o'clock afternoon, in order that the final accounts, showing the manner in which the winding up of the Company has been conducted and the property of the Company disposed of, may be submitted.

J. Dan Easson, Solicitor, Liquidator.
10 George Street, Edinburgh,
27th November 1908.

The building was later used as a home for the Buteshire Natural History Society's museum, and then as a music hall, before reopening in 1938 as the town's first indoor swimming pool, with hot seawater baths to attract those keen on the town's seaside health-giving properties (Figure 14). But while its time of popularity lasted it did good service, both on the scientific and on the recreation side. And the fact that it was the first in Scotland gave a reflected glory to the town.

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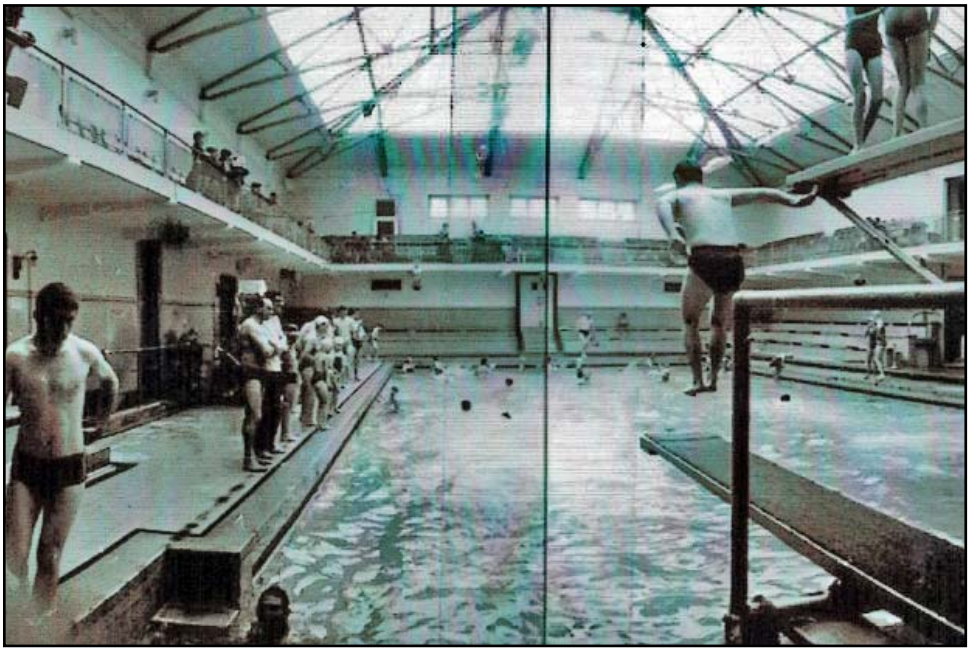

Figure 14: The Aquarium, reconverted in 1938 to an indoor swimming pool, complete with hot seawater baths.

PHILIP HENRY GOSSE'S $5,600 AQUARIUM!

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 29, 2016)

In the spring of 1876, Philip Gosse decided to build a marine aquarium using Lloyd's design used at the Crystal Palace Aquarium where the ratio of the water in the show tanks to the water in the reservoir was 1 to 5. As Gosse put it,

My old kind friend, Mr. W. Alford Lloyd, contemporary and fellow laborer from the first in aquarian development, gave me the invaluable aid of his counsel in every step of the work; ever suggesting and improving, as it went on, with a zeal which could not have been exceeded if the scheme had been his own. The mechanical contrivances and fittings were supplied by the eminent engineers, Messrs. Leete, Edwards, and Norman, to whose courtesy, skill, and thoroughness of work, I bear willing witness. The Tanks were made and put together, and the whole erected and set a-going, by mechanics of the place.

THE GENERAL PLAN

In Gosse's house in his servant's quarters was an apartment used as a lumber room, whose floor was about 12 feet from the ground. Gosse took out the window in the room and enlarged the opening for the reception of the tank. (Gosse referred to this aquarium as the "Tank" and the room it was in as the "Aquarium"; I will keep both these designations in this essay.) Gosse's house was a stone

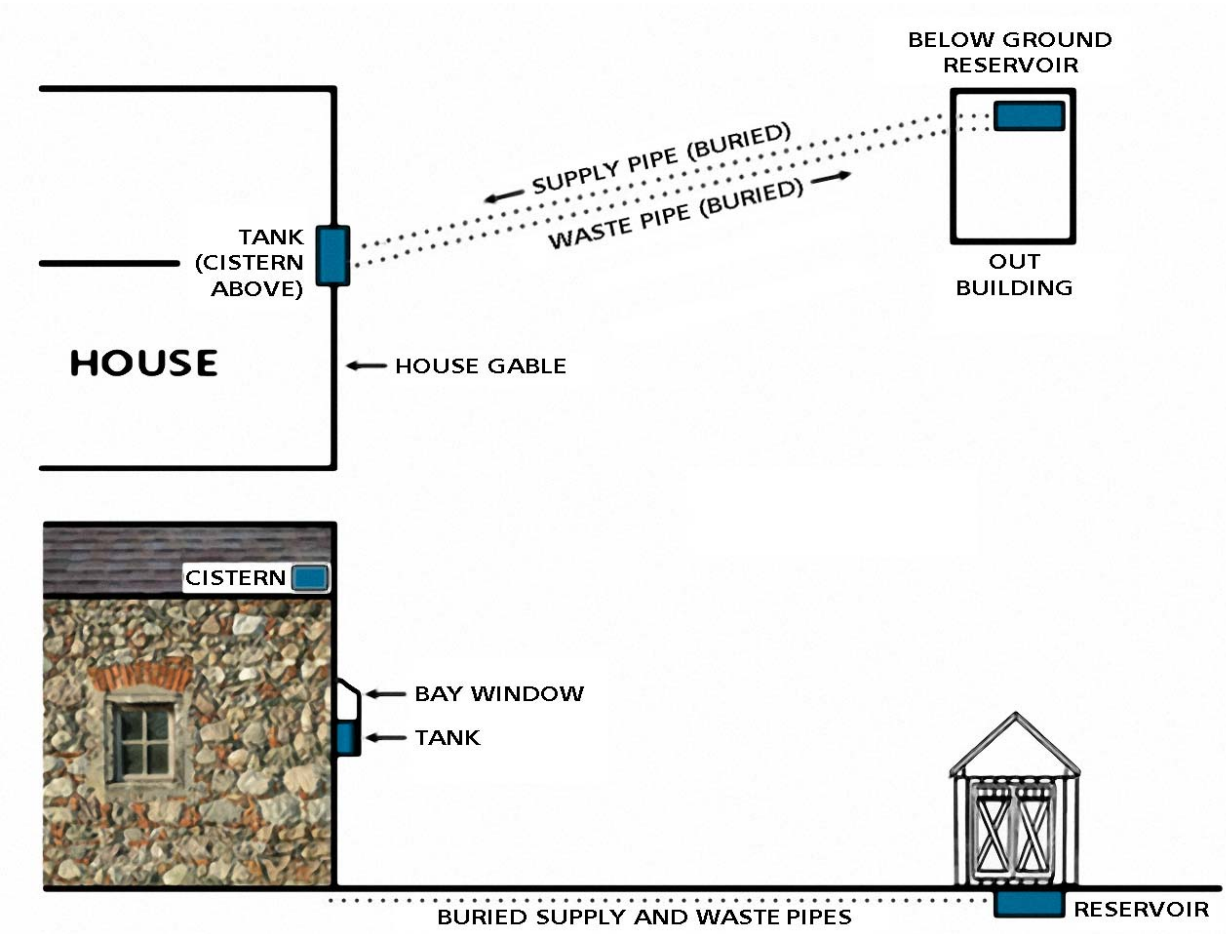

FIGURE 1: The overall siting plan for Gosse's aquarium.

structure so the Tank was to be placed half-way out of the room so that its center rested on the stone foundation of the house in a newly-constructed bay window. The window looked out upon a yard, across which was an out-building currently used as a coal cellar. Gosse excavated the farther corner of this building for the reception of the "Reservoir," which was sunk so that its top was level with the ground. This was protected from dirt and debris by a strong and tight cover of wood, divided and hinged in the middle so that the contents could easily be examined (Figure 1).

A large opening was made in the gable above the window and two cross-joists, 4 inches square, were inserted in the ceiling from the gable-wall to the center beam. Another tank - the "Cistern" - was placed within the roof, immediately over the Tank. This tank rested partly on the summit of the stone wall of the house and partly on the rafters, which were reinforced with the 4 inch square cross-joists.

THE CONSTRUCTION OF THE VESSELS

Three vessels were made of squared slabs of the best slate, varying in thickness from 1-1/2 in. (base) to 1 in. (sides), which were bolted together with iron rods, tightened by screws and nuts at the ends, a common construction method at the time (Figure 2). All the internal angles were filled with Portland cement. The side of the Tank that faced the interior of the room was made of 1/2 in. plate-glass.

The dimensions and capacities of these vessels were as follows. The Tank was 42 in. long, 18 in. wide, 18 in. deep, each inch of depth equal to 2.73 gallons for a total of 49 gallons. The Reservoir was 62.75 in. long, 35.25 in. wide and 26.25 in. deep, each inch of depth equal to 8 gallons for a total of 210 gallons. The Cistern was somewhat squarish, 34 in. long, 31 in. wide and 27 in. deep for a total of 112 gallons. Note that the dimensions of all three of these vessels represented their capacities and not their overall height or width since the end pieces had to be wider and higher to accommodate the iron rods.

THE ASSEMBLY GETS STARTED

Early in June, a water cart was filled three times with the crystal-clear water of Oddicombe Beach, near to St Marychurch (a suburb of Torquay) where Gosse lived at the time, and emptied by a hose into the Reservoir, providing Gosse with 210 gallons of pure seawater. Early in September the pump, pipes (1 inch ID) , valves, etc., arrived from the engineers. Vulcanite is a hard rubber produced by vulcanizing natural rubber with large amounts of sulfur (up to 30% or more) and at longer temperatures. The vulcanite pipes were all made in lengths, with the requisite angles and connections; and were sent from London, carefully numbered, according to copious working-drawings. No bend could in the least degree be changed, vulcanite being inflexible and brittle. Every piece was fitted and screwed to its fellow, using a red-lead sealant; some of the joints were also wrapped with muslin for this purpose.

Immediately the masonry of the house was opened to receive the Cistern and the Tank. The base of the Cistern was introduced and laid in situ, square and level, save a 1/2 in. inclination so that it might be emptied to the last drop. A hole was made in this part of the base for the insertion of a pipe - the "jet pipe" - over the Tank. This pipe extended down to near the surface of the Tank ending in a pin-point nozzle that forced a spray of water from the Cistern downward into the Tank to a depth of about a foot, entrapping air in the process (Figure 3).

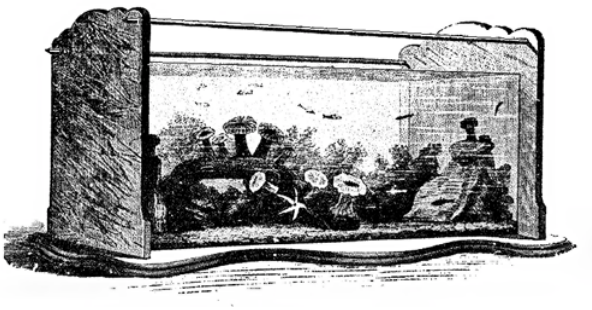

FIGURE 2: A typical marine tank of the time. The bottom had grooves to accommodate the bottom of the slate sides and the glass. The top was supported by the steel rods.

Gosse used four jets of which the orifices, perfectly true and round, graduated from the thickness of a lady's medium pin (No. 1, about 1.5 millimeters) to that of a cambric needle, (No. 4, about 30 micrometers). With No. 1, 18 pump strokes delivered an hour's supply of water into the Tank; with No. 2, about 10 strokes; with No. 3, 5 strokes; and with No. 4, about strokes. The orifice of each jet was just an inch from the surface of the Tank. A white cloud of dust-like air-bubbles was driven perpendicularly downward (about a foot with No. 1), after which they could still be followed, with a lens, moving swiftly to every part of the Tank.

The Cistern when being filled was out of sight in the roof above. In order to know when it was full and not allowed to overflow, a small pipe - called a "warning pipe" - was inserted into the side of the Cistern opposite to where the jet pipe was placed, an inch below the brim (Figure 3). This led down through the ceiling and ended at a few inches over the surface of the Tank. This was in sight of the person who was pumping water up into the Cistern and could not help hearing the noise of the stream as it came suddenly pouring down the warning-pipe. At such time, pumping was stopped immediately. The sides of the Cistern were then set up in Portland cement, bolted together and smoothed within and without.

A vulcanite pipe - the "Waste pipe" - coming from the right side of the Tank near the front carried away the excess water to the Reservoir. The position of its exit, about 2 in. from the margin, determined the level at which the water always stood in the Tank. It was at first proposed that this should be a simple pipe, screwed into a hole in the side, but this would have carried off only the surface water. To make the circulation complete, Gosse chose to take it from a point very near the bottom. To avoid the inelegant appearance of a pipe, however, Lloyd devised the following contrivance. A slab of slate, 2-1/2 in. wide, 1 in. thick and as high as the Tank, had a semi-cylindrical 1 in. groove gouged out it, but not reaching quite so far as either end. Its upper end met the hole in the side of the Tank at the surface (Figure 4A shows the slab's front and side). This was duplicated and then turned 180 degrees so the hole was at the bottom (Figure

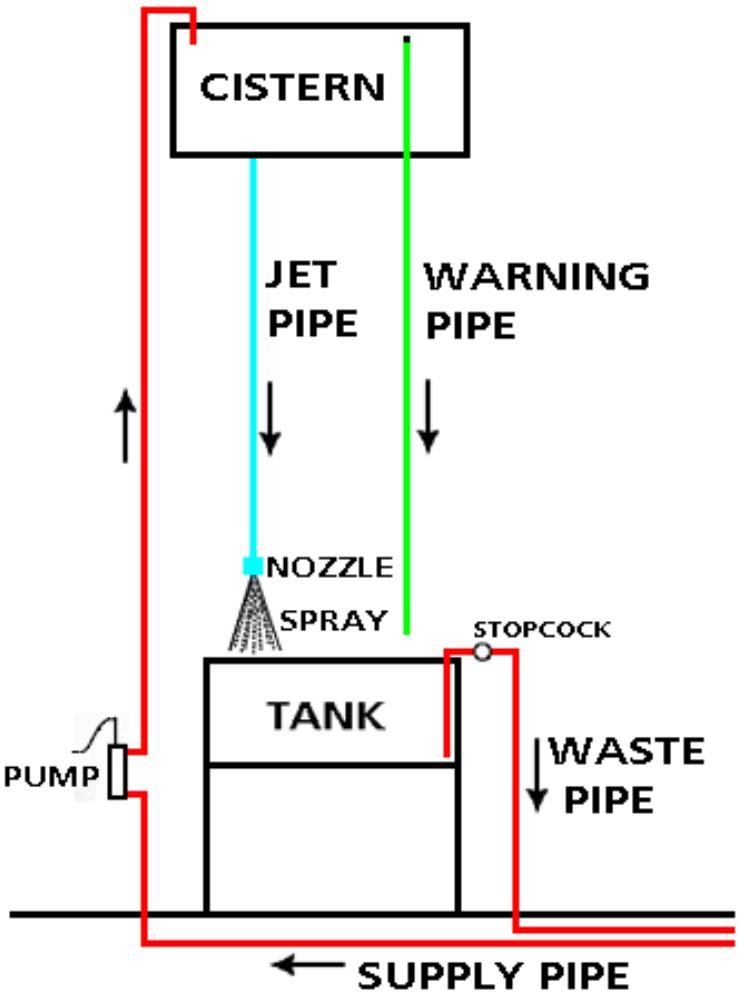

FIGURE 3: The arrangement of the four pipes.

4B). The two pieces were then cemented together, resulting in a single piece with a circular hole, 1 in. diameter, within (Figure 4C). This was firmly cemented in place. The water in the Tank entered through the bottom hole and rose in the hidden groove until it reached the exit hole in the Tank where it continued to trickle out through the waste pipe. The Tank could never overflow unless the inflow was more than the bore of the waste pipe could carry off or this pipe became choked.

To solve the latter problem, a shallow box of vulcanite, to which there was no cover, had its bottom drilled with a number of holes, 1/8 in. wide. This was set up on one of its sides on the Tank-bottom with its lidless top in contact with the lower part of the slab, the perforated bottom (now becoming the side) facing the interior of the Tank. Because Gosse needed at times to remove it in order to clean the holes, it was not cemented but merely kept in position by a heavy piece of rock work. By this contrivance, while the water can freely percolate and escape, nothing larger than the small holes can pass into the 1 in. bore waste-pipe and therefore it could never become choked.

In order to be able to lower the water surface in the Tank without dipping it out, the waste-pipe was cleverly turned into a Siphon. The waste pipe, after leaving the Tank, ran horizontally for a foot before it turned to the perpendicular. In the midst of this space a stopcock of vulcanite was inserted (Figure 3). This ordinarily was left open and served as an air vent. When Gosse wanted to draw off the water from the Tank, he took the tip of the stopcock into his mouth, and sucked strongly until the salt water came rushing up. In practice he found it necessary to suck such a mouthful at least three times before the up-current of water was strong enough to pour continuously down the perpendicular waste-pipe. He had to carefully to close the stopcock with is fingers at each suck, before he withdrew his mouth or the vacuum in part formed would again be destroyed. The water sucked into his mouth he instantly discharged into the Tank at each effort. After the water in the Tank was lowered to the desired level, the stopcock was opened, destroying the vacuum and the outflow instantly ceased. The jet-pipe in due course refilled the tank.

THE PUMP

The Pump supply pipe, a stout tube of vulcanite commencing 6 in. from the bottom of the Reservoir, passed over its edge, under the surface of the soil, across the yard, through the foundation of the house, up the interior of the wall, through the ceiling of the ground-floor and joined the bottom of the pump barrel, a cylinder of polished glass, 3 in. in diameter internally and 8 in. high. After allowing for the thickness of the piston it had a capacity of 1-1/ 2 pints when making its available stroke of 6 in. The engineers made two metal caps, one above and one below, grooved to hold the top and bottom of the glass cylinder (Figure 5). The caps were then joined by two metal rods

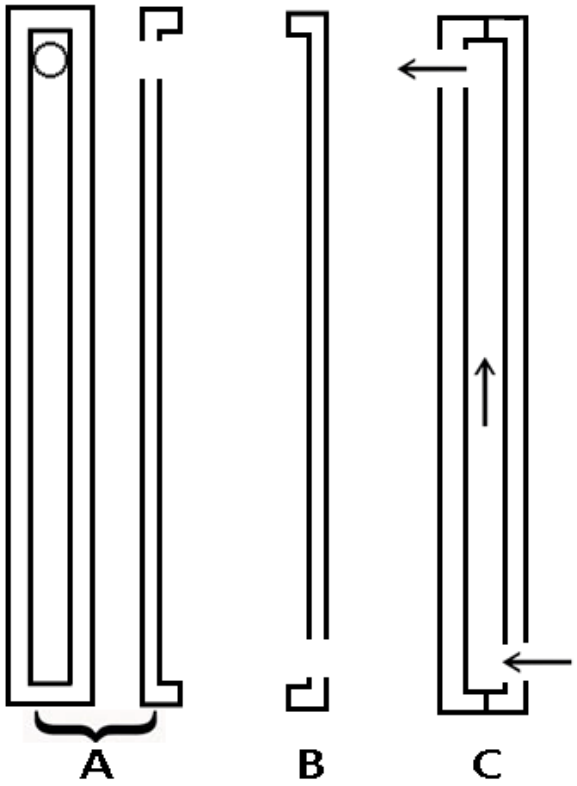

FIGURE 4: A 1/2 inch circular groove and a 1 inch hole were drilled in slabs A and B. When joined (C) and cemented to one side of the tank with the top opening at the end of the waste pipe, the waste water now entered at the bottom.

parallel to the glass barrel, screwed and nutted to the caps much in the manner of using rods to fasten the sides of the Reservoir, Cistern and Tank.

To avoid any oscillation during pumping, the fulcrum (handle) was fixed, independent of the barrel, to a stout wooden plank to which the pump was fastened. The end of a fulcrum travels in a slight arc that exposes the barrel to side strains that might break it. A "fork and cradle" motion, however, insured that the piston rod traveled strictly up and down . A guide to keep the fulcrum from moving side to side was also provided and fixed independently to the plank (Figure 6). These measures relieved the barrel from all side strains. The piston rod was of polished steel; the fulcrum of iron.

The basic operation of the pump is shown in Figure 7. The valve ball - a turned and polished ball of glass - descending by the up-stroke of the fulcrum, opened a chamber in which there was a second ball. This was forced in from the barrel by the incoming water and opened the Cistern supply pipe which, proceeding up through the ceiling, delivered the water into the Cistern above. At every downstroke of the handle, the pump delivered one and a-half pints of water from the Reservoir into the glass barrel, which water was the very next moment poured into the Cistern above by the following upstroke.

THE SYSTEM FINALLY GETS STARTED

The pump, pipes and the slate of the Tank were all painted black. An ornamental rim of polished Spanish mahogany was made to sit on the edge of the Tank and a curtain was hung to conceal the pump. By the end of September the whole was in place, and water was admitted into the Tank. Not till the last of October, however, were organisms admitted in the forms of growing Algae and Fishes, for not all went quite smoothly. The pump would not draw at first; the pipes leaked, and would not deliver until much

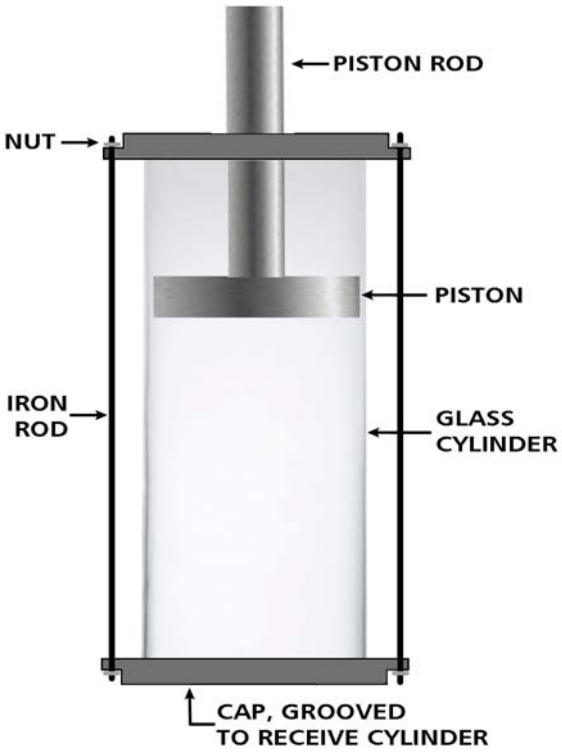

FIGURE 5:
Construction principle of the pump barrel (input and output not shown).

labor was expended in getting them water-tight. The water in the pump would drop back to ground level sooner or later after the pumping had ceased, so that sometimes it required more

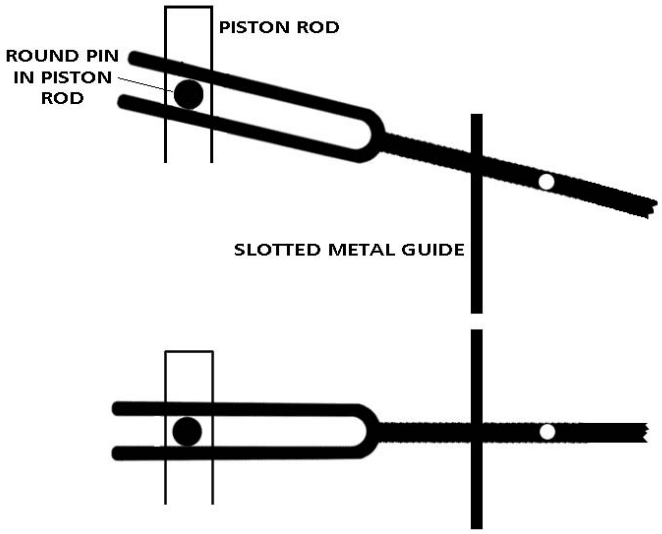

FIGURE 6: The "fork and cradle" movement .

than a hundred strokes of the handle before the water would rise to the barrel of the pump. This difficulty still continued in a mitigated form; it was the only one which Gosse never quite overcame. (Clearly the check valves were not tight. Gosse should have placed a ball-valve on the incoming supply line just before the pump, open during pumping and closed when pumping ceased.)

Then the siphon would not act at all for some time but, after several months, one day quite suddenly and unexpectedly it acted perfectly and operated without difficulty ever afterwards.

As soon as the system was operating regularly, Gosse found that his supply of water was inadequate. Some had been wasted and some had leaked in the imperfect fitting of the pipe joints. Accordingly, a further quantity was brought from Oddicombe beach, which made his stock as follows: Reservoir, 180 gallons; Cistern, 60; Tank, 40; equal to 280 gallons in all. This quantity was never afterwards needed to be replenished and its quality steadily improved.

Unfortunately, not enough time was spent in conditioning the vessels before adding specimens to the

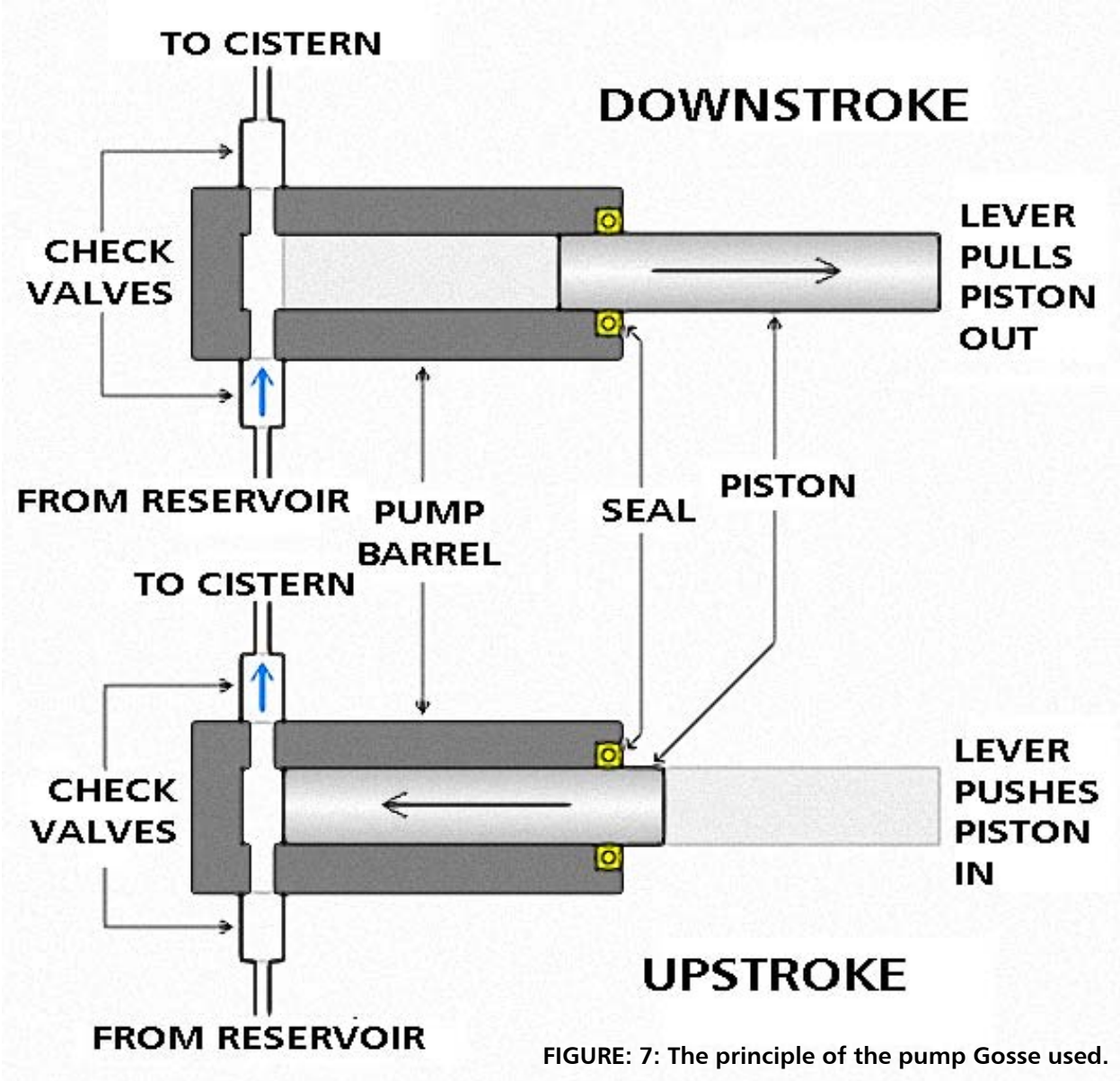

FIGURE: 7: The principle of the pump Gosse used.

Tank. Portland cement must be totally cured, as fresh cement leaches out materials that are poisonous to many aquatic animals. Vulcanite - a plastic - also requires conditioning time, as well as do the sealants Although many creatures died after a few weeks or even days a year before, a year later new arrivals lived in full health .

The system operation was as regular as clockwork. On Tuesday, Thursday and Saturday evenings, Gosse's servant pumped until the warning-pipe streamed, averaging some 675 strokes. The total of 675 strokes was performed in about half an hour. If the larger-bored jets were on, there had to be supplementary pumping in the off days to a varying amount. For fishes and the higher crustacea, etc., the fuller supply of jet No. 1 was required, and this took at least 250 strokes on each of the off days.

Not counting the cost of the pump, which was a gift from his friend Lloyd, the total cost was £60. Converting this amount to 2016 dollars, the result is $5,613, a pretty fair amount of change for a 40-gallon tank!

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Gosse, Philip Henry, "A Marine Aquarium," *The Midland Naturalist*, Vol. II, pp. 1-6, 1879.

Note: There are many methods available on the Internet for the historical conversion of Pounds Sterling to Dollars. This has given me a range of $4,540 to $9,300. However, I prefer Dr. Eric W. Nye's method. In order to convert British currency of former generations (I used 1876) to present-day (2016) American dollars, Nye uses the three following three sources in concert:

1. Davis, L. E. and Hughes, **J. R. T. "**A Dollar-Sterling Exchange, 1803-1895, *Economic History Review*, 2nd ser. 13:1, pp. 52-78, August 1960.
2. Douglas Jay, "Sterling: Its Use and Misuse, a Plea for Moderation" esp. "Appendix: The Purchasing Power of the Pound Sterling 1264-1983," London, Sidgwick & Jackson, 1985.
3. McCusker, John J., "How Much is that in Real Money?: A Historical Price Index for Use as a Deflator of Money Values in the Economy of the United States," reprinted from *Proceedings of the American Antiquarian Society*, 101:2 , American Antiquarian Society Worcester, MA., 1992.

Nye's calculation returns the value of $5,612.91.

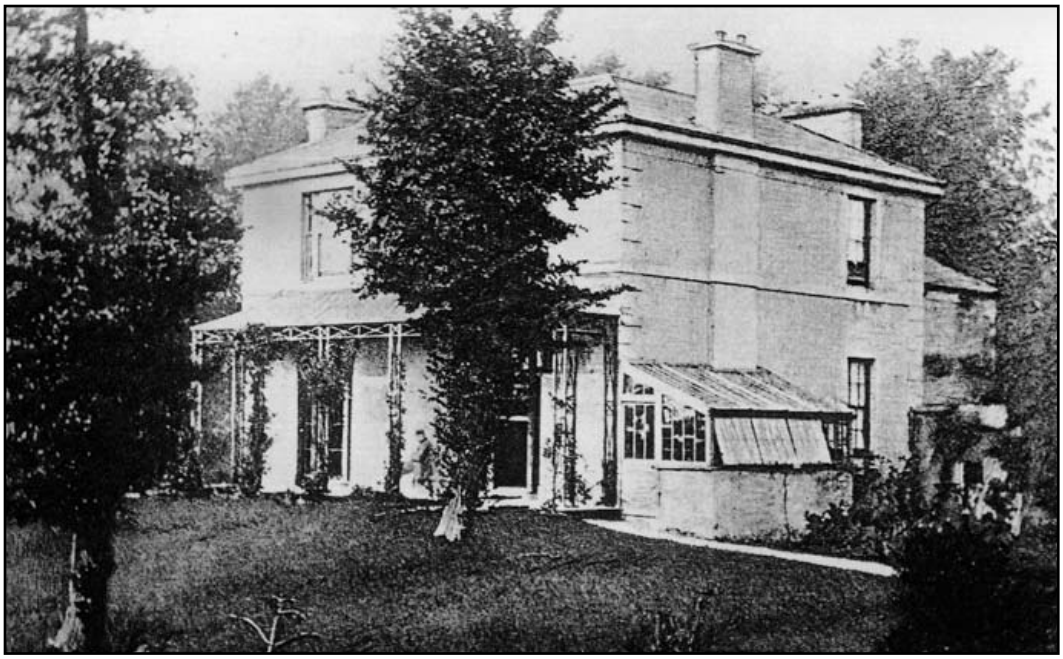

Figure 8: Gosse's House with the aquarium shown on the right.

DAVID WILLIAM MITCHELL

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, September 5, 2016)

The beginnings of what we think of as the aquarium hobby had its origins in the mid 1850's in England. Four individuals were at the fore in this development, three of the most prominent being Robert Warington, Philip Henry Gosse and William Alford Lloyd. The fourth, David William Mitchell, is lesser known but important in the development of the public aquarium. Like Shirley Hibberd and Hugo Mulertt, both of whom were known for their activities other than the aquarium - horticulture in their case - David Mitchell was known for his contributions to ornithology.

David William Mitchell was born in Chalfont St. Peter, a town about 23 miles northeast of London, on August 4, 1813. His parents were financially well-off, his father's occupation variously described from the 1841, 1851 and 1861 censuses as "Independent means" or "Fund Holder." The family moved to Gerard's Cross, Bucks County and then, when David Mitchell was at Oxford, to Cavendish Crescent in Bath. Mitchell graduated from Christ Church, Oxford in 1836 with a Bachelor of Arts and an interest in ornithology. The following year he married Prudence Philips Willes, the daughter of a Bath cleric.

PENZANCE

By 1838 Mitchell and his wife were settled in Penzance, Cornwall, a town about 255 air miles from London. Towards the end of 1838, the *Penzance Natural History and Antiquarian Society* was founded by the Mayor of Penzance, Richard Moyle, in response to a petition drawn up at a meeting held on the 4th of that month by 69 people. The Society, whose aim was "the cultivation of the science of Natural History, and for the investigation of the Antiquities referring to the early inhabitants," was established at a public meeting on November 20, 1839, with an annual subscription of 10 shillings or life membership of £5. The society held meetings where lectures were delivered and discussed, had an annual excursion to visit the antiquities of the area and maintained a museum.

The Officers of the Society included a President, three Vice-Presidents, a Treasurer, four Secretaries who were also Curators of the Museum, and ten other members that constituted a Council, all elected yearly at the annual meeting. David Mitchell was one of the Council members. Despite the initial enthusiasm, very little happened; the Secretaries and Curators' Report at the 1845 Annual General Meeting concluded: **The society having somewhat revived from the torpor which has for some time hung over it, the council hopes that its increased energy will**

Figure 1: David William Mitchell (1813-1859), 1850 portrait.

be continued without further interruption. The first volume of *Reports and Transactions* was finally published in 1851, covering the years 1845–51.

The problem is that the first printed *Reports and Transactions of the Society* was for the year 1845 and Mitchell's last year in Penzance was 1842. However, the following appeared in the *Report of the Society for 1847*:

In the ornithological department of our society, several interesting discoveries of rare species of British birds have been made… At the same time that it is gratifying to record the above interesting captures, it is to be regretted that we have been deprived of many valuable services which we formerly were able to avail ourselves of in this department of our society, by the absence of one of our late secretaries, Mr. Mitchell…

Thus, either in 1841 or 1842 or both, Mitchell served as Ornithological Secretary and Curator. Among his other activities, Mitchell was also a collector and dealer in bird skins and eggs.

Mitchell was well-known among the ornithologists of the day during his stay in Penzance. He is mentioned, for example, in William Jardine's "Birds of Britain and Ireland," William Yarrell's **"**A History of British Birds," Isaac William North's, "A Week in the Isles of Scilly," Henry E. Dresser's, "A History of the birds of Europe" and Jonathan Couch's "Jonathan Couch's Cornish Birds."

Figure 2. Species and subspecies of birds named after Mitchell. Upper Left: Diademed Plover (*Phegornus mitchellii*); Upper Right: Mitchell's Lorikeet (*Trichoglossus forsteni mitchellii*); Lower Left: Purple-throated Woodstar (*Calliphox mitchellii*); Lower Right: Grey-Capped Pigmy Woodpecker (*Dendrocopos canicapillus mitchellii*).

Jonathan Couch (1789-1870), a surgeon apothecary of Polperro, was one of the pioneering natural historians of his day, and his reputation is secured by his great works, notably his four-volume "Fishes of the British Islands," published in 1864 in four volumes and illustrated with 259 color plates based on his drawings. It is a classic still used by zoologists today. Couch was a good friend of William Yarrell (1784-1856) and stayed with him, for example, in Yarrell's London home in 1835 and 1849. In 1835-1836 Yarrell published "A History of British Birds," in two volumes and nearly 400 woodcuts, followed by a supplement in 1839; he also had an avid interest in fishes. Mitchell on the other hand, showed no interest in fishes during his stay in Penzance.

Mitchell also contributed to natural history magazines; the following istaken from *The Magazine of Natural History* in 1839:

Capture of rare Birds.—To the instances of the rose-coloured pastor mentioned by Mr. Yarrell, I have to add another (in mature plumage), which occurred in the beginning of last month at Gwithian, about twelve miles from this place, on the north coast.

On the 29th April I obtained a fine specimen of the greyheaded wagtail—a male—having the slight mixture of olive green in the grey feathers of the head, which Mr. Yarrell states to be characteristic of the bird of the preceding year. It was first noticed on the margin of a pool near the sea, between this place and Marazion.

Two instances of the little gull in this neighbourhood have come to my knowledge. The first, in St Ives' Bay, on the 26th of December last, was a young male in moult, and I suppose in transition to the mature plumage, as several grey feathers appear among the brown of the back. It seems to be a rather large specimen, the total length being 12 inches; wings from tip to carpal joint, 10-1/2 inches ; total extent, 33 inches: tarsus l-1/4 inch ; middle toe and claw l-1/4 inch; gape l-1/2 inch. The central feathers of the tail are 1 inch shorter than the outermost.

The other was also a male, but in the adult winter plumage, and of great beauty. It was shot here, in the harbour, March 4th, and is said to have been accompanied by another, which escaped. The only respect in which it differs from Temminck's description is the colour of the legs and feet, which were a delicate flesh colour.—D. W. Mitchell.—Penzance. July, 1839.

Towards the end of 1842 Mitchell was offered a job by George Robert Gray illustrating birds. Gray (1808-1872) was an English zoologist and author, and head of the ornithological section of the British Museum (now the Natural History Museum) in London for forty-one years. Gray had first published "A list of the Genera of Birds" in 1840, publishing a revised list in 1841 and an

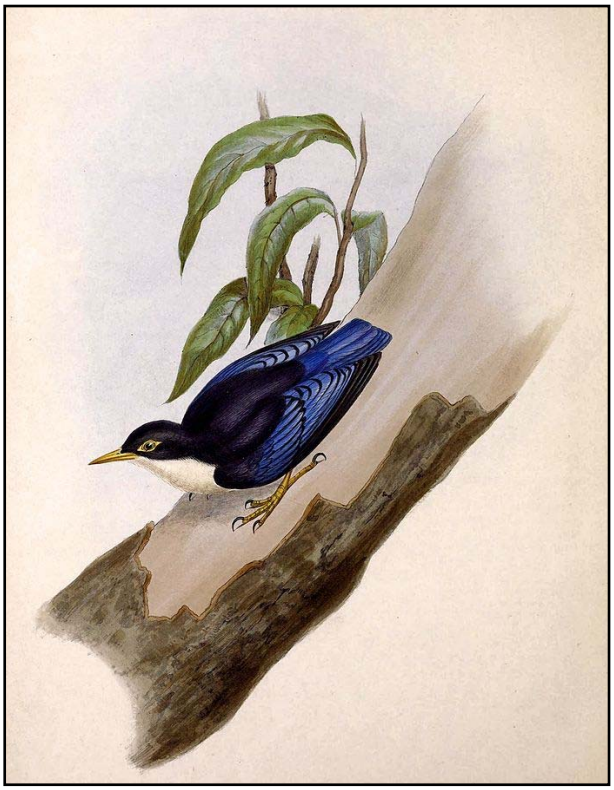

Figure 3. *Sitta azurea nigraventer*, one of Mitchell's illustrations in Gray's "The Genera of Birds."

updated list in 1842 before expanding it into three volumes called, "The Genera of Birds" (1844-1849), which was illustrated by Mitchell. In order to work closely with Gray and for easy access to the resources of the British Museum, by 1843 Mitchell and his wife had moved to London.

THE LINNEAN SOCIETY OF LONDON

The *Linnean Society of London* is the world's oldest active biological society. Founded in 1788, the Society took its name from the Swedish naturalist, Carl Linnaeus (1707–1778), whose botanical, zoological and library collections have been in its keeping since 1829. In the early 1800's, a cultural antipathy towards post-Napoleonic France generated a desire among British naturalists to wrest from French hands the intellectual leadership in zoology. In 1825, Yarrell was elected as a Fellow of the *Linnean Society*, and in 1849 was appointed treasurer, an office that he filled together with that of vice-president until his death.

However, The Linnean Society's botanical bias was seen as an obstruction in their path. Consequently, a group of zoologists banded together to form their own institution. On November 29, 1822 - the birthday of John Ray, "the father of modern zoology" - a meeting consisting of politically conservative natural theologians was held in the Linnean Society where it was resolved to form a *Zoological Club of the Linnean Society of London*. The group favored a method of zoological classification called the "Quinarian system," largely developed by the entomologist William Sharp MacLeay in 1819, in which it was proposed that all taxa were divisible into five subgroups, and if fewer than five subgroups were known, then they believed that a missing subgroup remained to be found.

Under the aegis of the *Linnaean Society*, the *Zoological Club* struggled from its inception for greater autonomy from the parent organization, in great part due to the Linnaean Society's overwhelming emphasis on botanical studies but also as reaction against Linnaean systematics and what they considered the Society's autocratic and outmoded restrictions on methodology.

THE ZOOLOGICAL SOCIETY OF LONDON

Our modern zoological gardens and zoological parks owe their origins to the enthusiasm and foresight of one man, Sir Stamford Raffles and a group of collaborators. Raffles had for a long time cherished the idea of establishing in London a collection of animals from all parts of the world. Most of his life, however, was spent in the Far East as a distinguished servant of the East India Company, and it was not until he returned home for good in 1824 that he was able to go ahead with the project. He had already been in contact with a number of people in London, and even while he was on the way home a meeting of "friends of a proposed Zoological Society" met in London and drew up a prospectus. The earliest record we have from Raffles himself is in a letter he wrote to a cousin, Dr. Thomas Raffles, in 1825:

Figure 4. Sir Thomas Stamford Raffles (1781-1826).

I am much interested in present in establishing a Grand Zoological Collection in the Metropolis, with a Society for the introduction of living animals bearing the same relations to Zoology as a science that the Horticultural Society does to Botany ... Sir Humphrey Davy and myself are the projectors, and, while he looks to the more practical and immediate utility to the country gentleman, my attention is more directed to the scientific.

Next to Raffles, Sir Humphrey Davy, President of the *Royal Society* from 1820 until 1829 and the acknowledged leader of British Science at that time, played the most important part in the development of the new Society. His backing probably had a considerable effect in enlisting the support of other eminent and influential men. When asked for support by Raffles, Davy helped to recruit but took a different approach. He was interested in recruiting members from those landed gentlemen who preferred to collect exotic animals rather than to discuss scholarly nomenclature. Unlike the first prospectus, the second comprised several short paragraphs, which proclaimed that the object of the society was the display and domestication of wild animals and the provision of successfully bred specimens for the subscribers. It omitted references to "a philosophy of Zoology," with its associations with the Quinarian system of taxonomy.

In this prospectus there was no mention of the existence of the *Zoological Club of the Linnean Society* but there was an overlapping of interest, and Aylward Vigors, an Irish zoologist who popularized the classification of birds on the basis of the Quinarian system and who was the first secretary and last chairman of the *Zoological Club*, was the first secretary of the *Zoological Society*. By 1829 the club was dissolved, by which time most of its members had joined the new Society.

Between 1824 and 1826 discussions between Stamford Raffles, Humphry Davy, Joseph Banks and others led to the idea that London should have an establishment similar to the *Jardin des Plantes* in Paris.

Frequent meetings of the committee over a period of nearly two years led finally to the first General Meeting of the Friends of the proposed Zoological Society. This took place on the April 29, 1826 at the offices of the *Horticultural Society*. It was at this meeting that the *Zoological Society* was definitely constituted, and a series of resolutions adopted fixing its principle features. The affairs of the Society were to be conducted by a President, Secretary, Treasurer and Council, and not unnaturally Raffles was elected first President.

At this meeting it was also announced that the Commissioners of Woods and Forests had agreed to allocate to the Society a plot of Crown land in Regent's Park extending to about five acres. There were 77 original subscribers, among whom included Sir Stamford Raffles, Sir Humphrey Davy, president of the Royal Society at the time, the duke of Bedford, the Marquis of Lansdowne,

Figure 5. Sir Humphry Davy (1778-1829).

Robert Peel and Alexander Baring, M.P. William Yarrell was one of the original members or founders of the Society and took an active part in its proceedings, both as a naturalist and as a man of business.

Raffles, however, died in July 1826 after only a few months in office. He was succeeded by the Marquis of Lansdowne who supervised the building of the first animal houses, the parcel of land in Regent's Park having already been obtained from the Crown at the inaugural meeting. (It received a Royal Charter from George IV on March 27, 1829.)

The purpose of the Society was to create a collection of animals for study at leisure, an associated museum and library. A house was obtained in Bruton Street in Mayfair for the new Society where meetings were held, a museum established, and a certain number of living birds and mammals kept. In the course of 1826 negotiations with the Crown were successfully conducted for the use of part of Regent's Park, and the latter part of 1826 and 1927 were occupied with the laying-out of the new Zoological gardens.

Early in 1828 there were a few pinioned wild duck on a lake, an emu, an otter, some silver-haired rabbits and several birds of prey. It is reported that on February 25, 1828, there were four visitors to the gardens, but under what conditions they were admitted is not known. On April 27, 1828, a superintendent was appointed, and the Zoological Gardens were opened to members. It was decided that visitors should be admitted on the presentation of a voucher from a Fellow and the payment of 1 shilling. Considerable progress was made during the remainder of 1828 in stocking and laying out the gardens.

In 1831 William IV presented the royal menagerie

Figure 6. The Gardens of the Zoological Society of London, Regent's Park, 1829.

to the *Zoological Society*, and in 1847 the public were admitted to aid funding, and Londoners soon christened the Zoological Gardens the "Zoo." The London Zoo soon had the most extensive collection of animals in the world. In its early days, when as property of the *Zoological Society*, the Zoo was open only to members and such of the public as obtained the consent of its members. At that period it was said, "The vulgar are too fond of irritating the fiercer animals and of teasing and hurting those that are gentle."

MITCHELL IN LONDON

On November 21, 1843, Mitchell was elected into the Fellowship of the Linnean Society of London. His many proposers included William Yarrell; Edward Doubleday (1811-1849), an outstanding ornithologist who doubled at the British Museum as an entomologist; and John Gould (1804-1881), a distinguished ornithologist, bird artist and publisher. In 1827, at age 23, Gould was appointed a taxidermist on the staff of the *Zoological Society of London*, of which society he was to become a leading figure in later years. With backers like these (especially Yarrell), it is not surprising that on December 6, 1843 Mitchell was elected into the Fellowship of the Zoological Society London. On November 6, 1844, he was elected Secretary of the Zoological Gardens and Arrangement Committee of the Zoological Society.

In 1827 it was resolved by the Society that "the Gardens be opened to the Public every Wednesday and Saturday, on the payment of 1s./each person." Members were however admitted at all times and they had the opportunity to introduce a non-member. But less than a year later it was decided that strangers could only be admitted to the Gardens by written orders from a member. There also existed a system of different tickets, with different privileges attaching to them. This meant that since the Council issued the tickets, the Society had total control of who visited the Gardens,. The purpose of this system was explained as follows:

It is evidently proper, that in the admission of

Figure 7. Three-Island Park. The Aquarium was located next to this pond.

Strangers, some degree of system should be observed, especially at the Garden, for the sake, both of preventing mischief and injury to the Animals, and to the Garden itself, and of contributing, in some degree, to save the visitors themselves from the accidents that sometimes attend exhibitions of wild beasts of prey. The vulgar are too fond of irritating the fiercer animals, and of teasing and hurting those which are gentle; and both vulgar and others are often exceedingly rash, in introducing their hands into the dens and enclosures, or careless in placing themselves so near the bars, as to defeat the effect of every precaution for their safety. The necessity for order almost prevents young people from coming without some superintendence.

This system was continued throughout the 1820s and 1830s but eventually changed at the end of the 1840s as will be described shortly.

The number of visitors to the Zoological Gardens had gone down steadily since 1836, a record-breaking year when more than a quarter of a million people passed through the gates. The 1830s and '40s were hard times in Britain generally and this most probably affected the entertainment industry as a whole with decreasing attendance at museums, panoramas and the like. At a special meeting in 1845 the Council tried to find out whether the wages paid to the officers and staff in the various establishments of the Society, i.e. general, museum, menagerie and carpentry and engineering, could be reduced.

The Committee of Receipts and Expenditure, however, could not find where these reductions were to be made. The only area that could perhaps be slimmed was the menagerie, but there had already been layoffs during the previous four years. Five people had had to go, including the medical superintendent (a measure not altogether beneficial for the collection in general) and three keepers. Therefore, the Committee could not see that any further reductions would be realistic. Unfortunately, the situation did not improve over the next few years, but instead grew worse.

Figure 8. Strolling next to the Parrot and Elephant Houses.

Another problem was that the Secretaries, important positions in an institution that had to be run like a paying business, traditionally were honorary and unpaid. The consequence of this was that they were prone to look to their own business rather than the Society's if they felt the need. In the beginning of 1847 the current Council Secretary, William Ogilby, sent a letter to the Council where he asked to be relieved of his duties. As an Irish magistrate and landlord his duties lay elsewhere. The Great Famine or the Great Hunger being a period of mass starvation, disease, and emigration in Ireland between 1845 and 1852, he informed the Council:

I am myself giving daily employment to from 30 to 40 heads of families to keep them from actual starvation: the distress is daily increasing, and though this part of the Country has been hitherto free from outrage no man can tell how long it will continue so...

The Council now decided that the position must carry a salary. The secretaries had hitherto been appointed from within the closest circle of the Society but now the net was cast a bit wider. At a special meeting on February 10, 1847, David William Mitchell was appointed a member of the Council and Secretary with a salary of £250 per annum. On April 27 of this same year, Mitchell's daughter, Lillian, was born.

JOSEPH WOLF

When Mitchell was appointed as Secretary to the Zoological Society he decided that he could no longer cope alone with illustrating Gray's "The Genera of Birds," and so looked to someone who could help in completing the project. That someone was Joseph Wolf (1820-1899), a young German artist who specialized in natural history illustration. Wolf depicted animals accurately in lifelike postures and is considered one of the great pioneers of wildlife art. Sir Edwin Landseer thought him "...without exception, the best all-round animal artist who ever lived." In 1847 Mitchell sent him a letter, inviting him to London to help with the book. Wolf declined at first but nine months later changed his mind and met Mitchell at the British Museum 1848.

At The Museum he was cordially welcomed by Mitchell (who was able to converse with him in French), and was straightway carried off to take possession of some temporary quarters in Howland Street, Fitzroy Square. Finding these quarters to be to his satisfaction, Wolf afterwards settled down permanently nearby. Mitchell was determined to counteract the depressing effect of the weather, and on the very first evening, he made up a little party for the theatre, including Mr. Trübner the publisher who acted as interpreter. The next day Wolf was installed in the Insect Room of the Museum, and began his work for Gray's Genera of Birds. Mitchell, in his "Postscript by the Illustrator," wrote:

It is perhaps scarcely necessary to state that the illustrations of this Book have no claim to be considered as works of art. My constant object has been to represent as closely as possible those characteristic variations of form

Figure 9. Joseph Wolf (1820-1899).

which are relied upon by ornithologists as the distinctive marks of generic separation. When I accepted the office of Secretary to the Zoological Society and found myself no longer able to devote to the completion of the series of plates the time which the work demanded, I was fortunate enough to obtain the assistance of Mr. Wolf of Coblenz [Mitchell did not know Wolf's native place]; and I have the pleasure of believing that, as I thus secured the best available talent in Europe as a substitute for my own pencil, my friends will have no cause for regret that the latter part of the work has been entrusted to another hand.— Montague Street, August 29, 1849."

If the illustrations by the veteran naturalist (Mitchell), are compared with those by the young, self-taught artist of twenty-seven (Wolf), one can at once see a difference and agree that the friends of the former had little cause to regret his relinquishing the work, even though only eleven or so of the hundred and eighty-five colored plates and fifty-nine out of the hundred and forty-eight plates of detail in the book are of Wolfs doing . It is especially noteworthy that while Mitchell often conscientiously copied the "distortions of the bird-stuffer," Wolf's work in no single instance ever suggests a stuffed specimen. It is in this power of revivifying a dried skin - and not merely revivifying, but showing the most characteristic and beautiful attitude and expression of the living bird or animal - that Wolf stood alone then and stands alone even now.

MITCHELL'S RISE TO PROMINANCE

Since the economy had not improved and it had not helped to cut expenses, only one thing remained for the Society to do: let the general public into the Gardens. The system with signed tickets had persisted until now, but it had to go. In 1847 in their annual report at a special meeting, the Committee of Auditors suggested that the public should be admitted to the Gardens:

Figure 10. The Monkey House at the Zoo.

…if active and energetic measures are taken for affording greater facilities to the Public of participating in that enjoyment, and for keeping constantly before the eyes of the Public, not only in London but throughout the kingdom, the collection of Quadrupeds, Birds and Reptiles [...] the Society will rapidly recover its ground and be again restored to its former gratifying and prosperous position...

Though unwilling in the past, the Council relented and resolved that the public should be admitted into the Gardens on Mondays and Tuesdays for payment of a shilling. This admission was furthermore extended to Easter and Whitsuntide (the 7th Sunday after Easter), both of which were legal holidays in England, Wales and Ireland. The following item appeared in *The Illustrated London News* May 22, 1847:

GARDENS, REGENT'S PARK. The Public are informed that Visitors will be admitted to the Gardens on the Zoological Society on WHIT MONDAY, and the Four Following Days, on the payment of 1sh. for each Person. An Exhibition of Domestic Poultry will take place on July 29th, 30th and 31st; the particulars of which and a list of the Prizes, may be had at the Office, No. 11, Hanover Square.

Judging by contemporary sources, Mitchell was the single most important person during this period in the Society's and the Gardens' history. Albert Gunther, later foreign member of the Society and curator of the Natural History Museum in London, wrote in his diary after a visit in 1854:

Wednesday to the zoological gardens; grandiose, excellently arranged and the animals happy. The Secretary, D.W Mitchell, must be something of a genius.

The Athenaeum, although not as enthusiastic as Günther, was still impressed:

The Zoological Society—started under the most favourable auspices—had fallen a few years ago into the condition of its older brethren. The gardens drooped,—the museum was closed, the meetings were dull, prosy and thinly attended. When things were at the worst, a new officer was appointed,—and 'hey, presto!' all was changed. The gardens grew into the most fashionable, as well as the most popular, of resorts.—the museum again courted the light of day,—the meetings of the Society were well attended...

Mitchell also invented the so-called starring system, which proved to be a long-lasting success at the Gardens. The condition of the system was that there should always be a "star" at the Zoological Gardens, an animal or an attraction that would be the primary reason for the public to visit the Gardens. Once there, they would be encouraged to feast their eyes upon the rest of the collection as

Figure 11. The Western Aviary.

well. This star was furthermore generously promoted in the press by articles and advertisements. The 1850s started with the four-ton hippo Obaysh, obtained in 1851. Other animals would soon follow; a female elephant and her calf, an anteater, a female companion to Obaysh and so on. The *Quarterly Review* thought that Mitchell:

…has shown by his system of 'starring' how alive he is to the fact that it is to the sixpenny and shilling visitors who flock to the gardens by tens of thousands on holidays that he must look to support the wise and liberal expenditure he has lately adopted.

In 1852, William White Cooper, who was a prominent ophthalmic surgeon and friend of Richard Owen, Frank Buckland, George Lewes and Thomas Huxley, wrote the following inscription in his "Adventures with Animals: Zoological Notes and Anecdotes":

To David William Mitchell, Esq., B.A., secretary to the Royal Zoological Society of London, etc. this volume is inscribed by an admirer of the zeal, energy, and talent, displayed by him in advancing the science of natural history.

Mitchell was on the crest of a wave of popularity.

MITCHELL'S INTEREST IN FISH IS BORN

Robert Warington married the daughter of surgeon George Jackson F.R.S. (1792-1860), a keen microscopist of repute. It was around this time that Warington joined the Mathematical Society of Spitalfields, which he attempted to regenerate by organizing a number of lectures at their meeting place in Crispin Street, but with little success. It was here that he was introduced to his father-in-law's close associate, James Bowerbank. James Scott Bowerbank, (1797 - 1877) was a British naturalist and paleontologist best known for his studies of British sponges. He devoted much time to the study of natural history while running a family business, Bowerbank and Company, distillers, in which he was an active partner until 1847.

In 1841 Nathaniel Ward set up an aquarium for fish and plants in a large earthenware vessel. In this vessel, which contained twenty gallons of water and in which he surrounded with rock-work raised several feet above its margin, he placed goldfish and several aquatic plants, viz. *Valisneria spiralis, Pontederia crassipes, Pistia stratiotes,* and *Papyrus elegans*. In this miniature lake, the water of which was never changed but kept in a constantly pure state by the action of the associated plants, the animals lived in a healthy condition for many years. However, he never published this in-

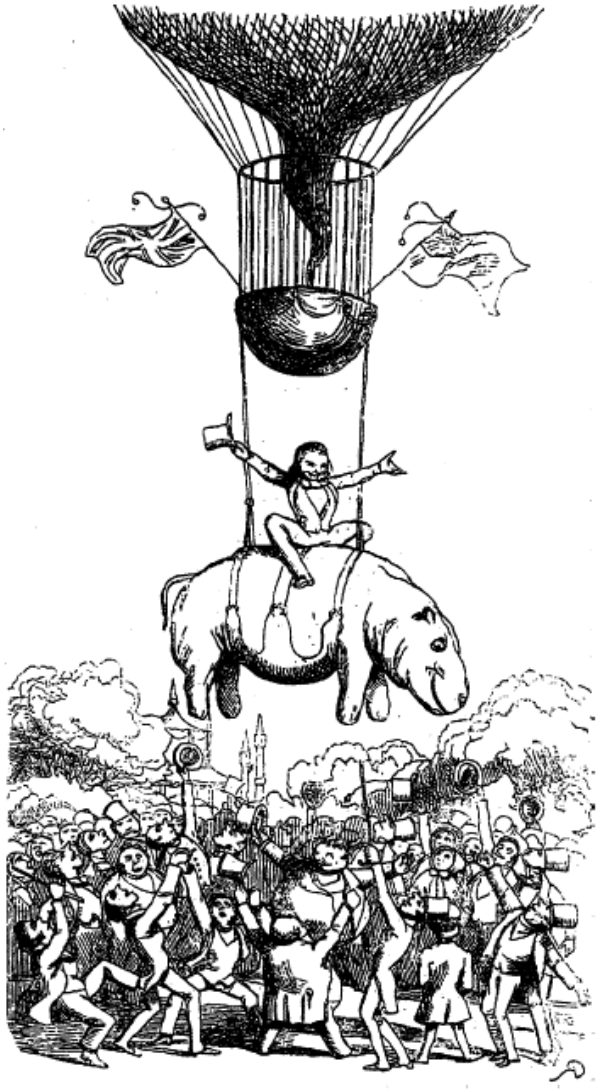

Figure 12. Punch pokes fun at the starring system. The hippopotamus with another popular attraction, the hot-air balloon (*Punch*, 1850).

formation. This aquarium gave Bowerbank (both he and Ward were members of the Microscopical Society of London and knew each other) the idea of taking a large glass jar, in which he placed sticklebacks, minnows, and snails along with plants of *Valisneria*, and covering it with a piece of glass. It was this jar of Bowerbank's that attracted the attention of Mitchell and gave him the idea for the public aquarium that was opened in 1853 in the Zoological Gardens in Regent's Park. The following is from Newman's aquarium history (*The Zoologist*, October 1873):

At our delightful reunions at Mr. Bowerbank's, first at Critchell-place and afterwards at Highbury, the lamented David William Mitchell, then the energetic Secretary of the Zoological Society, who was ever on the alert for something to "draw," was a frequent visitor; the sticklebacks arrested and riveted his attention, and he was not long in taking a lesson from Mr. Bowerbank's book: every one urged it; and Mr. Mitchell listened with marked attention, and conceived the project of an aquarium in the Regent's Park. With Mr. Mitchell there was seldom much time lost between the conception and the execution of a plan. In this instance these followed each other with unparalleled rapidity; he commenced building forthwith, ordered his tanks, and stocked them with their appropriate inhabitants, availing himself of every observation previously made either by Mr. Bowerbank or Mr. Warington.

Lloyd also credited Warington as being the inspiration for Mitchell's projects (Lloyd, 1879):

Mitchell's venture with the animals lower down in the scale of existence than birds [Lloyd is talking here about the first reptile house in any zoo, established at the Zoological gardens in 1849] **was so successful that he resolved at going down still further—namely, from and including fishes and to the very beginning, as it were of life, even down to zoophytes and sponges, thus comprising the mollusks, the animals, the worms, the starfish and their allies, and the sea anemones, so that visitors should be able to see in clear sea and fresh water, and through translucent plates crustaceous of thick glass, all manner of marine and fluviatile creatures, swimming, climbing, creeping, and almost or quite fixed, and of the most elegant forms and unusual coloring. This resolve was taken in 1850, and it was a direct consequence of the reading of a paper on the 4th of March in that year, by the late Mr. R. Warington, the chemist to Apothecaries' Hall, London, before the Chemical Society, on the manner in which he succeeded in maintaining some gold fish in unchanged water for a prolonged period.**

THE FISH HOUSE BECOMES A REALITY

On February 18, 1852 the Council of the Zoological Society agreed that work should start immediately on the building of an "Aquatic Vivarium," an early term for a fish tank or fish enclosure. The site chosen was between the Capybara's Pond and Eagle's Aviaries and the Three-Island Pond (Figure 7) consisting of chiefly British waterfowl. Mitchell conferred with both Gosse and Warington on the

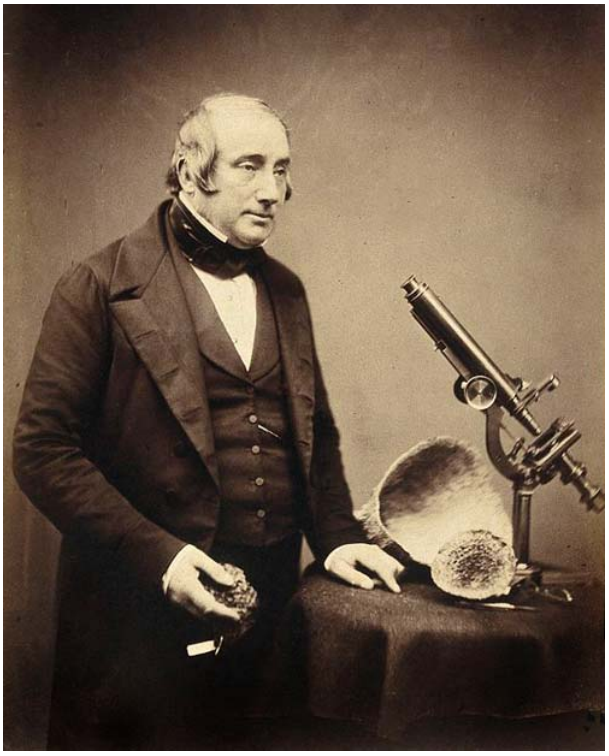

Figure 13.
James Scott Bowerbank (1797-1877).

Fish House. Gosse's idea for the larger display marine tanks was to place a small tank below each display tank. Using a hand pump, water was pumped from each of these tanks to a single large cistern and from there it flowed into the display tanks, being oxygenated as the water fell.

This was a scaled-up variation of the "drip-glass" method Gosse used for his own aquariums. (One should also note that the principle involved was put into practice by Anna Thynne in 1846 when she had her maid pour seawater back and forth in two glass bowls containing madrepores.) In fact, it was basically the system favored in the public aquariums designed some years later by William Saville-Kent. Neither Gosse's system in the Zoo's Fish House or Kent's system were adequate, however; the water became turbid, threatening the health of the marine animals and their visibility to the public, and had to be replaced often.

This, however, was not the case with the large freshwater display tanks. In 1823 a well was sunk and a steam-engine erected in the gardens, at a cost of about £2000. The steam-engine pumped water throughout the Gardens and was operated an average about eight hours daily, the average daily supply of water being about 1900 tons. The freshwater aquariums were connected to this system, allowing the water to run through them, the overflow then once again being available to the Gardens. The first tank that was installed contained freshwater, and this was set up according to Warington's instructions, with aquatic plants planted in the bottom and populated with a large pike.

Regarding tank construction, Warington actually invented the form of the aquarium as we know it today. The following is from the January 1852 issue of *The Garden Companion*:

Since the reading of my paper before the Chemical Society, on March 4, 1850, respecting the Miniature Aquarium (*Quarterly Journal of the Chemical Society,* iii 52), I have continued the investigations, introducing other water plants, and also three other varieties of water snail. But the principal alteration has been the construction of a better form of vessel for holding the water, as I found that the globular form of the glass receiver, produced a distortion in the vision of the fish, besides being very inconvenient for observation. I have therefore adopted the form of vessel, of which a sketch is appended, having flat surfaces of plate-glass at the back and front, the bottom and ends being formed of slate, and supplied with a loose plate of glass at the top to keep out dust and soot.

To render the whole more ornamental, as it was to stand in a sitting room, some pieces of tufa, or sandstone, were attached to the ends by means of Roman cement, so as to form ledges and slopes rising from the water line,

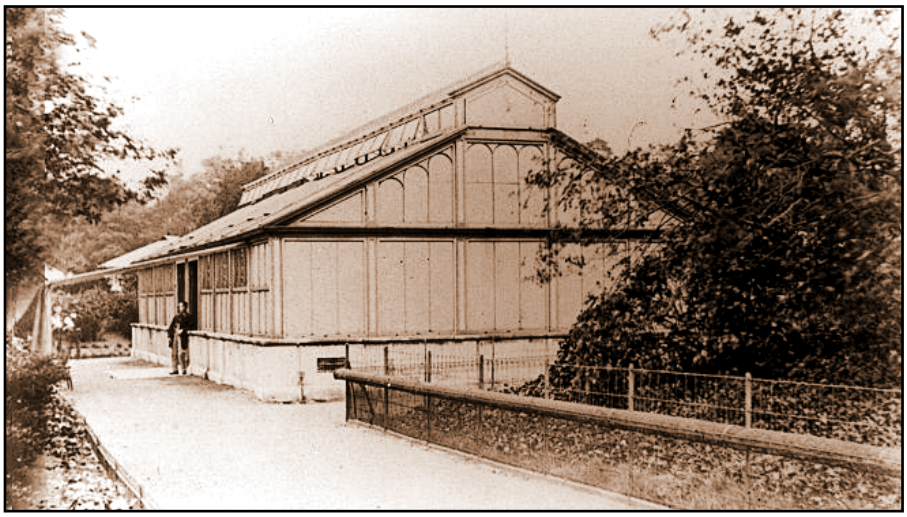

Figure 14.
The Fish House.

on which mosses and ferns, such as luxuriate in an atmosphere loaded with moisture, could be grown. These materials are set in a stout angular zinc framework, and connected with a mixture of white-lead ground in oil, to which about an equal quantity of red-lead is added. This arrangement I have found to answer all my expectations, as it has been going on most flourishingly since January 1851. The plants consist chiefly of *Hymenophylum tunbridgense*, and *H. Wilsoni*, *Trichomanes speciosum*, *Blechnum boreale*, *Adiantum Capillus-Veneris*, and several mosses. The whole of the interior can be viewed with the greatest ease, so that the natural habits of its living inhabitants can be watched and accurately noted in every particular.

The tanks destined for the Fish House that Mitchell obtained from Sanders &Woolcott (they had installed the piping in the Zoo's Hippopotamus House in 1850) followed Warington's design, save Mitchell opting not to place ornamental tufa or sandstone in them (See Figure 15).

Some more details were provided some years later by William Lloyd in the August 1879 issue of the *Scientific American Supplement*:

The erection of the Regent's Park Aquarium, or as it was and is called, the "Fish House," was proceeded with slowly in 1851, and I first saw it from its outside, through its glass walls, on Thursday, November 18,1852, at noon. It was not open, or even wholly complete, and it was indeed not opened to the public until 11 A.M. on Saturday, May 21, 1853, it being pictorially illustrated and described on one whole page of the Illustrated News of the following Saturday, May 28. It was and is a conservatory-like building, running north and south, measuring 54 ft. long, 80 ft. broad, and 12 ft. high to the upper part of the vertical portion, and 20 ft. high to the apex of the doubly-sloping roof. Surmounting the breast-high brick walls, which originally formed the only opaque part of the building, are seven tanks on one side and six tanks on the other, each measuring about 72 in. long, 24 in. broad, and 24 in. high. Placed on the floor in groups, with walking spaces between them, are about eight other and smaller tanks, standing on wooden-inclosed cupboard-like frames, and one of these cupboards contains an arrangement something like an inverted iron balance, by means of which the two tanks placed over it can be alternately depressed and elevated in such a manner that the water may run in and out and so give a kind of semblance to a tidal action. This apparatus, however, has never been used. All these tanks, which still remain in the same position of more than a quarter of

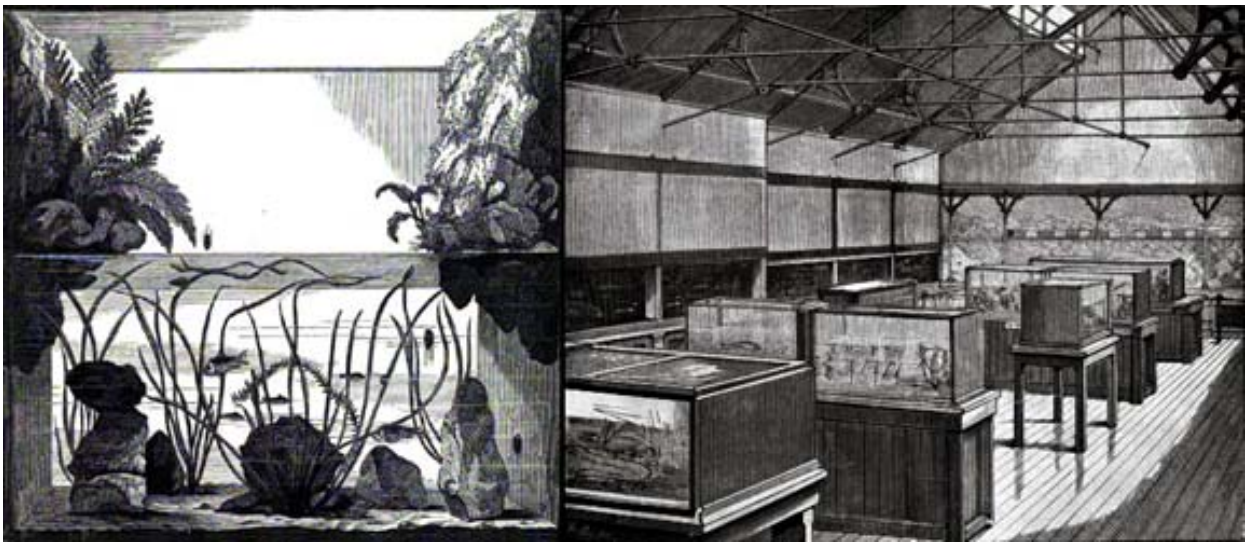

Figure 15. Left: Warington's aquarium design. Right: The aquariums in the Fish House.

a century ago, have, save one, slate bases and ends, and glass sides. The two ends of this "Fish House" are arranged for small aquatic reptiles, as tortoises and alligators, and for the lesser aquatic birds.

Fresh water from the ordinary sources supplying the gardens generally, ran into one end of the larger series of tanks (those on the side walls), and, running right and left of the entrance door, emptied their uncontaminated streams into two sunken and not glazed tanks at the ends of the house, and from them it flowed to waste (so called), into the garden sewers. The smaller fresh water tanks standing on the floor, and unconnected with each other or with any other tank, had no current in them, and their water was but occasionally renewed, as it seemed necessary.

The larger marine tanks had their water drawn from them, in part, every morning and every evening, by a gutta percha siphon, into slate cisterns placed below them, and from these cisterns it was pumped into a large slate cistern several feet higher up, and placed in the midst of a fresh-water cistern through which cold fresh water ran; the same cistern, in fact, which supplied, and supplies, the fresh water tanks. Thus the sea water received some degree of coolness in summer from the fresh water as it rose from the earth, it being raised by the steam engine generally supplying the gardens, and from this cistern it dribbled back into the show tanks through stoneware taps, being thus much aerated and refreshed by falling from a height twice daily. The other tanks, standing in the center of the "Fish House," and unconnected with any other tanks, were not thus cooled and aerated, and were changed or renewed occasionally as seemed needful.

It should be noted that save the aquatic creatures and plants, neither Warington, Gosse nor Mitchell actually installed anything themselves in the new aquarium. This was left up to Richard Sanders of Sanders & Woolcott, as he was the one installed the tanks his firm had made, and also the pipes, plumbing fixtures and pumps. An unfortunate aside: On November 10, 1857, Edward Woolcott, Sanders' partner, committed suicide (an irony as will be seen at the end of this essay) and, on November 21st of that year, Sanders filed for bankruptcy. William Lloyd had established his Aquarium Warehouse in 1856 and after Sanders' bankruptcy, obtained the rights and production facilities and was in a position to offer Sanders & Woolcott aquariums to the public once more.

The London Zoo's "Fish House" opened in May 1853; it was revolutionary for its time, the possibility of making tanks from large sheets of plate glass enabled visitors to have an underwater view of the life in tanks. Actually, the idea of keeping marine animals at the Gardens was not completely new; the *Athenaeum* had suggested it in 1850, saying that if the Society could procure a hippopotamus, then why not a whale?

The following is an excerpt from *The Illustrated London News* of May 28, 1853:

The arrangement is simple enough, and the effect of it is altogether charming. The whole length of the ponds is about eighty feet; they occupy two sides of a building of glass and iron, constructed expressly for this purpose at the beginning of 1852. [Note: At this point, no one was sure what to call the tanks. The *News* elected to call them "ponds."**] Each pond is six feet in length, and the water is enclosed by walls of plate-glass, each in a single piece. At the bottom of**

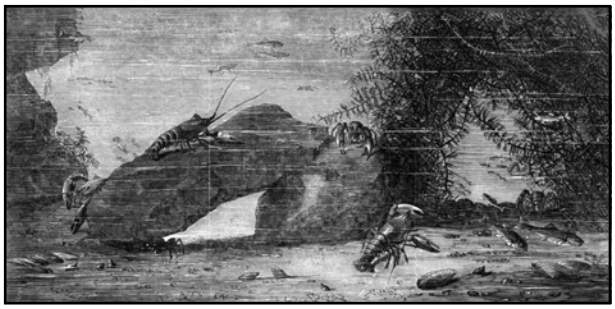

Figure 16. Engraving of a freshwater tank made in 1853 when the Aquarium was just opened to the public.

these translucent ponds, rocks, shingle, and sand, with seaweed growing in it, present a model of some nook at the bottom of the sea; and there we have a group of shell-fish, of living shells, of star-fish, of sea-anemones, or of nudibranchs, as the case may be, disporting themselves in precisely the same manner as if they were still uncaptured and free in the depths whence they were borne.

The singular mechanism by which these creatures move - by which they seize and devour their prey-the extraordinary changes of colour and form which some of them undergo, render each of these ponds the occupation of a day for a close observer; for, however long he may stand, contemplating the wonders which they inclose - some new action, some movement which he has not seen before, is constantly presented to him. The abundance of specimens which each pond contains, the numerous retreats which the rocks and plants afford to them, and of which a portion of the Inhabitants appear to avail themselves successively, will always prevent the exhaustion of the subject by the visitor; and we foresee in this fact, as well as in the extreme beauty of the objects themselves, a power of attraction which no previous work of the Society has ever yet attained; and we heartily congratulate them upon the success which cannot fail to attend so spirited, so interesting, and so instructive an attempt to carry out the most elevated principles of the science which they are associated to render popular.

That the people of this country are not only willing to appreciate such attempts, but anxious to benefit by them, is satisfactorily shown by the crowds who throng the Gardens on all public holidays; and that this feeling has not yet by any means reached its full development is evident from the result of Whit-Monday, when even the best days of 1851 were far exceeded, and the number of visitors amounted, as we are officially informed, to upwards of 22,000.

Gosse, by the way, anxious to let everybody know that he, not Warington was responsible for the marine part of the exhibit in the Fish House, wrote the following in his book, "A Naturalist's Rambles on the Devonshire Coast," published in 1853 shortly before the Aquarium was opened to the public:

What then is necessary but the presentation of the water, so charged with organic matter, to the atmosphere in a minutely divided state? This I did, and found the objectionable qualities of the water at once removed, and my difficulties vanished. I even took sea-water, containing animal matter in suspension, so putrescent as to be highly offensive, and after passing it through the air in a slender stream a few times successively, the water was restored to purity.

Another advantage is secured by the same process, viz. the aeration of the water. For though the requisite oxygen may be supplied by the agency of the plants alone, the mechanical admixture of the atmospheric air with the water by artificial aeration is highly conducive to the health and comfort of the animals, as is evident from their vigour and increased action under its stimulus.

Should any of my readers wish to see these experiments in operation, or to cultivate a personal acquaintance with many of the individual specimens whose history has been recorded in the preceding pages, they may do both by

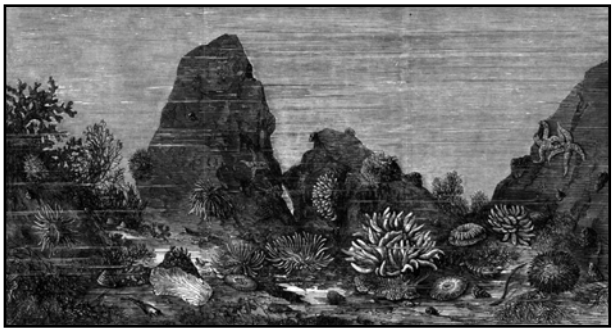

Figure 17. Engraving of a marine tank made in 1853 when the Aquarium was just opened to the public.

visiting the Zoological Gardens in the Regent's Park. The able and zealous Secretary, D. W. Mitchell, Esq., has already set up one large glass tank, filled with sea-water, (the purity of which is maintained in the manner I have just described,) and stocked with marine plants and animals so as to resemble one of those charming tide-pools, so often mentioned in these pages, with the advantage of having its sides formed of plate-glass, and its whole contents therefore clearly visible. There the visitor may see the *Sabellae*, the *Actinia* of brilliant hues and many kinds, *Mollusca* both shelled and naked, *Crustacea*, and *Annellida*, all pursuing their various avocations and enjoying themselves without restraint, under circumstances scarcely distinguishable from those of nature. All who have seen this aquarium concur in considering it a most attractive exhibition; and it is fairly anticipated that when seven other tanks of equal dimensions are added to the one already stocked, each containing some of the numerous tribes of marine creatures (a result which we hope to accomplish in the course of a few months), the whole will form one of the most unique and interesting features of these beautiful Gardens.

It has often been written that Warington's and Gosse's papers on the establishment of the marine aquarium were published very closely apart, suggesting that both deserved the credit equally. These authors, however, overlook the fact that like Hyperion to a satyr, Warington's paper was far superior; indeed, Gosse's paper really added nothing new of any consequence.

Early on there was much controversy over what to call these vessels that contained aquatic organisms and plants. Edwin Lankester, a stickler for Latin, called a tank an "aqua-vivarium," which technically was correct but rather unwieldy. During the planning stage of the Zoo's aquarium Mitchell used the term "Fish House," but changed this to "Aquatic Vivaria" by the time the aquarium opened. A year later Gosse's book, "The Aquarium," was published and in 1854 "aquarium" was taken up and popularized by the Zoo. However, in 1860 Holdsworth was still referring to the building as the "Fish-House" in his guidebook, although he did use "aquarium" to refer to the tanks themselves. It should be noted that Warington had used the word "aquarium" two years before Gosse did and therefore gets the credit for introducing the term to the aquarium hobby.

The first photograph of a living fish (a pike, *Esox lucius*) was taken in 1853 at the Fish House by the Count of Montizon (Don Juan de Borbón y Braganza, 1822-1887), a grandson of King Carlos IV of Spain. Although his childhood was spent at the court of his uncle Fernando VII, the king of Spain, Prince Juan de Borbón spent the major part of his life in England, in exile following his father's violent challenge to the succession of Fernando's daughter Isabel II in 1833. Apparently harboring no royal ambitions, Juan assumed the somewhat obscure title of Count de Montizon in public and, when the dubious title of pretender to the Spanish throne passed to him from his elder brother, he

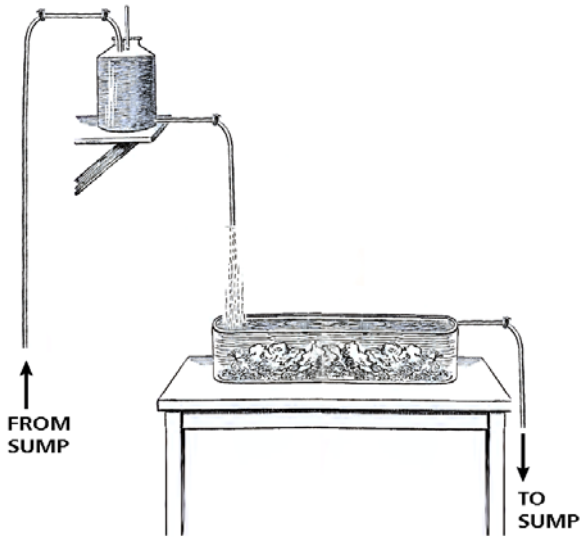

Figure 18. The drip method recommended by Gosse for the marine tanks. The water in the upper header tank was pumped up from a cistern below each display tank and the overflow from the display tank was directed to the cistern. It was a failure because the sizes of the header and sump tanks were too small.

renounced all claims in favor of Queen Isabel. His passions instead ran to physics, chemistry and natural history; photography, it seems, was an appropriate amateur pursuit that combined all three interests. His photograph of a pike (Figure 19) was the forerunner of an immense global interest in underwater photography and previously hidden aquatic habitats.

In 1852, Mitchell published the first guide to the Gardens (Mitchell, 1852) and this was followed by a number of editions written by him. In 1856 he edited and supplied notes to Wolf's book, Zoological Sketches. The following is an extract from the 1856 *Quarterly Review*:

Out of this large number many curious animals have doubtless left no trace; but through the care of Mr. Mitchell, no rare specimen has died within these five years at least, without previously sitting for his portrait. The first part of the valuable collection of coloured drawings, from the inimitable pencil of Mr. Wolf, accompanied by a description from the pen of Mr. Mitchell, the editor of the work, is just published, under the title of 'Zoological Sketches, &c.,' and the others will speedily follow. The work, when completed, will be unique in the annals of zoology, both for the extreme beauty of the drawings, which may be said to daguerreotype the subjects in their most characteristic attitudes, and for the nature of the letter press, which proves that the editor has written from the life.

PROBLEMS IN PICATORIAL PARADISE

All, however, was not well as William Alford Lloyd pointed out twenty-four years later (Lloyd, 1876):

In the earlier books on aquaria - notably in Mr. Gosse's two volumes, his Devonshire Coast and his Aquarium (the latter having gone through two editions, 1853 and 1856, besides a recent reprint without the plates, which have been accidentally destroyed) — aquaria are associated in idea with conservatories, especially as to the growth of plants in each. This notion was very natural. Accordingly the Regent's Park Aquarium was made virtually as a conservatory. But it was a diametrically wrong notion, as the first summer proved; and the second summer (1854) showed this still more conclusively; and the third (1855) yet more so, the evil being an accumulating one. It was then remembered, when too late, that marine and fresh-water plants and animals live in seas and rivers, where the temperature is much more restricted in range than that which obtains in the atmosphere.

It was seen that success was to be obtained by representing these conditions of nature just named, and that to place such organisms in a glass house, where the rays of a summer's sun heated a mass of imprisoned air, was to kill the animals and to stimulate the plants to unnatural growth, or rather to cause them and some of the animals to be covered with a parasitic growth of the lower green algae, which obscured them. The errors of this earliest aquarium were strikingly shown by its solitary merit, the latter being its fresh-water division, occupying one side of the building, where the water coursed through the tanks in a constant

Figure 19. The first photograph of a living fish (a pike*, Esox lucius*) was taken in 1853 at the Fish House by the Count of Montizon.

stream, it being clear and cool, and peopled with an adequate number of healthy animals; while on the other side of the building, and in its centre, were the marine tanks, in which the water was, and still is, turbid and warm, and sparsely inhabited by not healthy creatures.

These good results were, however, obtained by accident and not design. [Note: I disagree with Lloyd here. One does not by "accident" do a major plumbing job like this. I suspect that Richard Sanders observed that Gosse's more complex system was not necessary for the freshwater tanks and suggested this alternative arrangement to Mitchell.**] The society possessed already a steam-engine, which pumped up water for the general use of its gardens, and it was a mere matter of course to connect the aquarium with this engine, and allow the water (which chanced to be drawn from a pure source) to run through the fish tanks, and then be applied to ordinary purposes, drinking or other, for which its passage through the tanks in no way unfitted it; I reasoned with the society that if the sea-water tanks were similarly treated on some such system as the fresh-water series, a correspondingly good result would be attained; and I pointed out that the same law governed both, because in the centre of the building were some isolated fresh-water tanks having no stream in them, and these were in a similarly ill condition as the marine tanks by their side.**

In reply, the society answered that a circulatory system did exist in a part of the sea-water series, but that it was almost useless; and I then pointed out that that was because the reservoir into which the sea-water entered after it had run through the show-tanks was too small in relation to the dimensions of the latter, and that the reservoir should be several times greater than the show-tanks. My reasoning was all in vain, however, for the society went on throwing away the sea-water when it was only temporarily unfitted for use, and getting at a cost of several hundreds of pounds yearly a weekly supply from the sea, especially when soon afterwards another evil made its appearance, consisting of a greenish-brown dense opacity, permeating the water and quite hiding from view all it contained. This was caused by excess of light, for I found that darkness removed it and made the water clear again…

Because of the light and heat problem, the glass of the building, sides, ends and roof were painted opaque and white, and to further exclude the sun, heat and light, it was screened with canvas in hot weather. This, however, only partially solved the problems. In the first edition of Gosse's "Aquarium," published in April, 1854, he mentions the survival of several marine animals placed in the gardens "nearly a year" before, and that some of the sea water had not been changed for "seven months." This passage of praise was, however, omitted in the second edition of the book, published in August, 1856, twenty- eight months later. Furthermore, these problems still existed as of 1871, as illustrated by the following extract from

Figure 20. The Zoological Society's Headquarters, Hanover Square.

an article in *The Illustrated London News* of that year:

Consequently, in the first summer of its existence, the mortality of the animals in the Regent's Park aquarium was very great, and the vegetation was stimulated into far too rapid a growth, which rendered the water turbid. The modifications which have since been made in the building, and which still exist there, have but partially remedied its original defects, among which have also to be enumerated the very serious ones of the small dimensions and tall and narrow proportions of the tanks (thus giving insufficient air-absorbing surfaces of water); and, chiefest of all, the very serious fault (in any but very diminutive tanks) of the absence of adequate means of purification by keeping the water ever in motion; as in the sea, and in rivers, and even in ponds; this motion being needed in addition to the aeration effected by plants growing in the water.

Mitchell, however, glossed over these problems when making his reports to the Council, An example is his report to the Council of February 28, 1854:

Aquatic Vivaria.
The principal new work of the year has been the arrangement of living fish, Mollusca, zoophytes, and other aquatic animals, first projected in 1851, which has probably excited more attention from its novelty and the intrinsic beauty of the objects themselves, than any other of the recent additions to the collection.

Although the series of tanks is limited to a length of 84 feet by the present extent of the building in which they are placed, an immense number of species have been exhibited in them, and it is a satisfactory proof of the control under which the method of management has been reduced, that there are at this moment several of the fish and zoophytes in the tanks which were placed there in May last; and, in the case of the fish more particularly, several others which formed part of the number experimented on in 1852.

The fish have spawned, and the zoophytes have produced their young in considerable abundance.

Algae are growing luxuriantly in those tanks which are not agitated by the vivacious evolutions of the sea-fish, and this secondary feature is well worth the attention of botanists, to whom the opportunities thus afforded of studying the development of these plants are of the most complete character; while the extremely beautiful effect of colour, dependent partly on the Algae themselves, and partly on the peculiar action of transmitted light, are not less instructive to the artist.

The present arrangement of the house consists of six tanks of freshwater animals, chiefly fish, on the western side; and seven of marine animals on the eastern side; exclusive of several movable tanks of smaller size, which are placed as occasion requires in various parts of the central area.

The zoophytes which are most attractive in appearance are the Actinias or Sea-Anemones. The finest examples of them are to be found in tanks 9, 10, and 11, in which every age of these curious animals is well illustrated.

Figure_21.
Meeting Room of the Zoological Society.

A good illustration of that most singular fact in the physiology of zoophytes, the alternation of generations, is at present afforded here by the appearance of the detached young of Campanularia which appeared for the first time on the 9th of February.

The Crustaceans have been represented throughout the year by several of the smaller British species, among which the young of the hermit crab have also recently appeared in considerable numbers.

None of the Mollusca which have been obtained are more interesting or have lived more successfully than the species which belong to the Nudibranchiate genera, Aeolis and Doris. Ribands of spawn have been deposited by the last-named, and as the water in which they live is never disturbed, there is very little doubt that the whole existence of these animals will be here subjected to observation. The elaborate monograph of Messrs. Alder and Hancock, published by the Ray Society, facilitates the study of this group in the most delightful manner, and places a complete knowledge of it within the reach of every one who chooses to consult their work.

The curious group of Ascidian Polypes (which take an intermediate station between zoophytes and Mollusca) have been copiously illustrated, frequent specimens of Botryllidae, or compound Ascidians, of Ascidiadae, or simple Ascidians, having been received, although from their sluggish leathery appearance they may not have attracted so much attention as their peculiar organization deserves.

As can be seen, no mention was made of the turbidity of the water in the marine tanks, their generally unhealthy condition and the necessity of having to replenish the seawater frequently with new seawater, an expensive proposition.

GOSSE GETS INTO TROUBLE WITH THE COUNCIL

Although I have discussed this in my essay, "The Warington-Gosse Controversy Revisited" (Klee, 2016), I'll expand upon it in some detail.

Figure 22. The London Zoo Lion House.

The Surrey Literacy, Scientific and Zoological Society was formed by Edward Cross in 1831 with the intention of setting up a public zoo. Cross had previously owned a menagerie on the Strand and he sold his animals to the Society who had leased a 13-acre site from Lord Holland. The Surrey Zoological Gardens were laid out in 1831-2 on the south side of the river Thames, about a mile and a half from Blackfriars Bridge and an hour's walk from Regent's Park. Cross built a large circular domed glass conservatory in the gardens, 300 feet in circumference with more than 6,000 square feet of glass, to contain separate cages for lions, tigers, a rhinoceros and giraffes.

In its time this was the largest conservatory in England. It was also used for flower shows and exhibitions. The gardens were heavily planted with native and exotic trees and plants, and dotted with picturesque pavilions. The site also contained a lake of about three acres. From about 1840 on there were lavish fireworks displays, which seemed gradually to have taken priority over everything else. On Cross's retirement in 1844 his secretary and assistant, William Tyler, took over the place, whereupon it declined rapidly and in November 1856, the collection came under the auctioneer's hammer.

In 1854, Nathaniel Hawthorne (1804-1864), who was the American Consul in Liverpool at the time, visited both aquariums and had this to say in his diary of September 9, 1855 about the Regent's Park aquarium:

The Aquarium, containing, in some of its compartments, specimens of the animal and vegetable life of the sea, and, in others, those of the fresh water, was richly worth inspecting; but not nearly so perfect as it might be. Now I think we have a right to claim, in a metropolitan establishment of this kind, in all its departments, a degree of perfection that shall quite outdo the unpractised thought of any man on that particular subject.

Whether Hawthorne was disappointed in the quality of the water, the difficulty in seeing the marine fish or some other reason, he unfortunately did not, say. The menagerie at the Surrey Zoological

Figure 23. The Surrey Zoological Gardens circa 1830.

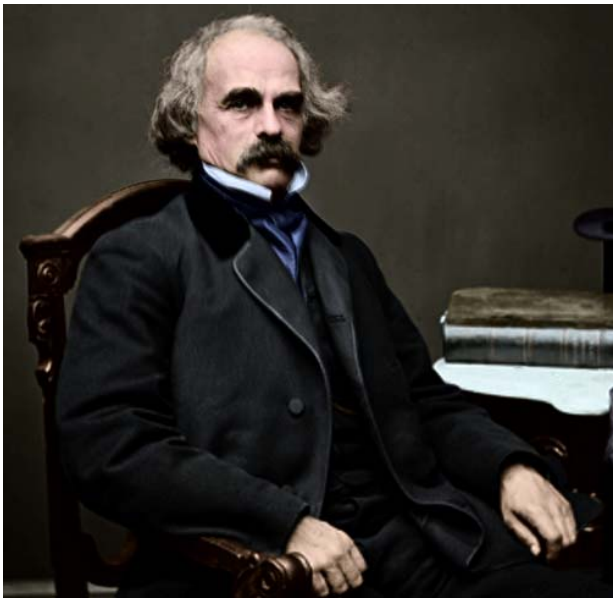

Figure 24. Nathaniel Hawthorne (1804-1864).

Gardens did not escape his disapprobation, either. The following was his diary comment of October 3, 1855 regarding his visit there:

The menagerie, though the ostensible staple of the gardens, is rather poor and scanty; pretty well provided with lions and lionesses, also one or two giraffes, some camels, a polar bear, --who plunged into a pool of water for bits of cake,--and two black bears, who sat on their haunches or climbed poles; besides a wilderness of monkeys, some parrots and macaws, an ostrich, various ducks, and other animal and ornithological trumpery; some skins of snakes so well stuffed that I took them for living serpents till J----- discovered the deception, and an aquarium, with a good many common fishes swimming among the sea-weed.

The fish Hawthorne saw obviously were freshwater fish, so the marine specimens Gosse collected for the Surrey Zoological Gardens did not last long. A poster in the British Library dated 1854 that advertised the various attractions included:

The Marine Aquarium!! An Exhibition of Marine and Fluviatile Fishes, Mollusceae, Crustaceae and Zoophites, in Glass Tanks.

Whitsun in 1854 would have occurred on July 4, and this is probably the date on which the Surrey aquarium opened. It is often said that the Surrey aquarium lasted only a "few weeks" or "a short time," but this is true only of the marine part of the exhibit, albeit, the most important part. As seen by Hawthorne's visit, parts of the freshwater exhibit lasted at least for another fourteen months.

Gosse ceased his association with the Zoological Gardens somewhat under a cloud. Gosse's main contribution to the aquarium at the zoo was to provide marine plants and animals, including fish, for which he was to be paid. However, at the time Gosse was collecting marine life for the Regent's Park zoo, the Surrey Zoological Gardens built their aquarium and contracted with Gosse to supply the same sort of specimens. When he submitted his bill

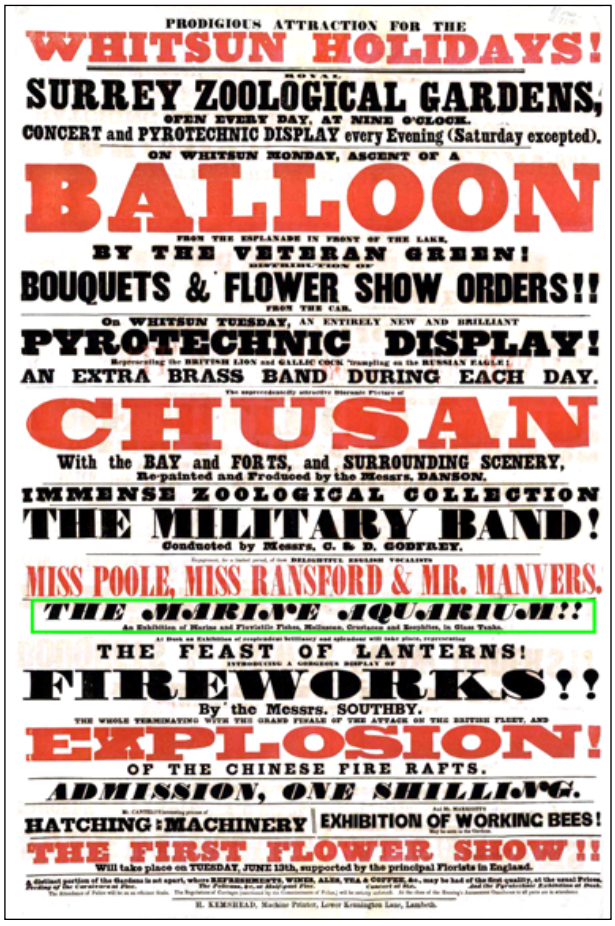
PRODIGIOUS ATTRACTION FOR THE
WHITSUN HOLIDAYS!
ROYAL
SURREY ZOOLOGICAL GARDENS,
OPEN EVERY DAY, AT NINE O'CLOCK.
CONCERT and PYROTECHNIC DISPLAY every Evening (Saturday excepted).
ON WHITSUN MONDAY, ASCENT OF A
BALLOON
FROM THE ESPLANADE IN FRONT OF THE LAKE,
BY THE VETERAN GREEN!
DESCRIPTION OF
BOUQUETS & FLOWER SHOW ORDERS!!
FROM THE CAR.
On WHITSUN TUESDAY, AN ENTIRELY NEW AND BRILLIANT
PYROTECHNIC DISPLAY!
AN EXTRA BRASS BAND DURING EACH DAY.
The unprecedentedly attractive Dioramic Picture of
CHUSAN
With the BAY and FORTS, and SURROUNDING SCENERY,
Re-painted and Produced by the Messrs. DANSON.
IMMENSE ZOOLOGICAL COLLECTION
THE MILITARY BAND!
Conducted by Messrs. C. & D. GODFREY.
Engagement, for a limited period, of four DELIGHTFUL ENGLISH VOCALISTS
MISS POOLE, MISS RANSFORD & MR. MANVERS.
THE MARINE AQUARIUM!!
An Exhibition of Marine and Fluviatile Fishes, Molluscæ, Crustacea and Zoophites, in Glass Tanks.
THE FEAST OF LANTERNS!
INTRODUCING A GORGEOUS DISPLAY OF
FIREWORKS!!
By the Messrs. SOUTHBY.
THE WHOLE TERMINATING WITH THE GRAND FINALE OF THE ATTACK ON THE BRITISH FLEET, AND
EXPLOSION!
OF THE CHINESE FIRE RAFTS.
ADMISSION, ONE SHILLING.
HATCHING MACHINERY | EXHIBITION OF WORKING BEES!
THE FIRST FLOWER SHOW!!
Will take place on TUESDAY, JUNE 13th, supported by the principal Florists in England.
A Refined portion of the Gardens is set apart, where REFRESHMENTS, WINES, ALES, TEA & COFFEE, &c., may be had of the first quality, at the usual Prices, according to the Carriages or Place.
The Policemen, &c. at their usual Post.
Concert of Mus...
and the Pyrotechnic Exhibition at Dusk.
The Regulation of Carriages (purchased by the Commissioners of Police) will be strictly enforced. At the close of the Evening's Amusement Omnibuses of all sorts are in attendance.
H. KEMSHEAD, Machine Printer, Lower Kennington Lane, Lambeth.

Figure 25. The text in the green box indicates the Marine Aquarium attraction. The poster is dated 1854.

to the Zoological Society of London, Mitchell presented it to the Society's Council and they directed him to try and persuade Gosse to reduce it, the reason being that they had discovered that Gosse had also collected and sent specimens to the Surrey Zoological Gardens during his time collecting in Weymouth but charged the Zoological Society of London for this time. The Council was incensed and angrily denounced his want of consideration for the Society. Gosse, replied, however, that if he wasn't paid then all collections would stop.

Gosse requested that the matter go to independent arbitration, with Thomas Bell, an older cousin and Fellow of the Zoological Society representing his interests. The Council agreed and appointed James Scott Bowerbank to represent the Society. Gosse argued that when he submitted his plan to the Zoological Society and offered to supply living specimens at a fixed rate, there was no stipulation that he should limit his supplies to that Society. Gosse maintained that he was not the salaried servant of the Zoological Society of London, and the council had no more right to forbid him to sell specimens elsewhere than to prohibit the tradesman who glazed their tanks from selling glass to anyone else. This was certainly true but it had nothing to do with the Council's actions, which involved Gosse's fee and nothing else. Therefore, after the arbiters had discovered that Gosse had also collected and sent specimens to the Surrey Zoological Gardens during his time in Weymouth but charged the Zoological Society for this time, the arbitrators found in favor of the Society, awarding Gosse only £150, which he quietly accepted. Thus ended Gosse's relationship with the Society.

Gosse was not a dishonest man, but he did make poor decisions, certainly this one. He should have realized that the Regent's Park aquarium and that of the Surrey Gardens were in competition. Another bad decision occurred when he concealed his knowledge about Schweitzer's seawater formulation when he met Warington in January of 1854 (see Klee, 2016).

MITCHELL RESIGNS FROM THE SOCIETY OF LONDON

Mitchell was interested in one of the original aims of the Society, acclimatization, and was a member of the French Société Zoologique d'Acclimatation. A letter is preserved in the Society's archives where Mitchell communicates with an unknown person residing in Paris. He addresses the recipient as "Your highness" so this person could either be Napoléon III, who expressed an interest in French acclimatization or, more likely, Prince Jérôme Napoléon, the emperor's cousin, who was appointed honorary president for the Société Jardin d'Acclimatation. In the letter, Mitchell specifies 28 species of deer and 38 species of antelope that would be suitable for acclimatization in England and France and states in the end:

I am confident that the acclimatisation of exotic animals in Europe may be carried out to a much greater extent than has yet been supposed possible—and I am happy to be able to acquaint you with the interesting fact, that the Council of the Zoological Society have at my earnest request within the last year applied themselves seriously to this object.

These attempts however do not seem to have been as successful as his measures to popularize the Gardens, and in April 1859 he resigned in order to oversee the building of the Jardin d'Acclimatation in Bois de Boulogne. This Jardin was the brainchild of Isidore Geoffroy Saint-Hilaire who based it on the descriptions in Bacons *New Atlantis* and it was to be devoted to "applied natural history"

Figure 26.
The Aquarium du Jardin d'Aclimatation.

rather than theoretical science." The aim was to "acclimatize, domesticate, breed, and sell new exotic animals that would meet the needs of industry, agriculture, and animal amateurs."

When Mitchell resigned, the Council praised him highly and in appreciation and gave him a gratuity of £500:

The Council cannot conclude this Report without placing on record their sense of the great obligations which the Zoological Society owe to Mr. Mitchell, who for the period of twelve years has filled the important situation of Secretary. They feel that the present prosperous and satisfactory position of the Society is chiefly, if not entirely, owing to the great ability and zeal of Mr. Mitchell.

With the view of bringing in a succinct form before the Fellows the improved position of the Society at the present time, as compared with what it was at the time of his appointment in 1847, they beg to call the attention of the Society to the subjoined statement.

The average Income of the Society, for the seven years previous to 1847, was £9,199. The average of the seven years, to Dec. 31, 1858, amounts to £15,062. For some years previous to 1847, the Income of the Society had been gradually falling off, and in that year was only £7,765, whereas in 1858 it amounted to no less a sum than £14,034—almost double of what it was at the time of Mr. Mitchell's appointment.

This great increase is mainly owing to the important improvements which have been made in the Gardens under the advice and superintendence of Mr. Mitchell. During that period, large additions have been made to the Collection of Animals, and most important improvements and additions have been made to the Buildings for their reception.

Great expense has been incurred on both those objects; but the Council have the satisfaction of being able, at the same time, to state, that, owing to the judicious manner in which the money has been laid out under Mr. Mitchell's direction, the attraction of the Gardens, and the interest felt in them by the Public, attested by the number of Visitors, has so greatly increased, as to give an excellent return for the money expended. The average number of Visitors for the seven years previous to 1847 was 111,500, and for the seven years ending Dec. 31, 1858, was no less than 350,620.

The Buildings which have been erected of late years are of a substantial construction, will require little or no repair for many years to come, and as an investment of capital, might be fairly considered as forming part of the Assets of the Society; but leaving them, and the additional value of the Collection of Animals, out of the account, the Net Assets of the Society, after deducting all Liabilities, and notwithstanding the very heavy expenses incurred in the erection of new Buildings and the repairs of the old, have increased since 1847 by the sum of £912, the Assets in 1847 being £5254, and in 1858, £6166. For these great improvements in their circumstances the Society is indebted to Mr. Mitchell.

Greatly as the Council must regret the loss of the services of so valuable an officer, they have the satisfaction of feeling that the whole of the concerns of the Society are now placed on so sure and solid a basis, that the task of maintaining them in their present satisfactory condition will be comparatively easy.

Figure 27. The Tortoise House of the Zoo.

The Council, in order to mark their sense of the value of Mr. Mitchell's services, of his zeal and assiduity, and of his unremitting attention to promote the prosperity of the Society, at their Meeting on the 20th inst., came to the unanimous resolution to present to him, on his retirement from the office of Secretary, a Gratuity of £500, in consideration of his long and valuable services to the Society.

Resigning his post as secretary of the Zoological Society of London on April 6, 1859, Mitchell became the Aquarium Director of the Jardin d'Acclimatation in Paris, but died suddenly on November 1, 1859, only months after taking up the position. The Jardin contracted with William Alford Lloyd to finish the work on the Aquarium.

THE MYSTERIOUS DEATH OF DAVID MITCHELL

At the Anniversary Meeting of April 30, 1859 Mitchell, having undertaken the direction of the new Jardin d'Acclimatation at Paris, retired from the office of Secretary, and Mr. Philip Lutley Sclater, M.A., Fellow of Corpus Christi College, Oxford, and Barrister-at-law who had been a Member of the Council during the previous two years, was nominated by Richard Owen and William Yarrell and elected in his place at a salary of £250 a year. In zoology, Sclater was an expert ornithologist, and identified the main zoogeographic regions of the world. Although ornithology was his chief study, he also did a large amount of work in mammology.

Sclater found that the Society's affairs were in a sad state of neglect and for the next three years, nearly his whole time was occupied in bringing its records and publications up to date, reorganizing the Gardens into separate departments under the Superintendent and having many of the animal houses rebuilt. Shortly after he became Secretary, however, Sclater discovered what appeared to be a discrepancy in Mitchell's last financial accounts that amounted to embezzlement.

Just before the Council meeting in November 1859, Daniel Elliot informed him of Mitchell's death. (Elliot, 1835-1915, was one of the founders of the American Museum of Natural History in New York, of the American Ornithologists' Union and of the Société Zoologique de France. He was also curator of zoology at the Field Museum in Chicago. From 1869 to 1879 he was in London and established strong links to British ornithologists and naturalists.) It was at this meeting that Sclater announced Mitchell's death to the Council and also advised them of the discrepancy in Mitchell's accounts. The result was that Sclater and two other members of the Council instructed that the Society's solicitors lay a claim to the executors of Mitchell's estate while the matter was investigated further. In the Report of the Council, April 29, 1861, the following was announced by Sclater:

The Council deeply regret to have to communicate to the Members that the sum of about £480, which has been ascertained to be due from the Estate of the late Secretary, Mr. Mitchell, to the Society, not been yet recovered; but the Council have taken, and will con-

Figure 28. Philip Lutley Sclater (1829-1913).

tinue to take, all steps in their power for this purpose Society.

However, the two council members, having completed their investigations, found that the allegations were unfounded and the matter was dropped. Most likely if the Secretary had been anyone else than Sclater, the charges would never have been brought to the Council. Sclater was never an object of admiration nor did he attract loyalty from the Zoo staff. He became involved in several arguments with the public, and appeared to them, and even to some of the Society's Fellows, to be stubborn and at times even arrogant. "Reformer" wrote to the *Marylebone Mercury* in 1875:

… to appeal from Mr. Sclater as Secretary to Mr. Sclater as Council is to appeal from Lord Eldon, sitting as Chancellor, to Lord Eldon, sitting as Judicial Committee of the House of Lords. Lord Eldon used to boast that he never had a judgement reversed. Mr. Sclater can similarly claim that the Council has never overruled his decision.

Sclater eventually resigned in 1902, and his son, William Lutley Sclater, whom he had hoped would succeed him and who was then Director of Cape Town Museum, was temporarily appointed until ratification by the Fellows at the next Annual General Meeting. However, at that meeting in April 1903, a second candidate was nominated by a group of Fellows. This other candidate was voted Secretary with a majority of 200 votes. The Society had enough of Sclaters. Ironically, when the news leaked out that Sclater was retiring at the age of seventy-two, a rumor had spread that bad management was the cause. The Council President arranged for a Special Committee to examine all the affairs of the Society and the administration of the Gardens. After a stringent investigation, Sclater was completely exonerated.

Journal articles discussing the history of the Jardin d'Acclimatation provide no details about Mitchell's death, only vague comments such that it was "sudden" or "premature." This led me at first to believe that it was a stroke or fatal heart attack, but the paucity of detail did have me wondering.

Most of the notices in England were no better, usually citing his death as sudden, also. Further research has indicated that there was some discussion as to whether Mitchell committed suicide and/or became insane, and if this might be connected to the alleged embezzlement of the Zoological Society's funds. Whether the allegations had anything to do with Mitchell's death is unlikely, however. They were presented to the Council after Mitchell's death and only then became public knowledge and so couldn't have affected him then. However, it is possible that someone was indiscrete and that Mitchell learned of it while he was still alive.

In any event, with regard to the possibility of suicide or insanity, there was a lot of controversy about the nature of Mitchell's death. The following appeared in the *The Morning Chronicle*, December 5, 1859:

THE LATE MR. D. W. MITCHELL.
The London correspondent of the *Manchester Guardian* writes as follows in reference to the death at Paris of Mr. Mitchell, the late Secretary to the Zoological Society: —

In the absence of political news I think it my duty, not without much consideration, to give

Figure 29. Library of the Zoological Society.

the publicity of your pages to some most mysterious circumstances attending the death of the late widely-known Secretary of the Zoological Society, Mr. D. Mitchell, which recently took place in Neuilly, and which has been ascribed in the brief newspaper paragraphs, which furnish all the information as yet published on the subject, to his own hand. Whether the wound of which Mr. Mitchell died was self-in-flicted or not, I think you will admit, in the face of the facts I am about to mention, to be very doubtful. At any rate, it seems to me that those facts are such as to make out a strong *prima facie* case for such judicial inquiry as the French laws admit.

Mr. Mitchell had married a second time, about six months ago. The marriage was not entered upon under circumstances that indicated, on Mr. Mitchell's part, any great hope of happiness, or the eagerness that is usually looked for in a bridegroom. I am afraid the wound of which he died was a pistol-shot in the groin. His death was not immediate. He lingered for days in a lunatic asylum, near his residence, to which he was received, at the request of his wife, who stated that he was insane, and had attempted self-destruction in a paroxysm of his disorder. On his death, she made application to have him buried as a pauper lunatic.

These circumstances, vaguely stated, had meanwhile come to the knowledge of two of Mr. Mitchell's English friends in Paris, These two gentlemen interfered, on learning the humiliating conditions under which their friend's body was about to be committed to the ground—uncoffined, and without the rites of the church—and, thanks to them, the interment was conducted with all befitting decency, and with the usual offices for the dead of the Romish Church, to which Mr. Mitchell had recently attached himself. His body was followed to the grave by these two friends, and by a large body of workmen employed in the New Zoological Gardens, in the Bois de Boulogne, which Mr. Mitchell, at the time of his death, was engaged in organising.

Figure 30. The Camel House at the Zoological Gardens.

Mr. Mitchell leaves an orphan daughter in England, who is entitled in her own right to a very considerable property. This poor girl is at present in a convent not far from London, where she was placed for her education. By a will of her father's, executors were appointed, who have not yet, I believe, made formal proof of the will, owing to a very natural desire not to saddle themselves with any responsibilities of executorship in the case of a testator so involved as Mr. Mitchell is known to have been. But I am informed that application for Miss Mitchell has been made to the convent by three gentlemen—her father's eldest and most trusted friends—and that the applica-tion has been met with a refusal to give up the young lady, based on directions received from her step-mother.

Those who best know Mr. Mitchell find the greatest difficulty in the supposition either of suicide or insanity. They refer to the position of the wound (in the groin) as the strongest *prima facie* ground for concluding against suicide. As to the idea of self-destruction prompted by embarrass-ment, they declare that Mr. Mitchell had been so long embarrassed, and had borne embarrassment so lightly, that they consider that explanation intrinsically improbable. Nor were there in this case any special circumstances of embarrassment—accumulating and driving their subject into a corner, or complicated with disreputable and illegal acts, as in the instance of Sadleir [This is a reference to John Sadleir who was a Junior Lord of the Treasury in 1853, and was found in 1856 to have by a long course of fraud swindled the Tipperary Bank of over £400,000, and escaped punishment by suicide.]**—to account for unwonted desperation taking refuge in self-destruction. There is extant, I am informed, a letter from Mr. Mitchell to an intimate friend in this country, written shortly before the catastrophe, and speaking of some impending calamity, suffering or danger, which is considered by the gentleman to whom it is ad-dressed to be consistent with the contemplation of a duel. But I do not wish to go into conjecture as to the mode of death. What I wish to insist on is, that the circumstances do not point to suicide, in the ordinary sense of the term; and that they are of so dark and mysterious a cha-racter as to render it a duty to have them investigated, in justice to the memory of Mr. Mitchell, as well as for the sa-tisfaction of his surviving child, and the many friends who have been shocked by the tidings of his sudden and un-looked-for end. I should not have stated these facts, which I only put on paper after considerable hesitation, on any insufficient or doubtful authority. My informants arc very old and intimate friends of Mr. Mitchell, and persons accus-tomed to weigh their words. I need hardly add, in conclu-sion, that my motive is one of respect for the dead, and pity for his poor orphan child, not any desire to spread a tale of horror, or to stimulate a prurient and aimless curiosity. I believe investigation to be called for, and I think publicity the best road to investigation.**

This report, were it true, would be the most fantastic account I have ever read that dealt with a figure prominent in the aquarium hobby. However, as it turns out, there is little in the report that is true, the only exception perhaps being Mitchell's letter where he speaks of some impending calamity, suffering or danger. The letter pokes a hole in the *Manchester* Guar*dian* correspondent's argument, as it clearly indicates Mitchell was not sound of mind when he wrote it. The following is from *Lloyd's Weekly London Newspaper*, January 8, 1860:

Figure 31.
The Ape House at the Zoological Gardens.

THE LATE MR. MITCHELL,

We extract the following from the *Critic* :—A short time ago we were misled in reproducing certain state-ments which were made by some of the French corre-spondents of the daily press respecting the death of the late Mr. Mitchell, ex-secretary of the Zoological society, and more lately of the Société d'Acclimation at Paris. As nothing was farther from our purpose than to hurt the feelings of any member of Mr. Mitchell's family, we are rejoiced to be in a po-sition to make some atonement for the fault which we unwittingly committed, and to prove beyond doubt that the lady whose char-acter was most maligned and tra-duced in the statements we have referred to is not only guiltless of what was most shamefully insinu-ated against her, but that her conduct in the matter was that of a brave, an upright, and most tender wife. First come the certificates of the medical men who attended Mr. Mitchell to the last, including one from the celebrated Pi-nel, whose reputation for the treat-ment of the insane is world wide. [Philippe Pinel (1745-1826) was a French physician who was instrumental in the development of a more humane psychological approach to the custody and care of psychiatric patients, referred to today as moral therapy. He also made notable contributions to the classification of mental disorders and has been described by some as "the father of modern psychiatry".]

I certify that Mr. Mitchell is attacked by an in-stinctive monomania for suicide and homicide (*aiteinte de monomonie instinctire homicide et suicide*) marked by his threats, and by a blind violence, of which he was not master, towards his wife, and by an attempt at self-murder which took place yesterday, October 29th, by means of a pistol shot which caused an acute wound in the chest. The situation of Mr. Mitchell inspires uneasiness; it is indispensable he should be treated in a special lunatic asy-lum (*maison de santé spéciale*). Signed, Dr. PINEL, Neuilly, 30th October, 1859.

Next comes a letter from the curé of Neuilly to the Hon. Mrs. Grantley Berkeley. who is the godmother of Mrs. Mitchell, describing the circumstances which attended Mr. Mitchell's death, and bearing full and honourable testi-mony to the conduct of the wife on such a try-ing occasion:—

Neuilly-sur-Seine, Nov., 1851. Diocese de Paris, Eglise Paroissille de Saint Jeon Biptiste.

To the Bon Mrs. Berkeley, Hampshire:

Madam, — I cannot let your excellent godchild leave without giving her a line for her dear godmother. I will not undertake describing to you the scene of horror which has passed, nor the outrage from which your much loved child escaped miraculously, and of which, to a great measure, I was an eye-witness. I leave to her to enter into all the details; but what I must re-veal to you, and what she will doubtless not tell you from a sense of modesty which I can-not cease admiring, and above all praise, is that calm, that of mind (d'âme), in the midst of the raging of the tempest, that superhuman perseverance in the faithful accomplishment of her duty; it is those minute and credulous cares, lavished on the suicide and assassin,

Figure 32.
The first cage in the Zoological Gardens, originally built for macaws.

whose wound she herself bathed and dressed, whom she nursed alone while her unhappy servants sought some repose, and from whom she only consented to be separated when I at last succeeded in making her comprehend that conscientiously, and for her responsibility to God and man, she must permit the dying man to be removed to the lunatic asylum, whither she actually followed him to wait on him with her own hand, and to soften as much as lay in her power the last moments of a madman who acknow-ledged no other regret than that of having failed in his attempt to have buried his wife in the same grave with himself. Thus, by this heroic conduct, of which we have no example, Mrs. Mitchell has acquired the universal esteem of all those who witnessed it, and especially that of her unworthy curé who feels in this moment the most lively and sincere regret to lose in your godchild one of his best and most devout parishioners,—I have the honor to be, madame, yours, &c., (Signed) P. Roy, Curé Doyen de Neuilly.

As it is to be feared that the abominable calumnies insinuated against Mrs. Mitchell were the result not of idle gossip, but of a shameful conspiracy organised by interested persons, the following letter from Dr. Pinel conclusively proves that those friends of Mr. Mitchell who took the trouble to inquire into the facts of the case were fully informed upon them: —

Chateau de St. James, Avenue de Madrid à Neuilly, prés Paris, le 24 December, 1859.
Maison de Santé de Dr. P. Pinel, Chevalier de la Légion d'Honneur, &c.—
Madame, I learn with indignation that persons have permitted themselves to insinuate odious calumnies about you with regard to the death of your husband, Mr. Mitchell. I should be sorry if they could be attributed to those who came here to obtain information from me, for having related to them the facts precisely as they took place, I cannot understand how they can incriminate your conduct.

I informed the three persons who presented themselves what took place at your house, which was attested by the evidence of Drs. Semelaigne, Becquet, and Follin, by that of M. le Curé de Neuilly and of your servants, and

Figure 33. The Terrace of the Zoological Gardens, from the main entrance.

also by the inquiry made by the Commissaire de Police and by him transmitted to the Procureur Imperial [an officer of the imperial court who either personally or by his deputy prosecutes every one who is accused of a crime according to the forms of French law**]. I told them that about three o'clock on the following day. Mitchell had been brought to my house, in accordance with the opinion of the three medical men above named, on account of his renewed attempt at suicide and of the difficulty of attending and watching him at his own house. I added that shortly after his arrival he was visited by Dr. Ferrus, the inspector general of Asiles d'Aliénes [**Asylums for the Insane**], who entirely agreed in the opinion of his brethren as to the nature of the malady and the necessity for his removal to a special establishment. I related how that, a few moments after his arrival, you came to see him; that he received you affectionately; that you paid him a second visit, in the evening; that the following day you remained with him to the moment of his death.**

In a word, Madame, your responsibility in the matter has been entirely shielded by the certificates of the three physicians named, and by the entire approval of the opinion given by Dr. Ferrus and by myself.

Is there any need to refute the absurd assertion which would lead to a belief that my house is a hospital?

Trample, them under your feet, Madame, these stupid calumnies, and derive from your own conscience, and from the truth of these facts the religious calm of a candid soul and the feeling of an accomplished duty. Receive, Madame, the assurance of my most distinguished considerations.

PINEL.

This ended the controversy and a typical report one year later is the following that appeared in the *Obituary Notices of the Proceedings of the Linnean Society* in 1861:

Figure 34. The Seal Pond.

D. W. Mitchell, Esq., B.A. Oxford, was elected Fellow, Nov. 21, 1843. He died in Paris, under very painful and melancholy circumstances, in November 1859. Mr. Mitchell was well known as a zoologist, and as Secretary for twelve years to the Zoological Society, which owes much of its prosperity to his tact and zealous exertions.

The bottom line is that Mitchell was insane and committed suicide. His demise was indeed a sorry end to a distinguished career and, at age forty seven, one that would have been even more distinguished had the Fates not decreed otherwise.

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THE EARLY HISTORY OF ARTIFICIAL SEAWATER FOR AQUARISTS

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, October 15, 2016)

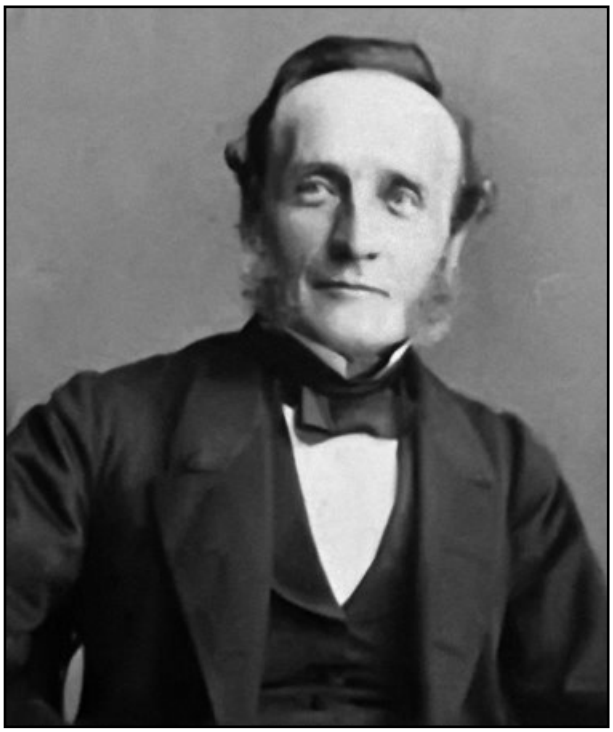
It was shortly before Christmas in 1853, a time when people were counting their blessings and eagerly anticipating the New Year. Philip Henry Gosse, however, was not one of them. The past few years had not been particularly joyous for him. In 1850, Warington was the first one to demonstrate the proof of principle of the balanced freshwater aquarium, and in 1852, he even preceded Gosse by nine months in publication priority for the marine aquarium.

In 1851, Gosse had recommended the system for the marine tanks at the new Fish House in the London Zoo, designed so as to not require replenishing, except for adding freshwater to replace that had evaporated; but by 1853, it was proving to be a failure and the Zoological Society of London had to keep buying expensive additional seawater in order to keep the exhibits alive. Then in July of 1853 when Gosse presented his bill for the marine specimens he had collected for the Fish House, the Society's Council found that Gosse had also collected and sent specimens to the Surrey Zoological Gardens (a competitor to the London Zoo) during his time collecting in Weymouth but charged the Zoological Society for this time. The Council was incensed and angrily denounced his want of consideration for the Society. Gosse was henceforth *persona non grata* with the Zoological Society of London.

However, there was an opportunity for him to increase his reputation within the scientific community. He had come across a paper written by Edward G. Schweitzer who presented his results in analyzing the waters in the English Channel off the coast of Brighton (Schweitzer, 1839). Schweitzer was a German physician and chemist, and Director of the Royal German Spa in Brighton. Schweitzer and Warington, by the way, knew each other. A list of the officers and members of the *Chemical Society of London* dated June 1843 shows Warington as one of its two Secretaries and Schweitzer as one of its members. I'll explain Schweitzer's interest by quoting the final paragraph of his paper:

I cannot conclude this paper without drawing the attention of medical men to the importance which the brine springs on the Continent have lately acquired, as, for instance, the springs near Kissingen, the Adelheids quelle, near Heilbroun, and above all, the springs of Kreugnach, which have been found highly beneficial in scrophulous diseases

Philip Henry Gosse (1810-1888).



Robert Warington (1807-1867).

when internally administered, their action being dependent entirely on the chlorides, iodides, and bromides they contain. Sea-water would afford similar advantages for bathing, and when evaporated to dryness, the residue might be kept in earthen vessels, and thus be conveyed to any distance; and as its constituents are very soluble, sea-water in perfection might be procured at any place. The evaporation of sea-water should be performed with care, and the ingredients kept by chemists. One great advantage would accrue from this method, viz. that sea-water could be had of any degree of concentration which the practitioner might deem necessary. At the baths of Kreugnach, for example, extraordinary effects have been produced when from 40 to 70 quarts of the mother liquor were added to the natural salt-water of that spring, and this mixture used for bathing.

It is amusing to note that the start of the development of artificial seawater for marine aquaria began with desire of the Victorians to immerse themselves in a tub full of water containing bath salts, and the more genuine or natural the salts the better!

Now there are a number of reasons why aquarists might be interested in artificial seawater rather than using the real thing. The density of the final solution is controllable, it is more stable, the formula can be varied for specific uses (e.g., for marine plants versus for marine animals) and it is sterile and thus diseases cannot spread. In Gosse's time, however, the main reason was economics. It was a lot less expensive to reconstitute the seawater with local freshwater than to bring seawater to the aquarium. Water is heavy, its salts are not.

GOSSE'S PLAN

Gosse could have made up the Schweitzer formula, added marine animals and plants and, if everything worked out satisfactorily, he could have written the very first paper on artificial seawater for aquarists. However, based upon his past experiences he wondered if Warington was preparing a paper on this subject; there had been some rumors to the effect that he had experimented with artificial seawater. His concern that Warington might be preparing such a paper is understandable. Warington's interest was but a pastime. In 1704, the House of Lords gave apothecaries the right to practice medicine, and so they may be viewed as forerunners of present-day family physicians. Furthermore, in 1815 the Apothecaries Act granted the society the power to license and regulate medical practitioners throughout England and Wales. Warington had an important job in Apothecaries' Hall and thus was limited in the time he could spend on aquarium research. For Gosse, on the other hand, a significant source of his income involved writing popular books on nature, and it was important for him to maintain a favorable reputation, not only among the masses, but with the scientific community as well. If he could write and publish a paper on artificial seawater before Warington did, it would be a very great advantage in this regard.

Apothecaries' Hall where Gosse met with Warington on January 16 and 21, 1854, and discussed artificial seawater.

Therefore, Gosse devised the following plan. He would visit Warington and steer the conversation in such a way that it would not be a consultation but Warington would talk about his experiences. Executing his plan, Gosse visited Warington in 1854 on two occasions at Apothecaries' Hall: on January 16th and again on January 21st. As it turns out, however, Warington did consider Gosse's visits to be consultations. During these "chats," Warington had no idea that Gosse already knew about Schweitzer's paper. However, Gosse did discover that Warington had no plans to publish a paper dealing with artificial seawater.

Gosse then went ahead with his plan to write his article and by April 21, 1854 he had devised an artificial seawater formula, made up a tank with the solution and added some marine invertebrates. Everything went well and on June 9th he submitted his paper to *The Annals and Magazine of Natural History*. On July 1854 it was published (Gosse, 1854) and Gosse had achieved his goal. For once, he had beaten Warington to the printed page and went down in history as the first to write about - and to provide a formula for - artificial seawater for aquarists!

For comparison purposes, Schweitzer had included the seawater formula based upon a sample from the Mediterranean Sea devised by G. Laurens. I wanted to find out something about him and why he did his analysis but unfortunately, Gosse had labeled him three times in his paper as "M. Laurent" (the M standing for Monsieur). Gosse wasn't the only one who made this error, however. In a report made on the action of air and water on cast iron, wrought iron and steel, Robert Mallett (1841) also misspelled the name as "Laurent." I finally went to Schweitzer's paper - something I should have done in the first place - and found the correct spelling. I also consulted Laurens' paper and found out that Gosse had made errors in Laurens' calcium sulphate and calcium carbonate numbers, and had also omitted entirely Laurens' entry for magnesium carbonate. Clearly Gosse had been in too much of a hurry to get his paper published.

In any event, in the original source (Laurens, 1834) I found that Laurens was a pharmacy student in Marseille and had sent a note to the *Société de Pharmacie* containing an analysis that he had made of the water of the Mediterranean Sea. The commentary on the article included the following (translated): "**In summary, the note from Mr. Laurens, describing the composition of the water of the Mediterranean Sea in a new, well-done analysis, should interest those doctors who prescribe the use of sea bathing.**" Thus, Laurens' purpose was also the same as that of Schweitzer's.

Unfortunately, Gosse had included the following paragraph in his paper:

Several scientific friends to whom I mentioned my thoughts, expressed their doubts of the possibility of the manufacture; and one or two went so far as to say that it had been tried, but that it had been found not to answer; that though it looked like sea-water, tasted, smelt, like the right thing, yet it would not support animal life. Still, I could not help saying, with the lawyers, "If not, why not?" - *Experientia docet* [i.e., Experience

teaches]. **I determined to try the matter for myself.**

From this, there were unexpected, disastrous consequences. One wonders what Warington really thought when he read Gosse's paper. He must, at the very least, have been dumfounded but as will be seen, he actually only used the word "surprised."

In any event, Gosse had miscalculated converting from grains to avoirdupois pounds and ounces, and had mistakenly assumed that the magnesium sulphate in Schweitzer's paper represented the ordinary crystallized salt, and not the anhydrous sulphate that is always the case in giving analytical results. Furthermore, Gosse had eliminated the following from Schweitzer's formula:

1. Magnesium bromide because of its small concentration and because Laurens did not find any in the water of the Mediterranean;
2. Calcium carbonate because calcium could be found in abundance in the fragments of shell, coral and calcareous material that made up the bottom of the aquarium;
3. Calcium sulphate because it was difficult to dissolve and because it was found by Laurens in a minute concentration.

Gosse's decision to eliminate magnesium bromide and calcium sulphate simply because Laurens found them absent or in a minute concentration made no sense. The composition of Mediterranean waters differs from that of the water in the English Channel. The English Channel sits on top of a layer of chalk and it was to be expected that its calcium content would be higher. Since Schweitzer's analysis was appropriate for marine animals found off the southern cost of England where most specimens would be collected for British aquaria, it was the relevant analysis and logically the one that should have been followed.

Warington responded to Gosse's paper thusly (Warington, 1854):

In the 'Annals and Magazine of Natural History' for July last, you published a short communication from Mr. Gosse, on the artificial formation of sea water, and having lately had my attention especially directed to this paper by a friend who wished to put the formula given into practice, I was surprised at the difference in the proportions of the ingredients as compared with what I had myself employed in the course of 1853, more particularly from the circumstance, that when Mr. Gosse called upon me in January last, and consulted me on the feasibility of the plan, I told him that there could be no difficulty in the matter, as I had made and had then in use several small quantities artificially produced, and that all that was required was that a good analysis should be taken as the basis for deducing the proportions, and at the same time referred him to the source from which I myself had worked, namely Dr. E. Schweitzer's analysis of the water of the English Channel taken off Brighton. Now, as numerous parties have been inquiring respecting this subject, and the erroneous formula has been copied into other journals, it may prevent much annoyance as well as disappointment if this matter is set right.

Upon reading Warington's corrections to his paper, Gosse had two reactions, the first being a rather acrimonious one (Gosse, 1855):

If Mr. Warington supposes that I obtained from him one atom of information previously unknown to me, on the subject of making sea -water from its constituent salts, he is most thoroughly mistaken. He is no less wrong in saying that I "consulted" him; since I merely mentioned what was on my mind in familiar conversation. With this, however, the public are of course not concerned, and I shall say no more on that head.

In this regard I fault Gosse. Up to this point Gosse and Warington had been good friends and Gosse should not have kept Warington in the dark

about what he knew, In any event, the two never corresponded or met again.

GOSSE DEFENDS HIS FORMULA

The second reaction was a defense of his formula. At one point Gosse states:

That Mr. Warington's calculations are correct I do not at all deny; but that they convict mine of "error" I by no means admit; as my facts will presently show. The "error" (which is of that kind technically called "nidus equæ") [a humorous comment meaning a "mare's nest, implying that the criticism was a "humbug"] lies altogether on the other side.

Essentially Gosse claimed in his rebuttal that (1) his formula was "…for practical people, to whom minute accuracy is impossible and to whom a chemical formula expressed in quantities of four or five decimals would certainly act as a prohibition," and (2) by actual experimentation, examples of Crustacea (crabs, etc.), Mollusca (sea snails, etc.), Annelida (worms, etc.) and Zoophyta (sponges, etc.), as well as *Ulva* and *Conferva* plants, thrived for over eight months. As can be seen from Table I, the differences between his formula and that of Schweitzer's were large enough to raise some eyebrows. Ironically, with regard to simplicity it was Warington who suggested the simplest solution of all (Warington, 1854):

There cannot be a question that by far the simplest plan would consist in the evaporation of the sea water itself in large quantities at the source, preserving the resulting salt in closely stopped vessels to prevent the absorption of moisture, and vending it in this form to the consumer; the proportion of this dry saline matter being 56-1/2 oz. to the 10 gallons of water, less the 3 pints. This plan was suggested by Dr. E. Schweitzer himself for the extemporaneous formation of sea water for medicinal baths, and, on inquiry since writing the above, I find that such a preparation is manufactured by Messrs. Brew and Schweitzer of No. 71 East Street, Brighton, under the title of "Marine Salts for the instantaneous production of sea water." Mr. H. Schweitzer writes me, that he has for many years made this compound in accordance with his cousin's analysis. The proportion ordered to be used is 6 oz. to the gallon of water and stirred well until dissolved.

TABLE I
THE SCHWEITZER, GOSSE AND LAURENS FORMULAS COMPARED
The numbers are lbs./ 100 lbs. of water (= 10 Imperial gallons).

COMPONENT	(1) SCHWEITZER	(2) GOSSE	% INCREASE (1) OVER (2)	(3) LAURENS
Sodium chloride	2.7060	2.1875	24%	2.722
Potassium chloride	0.0766	0.0563	36%	0.001
Magnesium chloride	0.3666	0.2813	30%	0.614
Magnesium bromide	0.0029	-	-	-
Calcium sulphate	0.1407	-	-	0.015
Magnesium sulphate	0.2296	0.1563	47%	0.702
Calcium carbonate	0.0030	-	-	0.009
Magnesium carbonate	-	-	-	0.011

TABLE II
THE SIX MAJOR IONIC COMPONENTS OF SEAWATER

COMPONENT	Mg/L
Chloride	19,000
Sodium	10,500
Sulphate	2,600
Magnesium	1,350
Calcium	400
Potassium	380

Now the major ionic components of seawater are the same as those ions responsible for maintaining the electrical and osmotic balance within the cells of living animals and for the transmission of nerve impulses. What is an ion? Well sometimes atoms gain or lose electrons. The atom then loses or gains a "negative" charge. These atoms are then called ions. For example, when common salt is dissolved the Na (sodium) loses an electron and the Cl (chlorine) gains an electron; the Na becomes Na+ (the sodium ion) and the chlorine becomes Cl- (the chlorine ion). The major ionic components are shown in Table II. The complete absence of any one of these major ions is fatal. A fish placed into artificial seawater that contained no calcium, for example, would soon die as a result of the chemical imbalance. Therefore, one of the theoretical problems with Gosse's formula was that he had omitted the calcium.

Fortunately for Gosse, laboratory grade chemicals are not 100% pure and technical grade chemicals are far less so, especially in Gosse's day. Thus Gosse's formulation not only contained the necessary calcium but it also contained trace elements, such as silica and iron, that known to be biologically active.

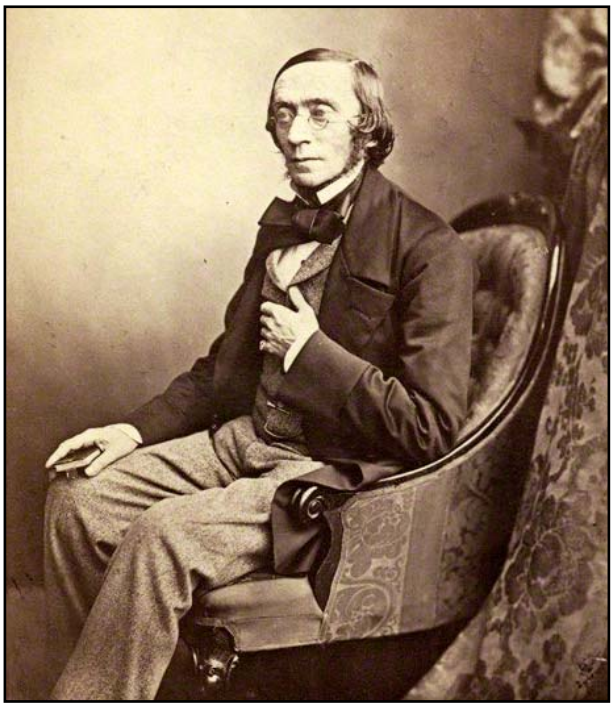
In support of his assertion that his formula worked, Gosse provided the following postscript to his article:

P.S. Some letters which have been lately published by Mr. W. A. Lloyd in the 'Athenaeum' confirm my experience. Perhaps I may be excused for citing a few words contained in a private letter from the same gentleman to myself: — "In reference to what has recently been published on an improvement (or a supposed improvement) on your receipt for the manufacture of sea water, a friend of mine took me by the button and said, 'My dear Sir, Mr. Gosse is altogether wrong; he has not salt enough; he has no—." To which I replied, pointing to two fine *Actinia dianthus* [an anemone] in full blow in one of my vessels, — 'But if Mr. Gosse is altogether wrong, why do these *Actiniæ* flourish ?' This was unanswerable."

However, except for the Crustacea, all of the animals studied by Gosse and Lloyd were invertebrates; no fish were involved.

OTHER PEOPLE CHIME IN

At first Gosse was criticized in the scientific community for his decisions made when he modified Schweitzer's formula. George Wilson (1818-



George Wilson (1818-1859).

1859), a Scottish chemist and physician, lecturer in the School of Arts, director of the Industrial Museum of Scotland and regius professor of technology in the university of his native city was reported as saying (Wilson, 1854):

Dr. Wilson considers, however, that the less abundant, but still essential, constituents of sea-water—such as carbonate of lime, sulphate of lime, phosphate of lime, fluoride of calcium, silica, iodine, and bromine—should not be absent, as these latter substances are found in marine plants and animals; and it is therefore plainly evident that the medium in which they live ought to contain the same substances.

However, after Gosse had learned of Wilson's remarks, he sent Wilson two samples of his artificial seawater, both of which had sustained living plants and animals, one for six months and the other for ten months. By the next year, Wilson had completed his analyses of Gosse's samples. The following is an extract from *The Eclectic Magazine*, reporting on the meeting of *The British Association for the Advancement of Science* in Glasgow in 1855 (Anon., 1855):

Professor George Wilson, of Edinburgh, read a paper on "The Chemical Changes undergone by Artificial Sea Water after Ten Months' Use in the Marine Vivarium." The author stated that the communication which he now made to the section was in continuation of one read to it at the meeting in Liverpool last year. Mr. Gosse, the distinguished naturalist, who has done so much for the improvement of marine vivaria, had given him two specimens of artificial sea water, in which living plants and animals had been kept in full vigor for periods respectively of ten and six months. On analysis, it appeared that, whereas magnesia, sulphuric acid, potassium, sodium, and chlorine, were the only substances originally present in solution in the artificial sea water; lime, phosphoric acid, silica, iodine, and iron now occurred in it. The lime [i.e., calcium oxide] was probably dissolved by carbonic acid [i.e., the name given to solutions of carbon dioxide in water] evolved from the animals; the phosphoric acid was taken up as phosphate of lime by the same gas, along with water; the iodine was separated from the sea weeds; the silica from the *Infusoria* and fragments of rock within the vivarium; and the iron from many sources. It was further stated, that certain important substances which were likely to be present could not be detected, owing, as the author believed, solely to the small amount , of water which could be spared from the vivaria not permitting a minute amount of such bodies as bromine, fluorine, ammonia, or nitric acid to be discovered. The success of Mr. Gosse's artificial sea water was shown to be complete.

Wilson, therefore, found trace elements of calcium, phosphorus, silica, iodine and iron in the sample, and offered some ideas on how they arrived there. He neglected, however, to mention the impurities of the constituents and also that trace elements could find their way into the artificial seawater through the foods and the water used to reconstitute the seawater. He did note that most likely other substances, such as bromides, fluorides, ammonia and nitrates, were in the samples but the samples were small, defying detection using the analytical tools available at the time.

Aquarists were satisfied by this report coming from a scientific person of such high stature and began to experiment themselves with Gosse's formula. However, a year later, Hibberd wrote (1856):

"But artificial water is quite unsuited for animal life of any kind, until it has been brought into condition by means of growing weeds for eight or ten days, and for Crustaceans, Starfishes, and Fishes proper, it is not suitable till it has been in use for many months, and even then some species lose their health in it, and at last perish…"

ARTIFICIAL SEAWATER GETS A BIG BOOST

In his Hand-Book to the Marine Aquarium (June 23, 1873), Lloyd was still favorably disposed to Gosse's formula: **Such artificial sea-water answers very well: indeed the large aquaria at Hanover and Berlin have no other.** It was Lloyd, by the way, who suggested that these two public aquaria use artificial seawater.

However, by 1879 Lloyd had changed his mind. He had secured the post of Superintendent of the Aston Aquarium and since it was located far from the coast where seawater was easily obtained and transportation of the water from the coast would be expensive, Lloyd decided that the use of artificial seawater was justified and selected the Schweitzer formula. Thus was the first use of artificial seawater in a public aquarium in England. In an article titled, "The Artificial Sea-Water at the Aston Aquarium," William Southall (1879) wrote:

My firm (Southall Bros. and Barclay) was appointed to manufacture the water, and about fifty tons of chemical substances have been used. Each ingredient was subjected to analysis, and allowance made in every case for water of crystallization, hygroscopic moisture and impurities, and the various constituents of the well-water used were also allowed for in calculating the working formula. The analysis of Dr. Schweitzer was taken as a basis, supplemented by our own analysis of water recently taken near Brighton, a mile from the shore; and from the latter the data necessary for the required amounts of iodine, &c., were obtained.

Table III provides a comparison between the Schweitzer and Aston Aquarium formulas, the latter being supplied to Lloyd by H. W. Jones, analyst to Messrs. Southall Brothers and Barclay

TABLE III
THE ASTON FORMULA COMPARED TO THE SCHWEITZER FORMULA
The numbers are lbs./100 lbs. of water (= 10 Imperial gallons).

	SCHWEITZER	ASTON
Sodium chloride	2.70595	2.72143
Potassium chloride	0.07655	0.07857
Magnesium chloride	0.36666	0.37643
Magnesium bromide	0.00293	0.00400
Calcium sulphate	0.14062	0.14429
Magnesium sulphate	0.29578	0.23700
Calcium carbonate	0.00330	0.00841
Calcium carbonate		0.00329
Magnesium carbonate		0.00217
Silica		0.00148
Magnesium sulphate		0.00046
Oxide of Iron and alumina		0.00022
Sodium chloride		0.00201
Magnesium nitrate		0.00050
Sodium nitrate		0.00040
Potassium chloride		0.00006
Sodium iodide		traces
Ammoniacal salts & organic matter		slight traces

Those below the dashed line were those present in the well water.

Johan Georg Forchhammer (1794-1865).

of Birmingham. Above the dotted line are the concentrations of the salts added to the well-water (as can be seen, the components and concentrations are essentially identical to those of the Schweitzer formula) and below are the components and concentrations of what was found in an analysis of the well water. Added together they are the actual components and concentrations in the Aston tanks.

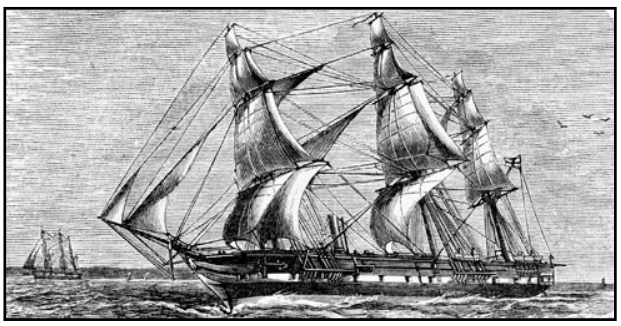
It is clear from these measurements that the water added to a basic group of components is a major consideration with regard to trace elements. All freshwater contains one or more of those used in the Aston Aquarium, more or less, but usually more. Lloyd pointed out that the Thames at London contains about 0.02 or 0.03 pounds of trace elements instead of the roughly 0.01 lbs. per 100 lbs. of water of the Aston well water (Lloyd,1879). Considering the accuracy required for the correct reproduction of certain of the minor constituents, the purity of the added salts and of the water used is critical, endangering the final formulation unless the quantity and quality of the impurities are known. For example, if the sodium chloride used is the commercial grade or household salt, the arsenic and barium levels (even though these are in minute quantities and can be measured in single figures in parts per million) can present problems unless accounted for. In addition to these two, sodium chloride of this grade contains as many as twelve other elements in substantial enough quantities to give rise to doubt as to what their final concentrations would be.

FORCHHAMMER'S PRINCIPLE

The concept of salinity was introduced in 1865 by the Danish chemist and mineralogist Johan Georg Forchhammer (1794-1865). Forchhammer worked under great disadvantages: his samples of water were brought home by seafaring men from different parts of the world in corked bottles, and they were necessarily all taken from the surface or immediately beneath it. Forchhammer did not attempt to determine quantitatively all the elements that occur in sea water, but confined himself to the very accurate estimation of the principal salt components, such as chlorine, sulphuric acid, magnesia, lime, potash and soda. Forchhammer found that the ratio of major salts in samples of seawater from various locations was constant. This constant ratio is known as Forchhammer's Principle, or the Principle of Constant Proportions. One of the most interesting of his scientific work, “On the Constitution of Sea Water at Different Depths and in Different Latitudes” (1863) started a new era in the history of ocean chemistry.

THE H.M.S. CHALLENGER EXPEDITION

The 1870s voyage of H.M.S. Challenger lasted 1,000 days and covered more than 68,000 nautical miles. Many consider it to be the first true oceanographic expedition because it yielded a wealth of



HMS Challenger, 1872.

Dr. Charles Wyville Thomson (1830-1882).

information about the marine environment. Those aboard identified many organisms then new to science, and they gathered data at 362 oceanographic stations on temperature, currents, water chemistry and ocean floor deposits. The scientific results of the voyage were published in a 50-volume, 29,500-page report that took 23 years to compile. Specialists in numerous scientific disciplines studied the collections and data, and helped produce the reports. Also, the reports written by members of the Challenger expedition provided rich descriptions of the flora, fauna and cultures of the lands visited. Photography - new at the time - was highlighted as well, along with scientific illustration.

The HMS Challenger originally was designed as a British warship - a steam corvette in the Royal Navy - outfitted with 17 guns and an engine capable of over 1,200 horsepower. The 200-foot ship was three-masted, square-rigged and built of wood.

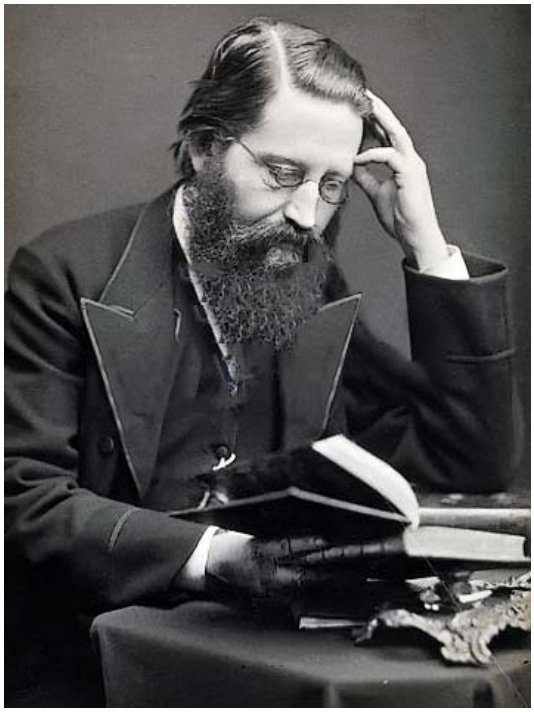
In 1870, Dr. Charles Wyville Thomson, a Scottish natural historian and marine zoologist, suggested that the *Royal Society of London* ask the British government for the use of one of its ships for an extended research cruise. The government agreed, and the HMS Challenger was modified to conduct oceanic research. Ammunition and 15 of the guns were removed from the ship and replaced with laboratories, workrooms and storage space. The HMS Challenger used sails rather than the steam engine most of the time to allow for frequent stops when collecting data. The steam engine was used only during dredging operations to collect samples from the depths of the ocean

At the start of the voyage in 1872, the science and ship crew consisted of six civilian/scientific staff, led by Dr. Thomson. It also included 21 naval officers, including Captain George Nares (replaced by Captain Frank Thomson in 1875), and approximately 216 crew. When the voyage ended in 1876, only 144 crew remained on the ship. Seven people had died, five left when Captain Nares did, 26 were left in hospitals or were unable to continue the journey, and several had deserted at the various ports of call.

The following are the "Editorial Notes" taken from the report on the scientific results of the voyage:

The physical and chemical investigations conducted by Mr. J. Y. Buchanan, during the three and a half years' cruise of H.M.S. Challenger, are among the most important and valuable of the Expedition.

The Challenger's Natural History Workroom.



Wilhelm Dittmar (1833-1892).

Mr. Buchanan collected daily, with much care, samples of the surface, water, and determined the specific gravity. At all Stations, a slip water bottle was attached to the sounding line, and the specific gravity of the specimen of bottom water thus collected was also ascertained. At every Station, where practicable, waters were collected from intermediate depths at 25, 50, 100,200, 300, 400, and 800 fathoms from the surface, with a stop-cock water bottle attached to a separate sounding line, under Mr. Buchanan's personal supervision. The specific gravity of these waters was also determined.

The routine chemical work of the Laboratory consisted in boiling out the gases from, and in determining the carbonic acid in, as many samples as possible. A very large number of samples of sea-water were collected from the surface, bottom, and intermediate depths, and preserved in glass stoppered bottles. These were either sent homo along with other collections from various ports touched at during the Expedition, or brought home by the ship.

It is difficult for any one, except those who actually witnessed the daily work at sea. to form an adequate idea of the labour, skill, and continuous effort required to carry on these observations in all sorts of weather, and to form, and bring home successfully, collections and observations like those which have resulted from Mr. Buchanan's exertions.

THE DITTMAR ANALYSES

The most comprehensive early study of the composition of seawater was that made in 1884 by Wilhelm Dittmar (1833-1892), a German-born chemist renowned as a chemical analyst, on the 77 samples collected by chemist J.Y. Buchanan during the Challenger Expedition.

It should be noted that the analysis of seawater is primarily concerned with its ions, notably chloride, sodium, sulphate, magnesium, calcium and potassium. To construct a formula useful for the manufacture of artificial seawater, however, this information must be translated into specific chemical compounds. This is an arbitrary procedure since it doesn't make any difference what chemical compounds and their concentrations are chosen as long as the mixture after being dissolved contains the ions in their correct amounts. An example is potassium. Schweitzer added it as potassium chloride and adjusted the amount of chloride elsewhere; Dittmar added it as the sulphate and adjusted the amount of sulphate elsewhere. Thus, combining the acids and bases in the arbitrary mode shown in Table IV, Dittmar held that the seven numbers in the table expressed as percentages of the total salts - Column (1) - may be taken as holding approximately for any sample of seawater, in other words, the ratios of these components is constant. I quote Dittmar here:

From my analysis (which I do not pretend exhaust the subject), it would appear that the composition of seawater is independent of the latitude and longitude whence the same is taken. Nor can we trace any influence of the depth from which the same comes, if we confine ourselves to the ratio to one another of chlorine, sulphuric acid, magnesia, potash and bromine. I emphasize the bromine because,

while present in very small proportion, it is taken up preferably by sea-plants, and consequently must be presumed to be more liable than any of the major components to at least temporary local diminution. And yet my analyses of the three mixtures of Challenger waters, and of the Arran water referred to, gave identical values for the bromine present per 100 of the chlorine. [As shallow shore waters did not occur in the series of Challenger samples, Dittmar also analyzed a water that had been collected for him near Port Arran, Scotland, at a shallow place where there was an abundance of marine vegetation.] But the determination of the lime in the same set of waters make it most highly probable that the proportion of this component increases with the depth.

In order to derive a formula for artificial seawater, one has to know the salinity, i.e., the total amount of the salts in the water. For Table IV, I chose the average ocean salinity of 3.5 grams of salts per 100 grams of seawater. By multiplying the percentage figures in Column (1) of Table IV by this number, I obtained the gram weights for each compound; these are listed in Column (2) as grams per 100 grams of seawater. As Warington showed in his critique of Gosse's paper, we can consider these numbers as lbs./100 lbs. of water and the Dittmar and Schweitzer formulas, therefore, can be compared directly in Table IV. There are some significant differences, mainly in the magnesium sulfate, calcium carbonate and magnesium bromide.

If Dittmar's formula may have been of some interest to public aquaria, it had no effect on the aquarium hobby. The interest in marine aquaria had waned because it was expensive and required careful attention on the part of the hobbyist. In this country Stage IV of the aquarium hobby (the Stage we are in now) started just before 1900, but the emphasis was on freshwater and, to a very limited extent, brackish water fishes. Some public aquaria, particularly those situated inland, did use artificial seawater but this had no real effect on the hobby until after World War II ended. This did not, however, stop oceanographers from devising new formulas, such as McClendon et al. in 1917 and Brujewicz (in Subow, 1931). Furthermore, every time the International Atomic Weights were revised, the formulas were revised also. In 1940, for example, Lyman and Fleming recalculated Dittmar's figures using the 1938 Atomic Weights.

TABLE IV
THE SCHWEITZER AND DITTMAR FORMULAS COMPARED

The numbers in Column (1)are the % of each salt in the total of the salts in the sample. The total used in this comparison was the average ocean salinity of 3.5 grams per 100 grams of water. The numbers in Column (2) are in grams/100 grams of Water and they are obtained by multiplying the percentages in Column (1) by 3.5; the numbers in Column (3) are in lbs./100 lbs. of water. Note that they are identical scales.

COMPONENT	(1) SALT %	(2) DITTMAR	(3) SCHWEITZER
Sodium chloride	77.758	2.7215	2.7060
Magnesium chloride	10.878	0.3807	0.3666
Magnesium sulphate	4.737	0.1658	0.2296
Calcium sulphate	3.600	0.1260	0.1407
Potassium chloride			0.0766
Potassium sulphate	2.465	0.0863	
Magnesium bromide	0.217	0.0076	0.0029
Calcium carbonate	0.345	0.0121	0.0030
TOTAL	100%		

THE ORIGIN OF MARINE MIX

The Lilly Ackerland Fleischmann Memorial Aquarium at the Cincinnati Zoo opened on Friday, May 26, 1950. I moved to Cincinnati in June of 1950 and by 1951 I was a consultant to the Aquarium, mostly engaged in identifying species of newly-obtained fishes. The Aquarium was interested in displaying marine life - it was all freshwater at the time - and wanted to set up some experimental ma-

rine aquaria. However, at that time there were no artificial seawater mixes on the market, so I was asked to provide a formula.

In early 1952 I turned over a copy of what I had come up with to the Chief Aquarist and we sat down for a lengthy discussion over the details. It was decided to go ahead with the experiments and so the Aquarium had a quantity of the mixture made up by a local commercial chemist, enough for about 100 gallons of water. In May of that year, however, I entered the United States Army (the Korean War still was in full tilt) so I was not around to see how things turned out. The following, however, is from the *Cincinnati Enquirer* of Sunday, November 16, 1952:

Something's Latest addition to the Fleischmann Aquarium at the Cincinnati Zoo is a collection of tropical fish, some of which are pictured on these pages. The first of their kind to be shown in Cincinnati, these specimens were flown here from the gulf of Mexico. Special water prepared from a formula, is required to keep the marine inhabitants who are used to a saltier atmosphere than Cincinnati.

The caption under one of the pictures read: **J.F. Heusser, Zoo Director, checks the temperature of the artificial sea water in one of the seven new exhibition tanks for tropical fish in the Fleischmann Aquarium.**

After my tour of duty ended (I had been Commanding Officer of the 501st Chemical Depot Company), I spent a year in graduate school and returned to Cincinnati at the end of August 1955. I renewed my acquaintances with the Cincinnati Zoo and Fleischmann Aquarium staff and was able to examine the seven tanks that utilized the formula that I had provided. Everything was fine; the vertebrates, were in good health, as well as were the anemones and other marine creatures.

Much to my surprise, I learned that during my absence the Aquarium had decided to sell the salt mixture to aquarists under the name of "Marine Mix." This was done mainly because it was cheaper to manufacture in large quantities than small. Thus, in 1956 the first artificial seawater mix appeared on the market in this country. It was only on the market briefly since the Fleischmann Aquarium was satisfied that artificial seawater was feasible and so they planned to build an East Wing on the building to house small marine tanks. This took some time to plan, secure the necessary funds and build, but the addition was finally opened in June 1972. By this time, of course, there were a number of improved mixes on the market and the Aquarium did not need to manufacture its own as it did in the 1950s.

ADDENDUM: THE COMPOSITION OF MARINE MIX

The element strontium, one of the major constituents of seawater, had not been isolated in Dittmar's time. The usual wet-chemical analysis methods for calcium register any strontium present as an equivalent amount of calcium As a result, the strontium went unreported in the early analysis of seawater. I had briefly looked over several older formulas, but settled on that of Lyman and Fleming (1940) since they had included strontium. Their formula yields a water containing all of the major ionic components in their correct proportions, lacking only in the minor elements.

First, some biographical information. Dr. John Lyman (1915-1977) directed studies of the ocean for three agencies in the course of 20 years with the federal government. Born in Berkeley, Calif., Lyman did undergraduate work there and received his master's and doctorate degrees from Scripps Institution of Oceanography, part of the University of California in Los Angeles. He began his career in Washington in 1946, when he became director of oceanography for the Navy Hydrographic Office. He later became director of oceanography at the National Science Foundation and then chief adviser for oceanographic research at the Bureau of Commercial Fisheries. Before going to Chapel Hill in 1968, he worked for the Office of Naval

Dr. John Lyman (1915-1977) in 1936.

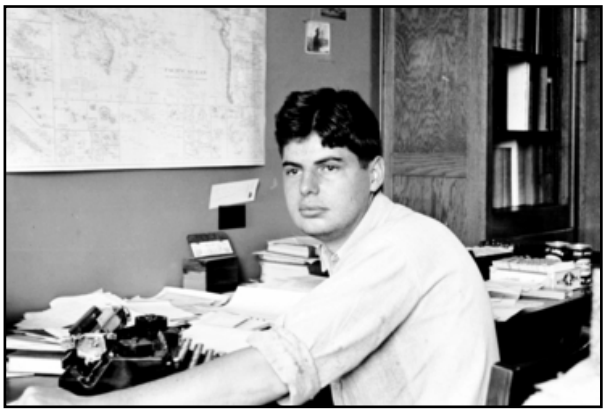
Research. At the time of his death, at age 62, Lyman was professor emeritus of environmental chemistry at the University of North Carolina, where he had moved in 1968 to head the school's office of marine sciences. He served in the Navy in World War II and was a member of the Washington Academy of Sciences and the American Association for the Advancement of Science.

Richard Howell Fleming (1909-1989), was a Canadian-born American oceanographer who conducted wide-ranging studies in the areas of chemical and biochemical oceanography, ocean currents (particularly those off the Pacific coast of Central America), and naval uses of oceanography. He joined the Scripps Institution in La Jolla, California, in 1931 and served as assistant director from 1946 to 1950, when he left to become professor of oceanography at the University of Washington. Fleming measured the amounts of chemical elements in sea water and in marine life. His work on ocean currents included measurement of tidal-current velocities, description of upwelling of seawater, and observations of seasonal variations in currents. He also explored sedimentation in moving and stagnant bodies of water. With H.U. Sverdrup and Martin W. Johnson, Fleming wrote *The Oceans* (1942).

Those aquarists not interested in an arithmetic exercise can safely skip this part of the Addendum and go directly to Column (2) of Table V.

Referring to Table V, lines 1-10 in Column (1) comprise the Lyman and Fleming formula; lines 11-17 are my additions. The sum of lines 1-10 in Column (1) is 34.481 grams. This, by the way, rounded is a salinity of 34.5 (in grams of salts per 1000 grams of seawater). Subtracting this from 1000 grams (1 kilogram) we obtain 965.519 grams of water. (Items 11-17 were not included since they are in quantities too small to have any effect on these calculations.) Since 1 gallon of water = 3.79 kilograms, 965.519/3790 = 0.2547543 gallons. (At this stage in the computations I like to keep as many decimal places as possible in order to minimize rounding errors.)
Now I wanted a formula for 10 gallons of water, not 0.2547543 gallons. Therefore, I multiplied the lines 1-17 in Column (1) by 10/0.2547543 = 39.253508 and obtained the final formula for Marine Mix shown in Column (2). The salinity of this formulation was not affected and remained at 34.5.

There has always been controversy over the relative merits of natural and synthetic seawater, especially with regard to trace or minor elements. Most synthetic seawaters have at some stage



Richard Howell Fleming (1909-1989) in 1935.

TABLE V
COMPONENTS AND CALCULATIONS FOR MARINE MIX

COMPONENT	(1) AMT./1 KILOGRAM	(2) AMT. ADDED TO 10 GAL.
1. Sodium chloride, NaCl	23.476 grams	921.515 grams
2. Magnesium chloride, $MgCl_2$	4.981	195.522
3. Sodium sulphate, Na_2SO_4	3.917	153.756
4. Calcium chloride, $CaCl_2$	1.102	43.257
5. Potassium chloride, KCl	0.664	26.064
6. Sodium bicarbonate, $NaHCO_3$	0.192	7.367
7. Potassium bromide, KBr	0.096	3.768
8. Boric acid, H_3BO_3	0.026	1.021
9. Strontium chloride, $SrCl_2$	0.024	0.942
10. Sodium fluoride, NaF	0.003	0.118
11. Disodium phosphate, Na_2HPO_4	0.250 milligrams	9.813 milligrams
12. Potassium iodide, KI	0.077	3.023
13. Alum, $AlK(SO_4)$	0.044	.727
14. Zinc sulphate, $ZnSO_4.7H_2O$	0.015	0.589
15. Manganese chloride, $MnCl_2.4H_2O$	0.005	0.196
16. Barium chloride, $BaCl_2.2H_2O$	0.005	0.196
17. Copper sulphate, $CuSO_4.5H_2O$	0.002	0.076
18. Water	65.519 grams (0.2547543 gal)	10 gallons

failed in certain respects, such as in maintaining a specific marine organism or plant, or in the breeding and rearing of the higher forms of marine life such as the fishes. A list of components in seawater of proven or suspected biological activity, in order of their concentrations in micrograms per liter (μ/l), is shown in Table VI. Copper, Barium and Nitrate (as NO_3) are found in Cincinnati water. If I had such a list when I was putting together my formula for Marine Mix, I might have replaced the Barium, Aluminum and Copper with Silicon, Iron and Molybdenum.

TABLE VI
A LIST OF COMPONENTS IN SEAWATER OF PROVEN OR SUSPECTED BIOLOGICAL ACTIVITY

COMPONENT	CONCENTRATION, MICROGRAMS PER LITER (μ/l)
SILICON	500-2900
NITROGEN AS NO_3	500-700
IODINE	45-65
PHOSPHORUS AS PO_4	1-90
BARIUM	6-90
IRON	1-40
MOLYBDENUM	9-16
ZINC	5-21
MANGANESE	0.4-10
VANADIUM	0.2-7
NICKLE	0.5-6.6
ARSENIC	2.1-2.7
COPPER	0.9-3
COBALT	0.1-0.7
NIOBIUM	0.015
YTTRIUM	0.01-0.3
VITAMIN B_{12}	0.001-0.05
GOLD	0.004-0.01

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THE HISTORY OF FLAT GLASS AND THE AQUARIUM

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, October 29, 2016)

The history of the modern-day aquarium is essentially the history of flat glass, and the history of flat glass is essentially the history of window glass. This essay traces the history of window glass over the past five centuries in England, where it ultimately became the special "four-sided window" we call an aquarium.

Almost all window glass has been, and continues to be, produced from sand, which is composed almost entirely of silica, a chemical compound that is an oxide of silicon with the chemical formula SiO_2. In order to melt silica, however, it is necessary to add a flux, i.e., any material which will lower the melting temperature of the silica. The most common fluxes used in window glass manufacture are the alkalis sodium and potassium. The more alkali that is added, the lower the melting temperature; however, an excess of alkali will leave the glass prone to weathering. Therefore, in order to increase the chemical durability of glass, a stabilizer is usually added. A wide variety of elements can act as glass stabilizers but the most important have been calcium and magnesium. Early glassmakers were not necessarily aware of the range and concentration of the different elements in the raw materials they used, yet in spite of this they developed working practices that were successful.

FOREST GLASS (before c. 1567)

The first phase of historic window glass manufacture covers the medieval period up to the arrival in England of French glassmakers in 1567, although documentary sources hint that glass production may extend back into the thirteenth century. The glass of this period was made using sand and ashes from woodland plants and was characterized by high levels of potassium and magnesium. While written sources appear to recommend the use of a wide range of plants, the chemical composition of most English medieval glass was most consistent with the use of bracken as a source of the alkali. Unfortunately, the glass of this period was not particularly stable and it is rare for it to have survived in contemporary windows. This glass type was also used to manufacture a wide range of other goods, including drinking vessels.

It is probable that the flat glass was formed using the cylinder glass technique. A bubble of glass would be blown and elongated to form a cylinder; the ends were removed and the cylinder cut along its length and flattened (Figure 1). The flattening process was undertaken with blocks of wood

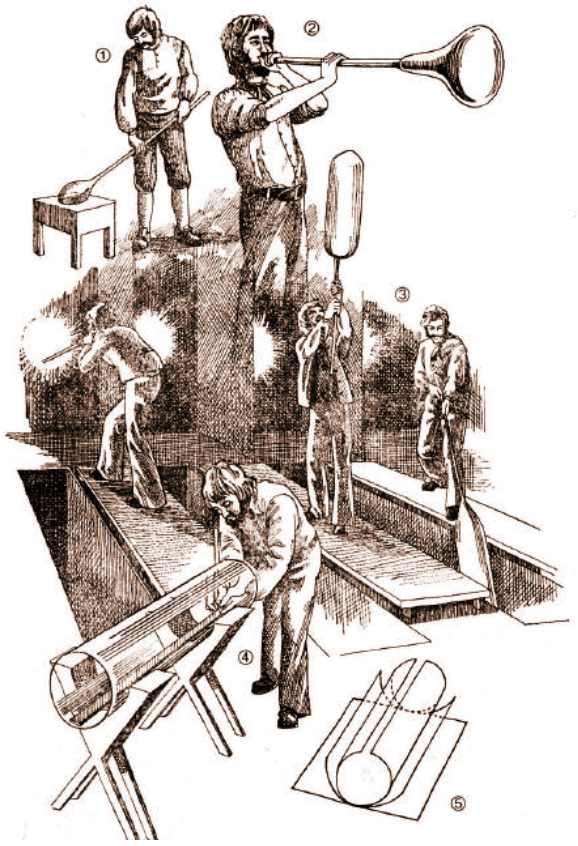

FIGURE 1: Cylinder window glass Manufacture. A bubble of glass was elongated to form a cylinder, which was then cut open and flattened to form a large sheet.
(Image © Pilkington Group Limited.)

while the glass was still sufficiently soft, but this left a more-or-less rough surface on the glass. At some stage, a second forming method was developed that came to be known as crown glass. The glass was blown as a bubble, which was then opened and spun round until it formed a disc of glass (Figure 2). Crown glass did not have to be flattened and so had a superior surface finish compared to cylinder glass. The drawback with crown glass, however, was the central swelling or bull's eye, which prevented the production of large panes of glass. Since almost all glass of this period (whether cylinder or crown) was made using plant ashes, it had a natural tint or color which came primarily from the traces of iron present in the raw materials used.

HIGH-LIME, LOW-ALKALI GLASS (c. 1567 to c. 1700)

The second phase started in 1567 with the arrival of the French glassmakers. The glass of this period was characterized by a high calcium content and relatively low levels of sodium and potassium. It has long been argued that these French glassmakers brought with them a number of technical developments and it is now clear that the glass made by the French glassmakers was indeed of a new type. This new high-lime, low-alkali (HLLA) glass appears to have been produced using different types of plant ashes as the source of the alkali. The high lime content of this glass strongly suggested the use of wood ash. Contemporary sources mention the use of a wide variety including trees (oak, birch, fir etc.) and a variety of other plants, such as thistle, hops, brambles and even tobacco. HLLA glass was also used to manufacture a wide range of goods including tableware and bottles.

The late-sixteenth-century influx of glassworkers (again, mostly from France) is well known from documentary sources; however, it has not been clear what effects this had on the nature of the window glass produced. The glassmakers from Lorraine were traditionally associated with the production of cylinder glass, while those from Normandy were usually thought of as crown glass manufacturers.

Window glass continued to be manufactured in the forests until the beginning of the seventeenth century. The early seventeenth century saw a major change in the glass industry as a whole when the use of wood as a fuel was banned. The glass makers in southern England (those established by French Huguenot refugees) were burning wood at such a rate that a law of 1615 made it illegal to use wood for glass furnaces. This caused the first shift of fuel for glassmaking in its long history, leading ultimately to the use of coal and the inevitable migration of glass industries to areas of Britain with surface coal and good communications, such as Stourbridge and Newcastle.

FIGURE 2:
Crown window glass manufacture. A bubble of glass was spun to form a circular sheet that was cut to form small panes.
(Image © Pilkington Group Limited.)

Written sources are equivocal about the types of window glass made during this period. This is not helped by the fact that the term "cylinder glass" (or its cognates, "broad" or "muff glass") was widely used to mean any sheet glass suitable for windows. Although crown glass was described as "first made" in England in 1691, there is abundant archaeological evidence for its manufacture in the early sixteenth century.

The identification of cylinder or crown glass in extant seventeenth-century windows is also made difficult by the fashion for small diamond panes of a rather small size. The panes were held together with lead strips, each window often containing 20 to 50 panes. The small size of the panes, the lead strips and the greenish quality of the glass all contributed to a window that would provide much less light than a modern window and that could give only a rather distorted view of the outside world (Figure 3). The late seventeenth century saw the introduction of the sash window that used cords and counterweights, and these quickly made use of larger panes of glass. The sash window became increasingly popular during the eighteenth century and was used to allow more light into a room and a more useful view of the outside world.

KELP GLASS (c. 1700 to c. 1835)

This phase saw wide-ranging changes in the manufacture and use of window glass. Glass of this phase was a mixed alkali glass and contained substantial proportions of both sodium and potassium. In addition, the glass contained a relatively high proportion of strontium, suggesting the use of a marine plant. The analysis of strontium isotopes in this glass has confirmed the use of seaweed, and historical sources corroborate the use of seaweed (usually referred to as kelp) from at least the middle of the eighteenth century. Also, the chemical analysis of this glass shows that it was used in windows from at least the beginning of the eighteenth century. During the eighteenth century the production of cylinder glass declined and crown glass came to dominate the market. While crown glass may have been an aesthetically superior glass, the system of taxation on window glass production at the time worked in its favor since window glass manufacturers were taxed on the weight of the materials they used to make the glass but derived their profit from the glass they sold. As crown glass was routinely thinner than cylinder glass, there was more profit to be made in it than in cylinder glass.

A new technique for producing sheet glass suitable for windows had developed in France in the late seventeenth century. The molten glass was cast onto a metal table and rolled flat. Once cooled, the glass was laboriously ground and polished to produce two perfectly flat and polished surfaces called "plate glass." The long polishing process made plate glass very expensive compared to crown or cylinder glass, It has been estimated that in the early eighteenth century plate glass was five to twenty times more expensive than ordinary sheet glass, and so its use was largely restricted to mirrors. Plate glass was also used for the windows of coaches but was only used for domestic windows in the houses of the fabulously wealthy. Plate glass production was introduced to England in the late seventeenth century but production seems to have been short lived. The technology was reintroduced in the late eighteenth century and continued into the twentieth century. Very little is known about the sorts

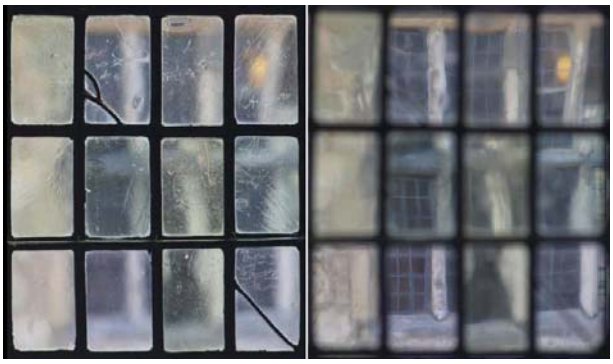

FIGURE 3: An example of the quality of glass and its transmitted image. The left image is focused on the glass, the right on the exterior).
(Photograph by David Dungworth.)

of ingredients used in plate glass manufacture but the apparent concern with transparency is likely to have encouraged the use of more select materials than those employed by crown or cylinder glass manufacturers.

LEBLANC SODA GLASS (c. 1835 to c. 1930)

The nineteenth century saw many significant developments in the English glass industry, including the nature of the raw materials and forming techniques. It also was the period that supplied aquarists with the flat glass needed for their aquariums. For centuries all window glass had been made using the ashes of selected plants, but by the eighteenth century it was increasingly appreciated that the active ingredients in plant ashes were the alkalis, sodium and potassium. Although common salt was rich in sodium, it would not react with sand to form glass. Towards the end of the eighteenth, Nicolas Leblanc developed a technique for converting sodium chloride into sodium carbonate and this worked for the glass. The technology was imported to England in the late 1820s, and by the late 1830s Leblanc soda had largely displaced plant-based alkalis. Window glass made using Leblanc soda is a soda-lime-silica glass which contains very low levels of impurities compared with any of the earlier plant-ash glasses. In particular, glass made after circa 1835 contains little or no phosphorus.

Most people experience window glass as a fully transparent material and, since the early nineteenth century, most window glass has been manufactured from materials that gave virtually no tint to the glass. Before the industrial production of synthetic (Leblanc) soda, however, almost all glass had at least a slight tint that gave a distinct character to both transmitted light and images viewed through the glass. The exact tint of the glass could vary considerably depending on the composition of the glass and the way in which the original glass had been melted. The most significant element in glass which affects its color is iron. It results in the green tint shown in Figure 4. Before the use of synthetic soda, the sands employed by window glassmakers all appear to have contained enough iron to give the glass at least some color. Due to the use of better quality sand, the glass of this period rarely has any significant color.

Documentary sources indicate that Leblanc soda was first manufactured in England in the late 1820s but it did not make any serious impact on the glass industry until the 1830s.This phase also introduced the practice of using refining agents. Refining agents are used to remove bubbles from glass; paradoxically, this is usually achieved by using a material which produces glass bubbles. The introduction of arsenic, saltpeter and even potatoes will evolve gas bubbles that, being large, will rise quickly and tend to gather in small bubbles.

Glass made for the first few decades after the introduction of Leblanc soda usually contained significant concentrations of arsenic and its use as a refining agent is mentioned in several contempo-

FIGURE 4: An example of the green tint in old glass produced by iron impurities.

rary documentary sources (written sources also mention the use of saltpeter, i.e., potassium nitrate, as a refining agent). Around the 1870s, the arsenic disappeared from window glass but there was a small increase in the potassium content.

The 1830s saw the Chance Brothers introduce what they called improved cylinder glass. Chance Brothers and Company was a glassworks originally based in the West Midlands in England. It was a leading glass manufacturer and a pioneer of British glassmaking technology. This glass was made using some variation on the traditional cylinder glass technique, although it is not immediately apparent what the improvements were. Chance made use of skilled labor brought from continental Europe and appears to have been able to supply sheets that were larger than those made by traditional cylinder producers. It is likely that, like so many industrial developments of this time, the improvement was actually embodied in the manual skill of the workers and so was not easily captured in a written text. Contemporary observers contrasted the quality of traditional, English cylinder glass, "coarse in texture, of a wavy wrinkled surface, and very cheap," with the new improved cylinder glass. The quality of improved cylinder glass also probably benefited from the recent availability of Leblanc soda. Its production expanded rapidly and by 1844 accounted for almost a quarter of the flat glass made in England. Crown glass production continued to decline and by the early twentieth century the technique was described as "nearly obsolete."

MECHANIZED SYSTEMS (from c. 1890)

There are two ways whereby flat glass can be produced: manually and mechanically. The latter, however, can be either batch or continuous. The processes described here so far have included the cylinder, crown and plate glass processes, all of which are manual. However, all produced their flat glass in batches and so were both batch as well as manual processes. The problem with all of them involved the use of labor, which is time-intensive and expensive. The early twentieth century saw the mechanization of window glass production with the introduction of the Lubbers Process that originated in the United States in the 1890s (Figure 5: additional information can be found in Klee, 2014). The process essentially mechanized the production of cylinder glass but it still was a batch process that required a fair amount of labor.

By the late 1920s continuous sheet drawing techniques had been introduced to England, especially the Fourcault process. First developed in Belgium by Émile Fourcault during the early 1900s, the process was used globally. Fourcault is an example of a "vertical draw" process, in that the glass is drawn against gravity in an upward direction. Gravity forces influence parts of the process.

The process used a ceramic die to shape molten glass into a ribbon of rectangular cross section. The die, known as a Debiteuse, floated in the molten glass inside of the pit to a prescribed depth that pushed a part of the molten glass slightly above the top surface of the die. A slot was cut through the center of the Debiteuse, which was shaped to produce the best quality of

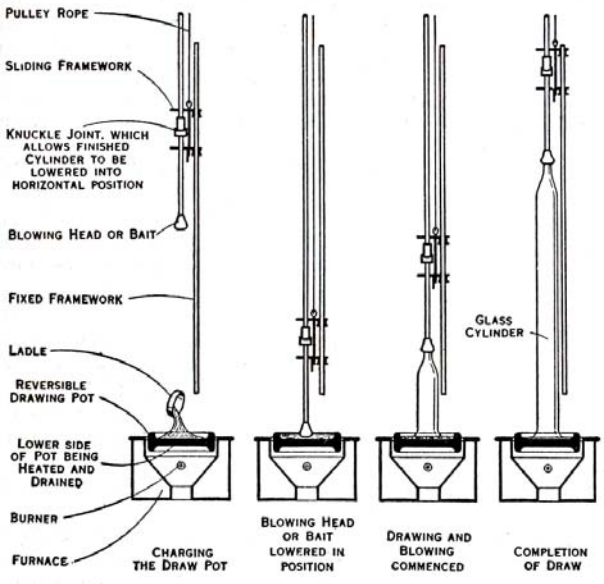

FIGURE 5: The Lubbers Process.

glass. The Debiteuse was the starting point of the vertical draw, where the glass began to change from a hot syrupy mass into a useful flat glass (Figure 6).

From the point of the Debiteuse until it was cut, the glass resembled a ribbon. The base of the ribbon was shielded from heat radiation from the fused glass so that it continued to hold the shape imparted to it by the Debiteuse. This preserved the rectangular cross section of the drawn glass by cooling the ribbon glass below the temperature where it would collapse into a column or break back into the melted glass. Immediately after being drawn, the ribbon was cooled using mechanical coolers so that it maintained its rectangular shape in two dimensions but assumed a ribbon like structure that extended down into the Debiteuse and upwards into a drawing assembly. This mechanical cooling allowed the ribbon to hold its integrity. The mechanical coolers used water contained in specially shaped radiators to remove the heat radiated by the ribbon.

The scale of this process was such that the glass produced had to be kept hot for longer periods compared to the earlier manual techniques and this resulted in a tendency for the glass to devitrify, the formation of small crystals in the glass obviously detracting from its transparency. Various attempts were made to alter the composition of the glass to avoid this problem but the lasting solution was found to be the replacement of a proportion of the calcium in the glass with magnesium. In any case, the resultant product is a form of flat glass which is suitable for lesser quality uses. Due to process instabilities, Fourcault process glass could have waves, seeds (small gas bubbles) or stones (undissolved materials).

The Colburn/Libbey-Owen process also drew its sheet vertically from an open bath, the glass ribbon being drawn vertically from the tank for about 30 inches by a metal bait before being bent over a roller into the horizontal plane ready for cutting and annealing (Klee, 2014). The process was twice as fast as the Fourcault process so the glass had less time to cool and so the annealing process eliminated or limited the stresses previously mentioned. However, the bending tended to spoil the surface of the glass.

The third process, the Pittsburg process, combined and enhanced the main features of the Fourcault and Libbey-Owens processes. The glass was drawn from the melt and conveyed vertically through an annealing shaft around 40 feet long prior to cutting. By 1928 these processes replaced the mechanical cylinder-drawing machines.

Continuous processes such as these were fast and economical, but not necessarily of high quality. In

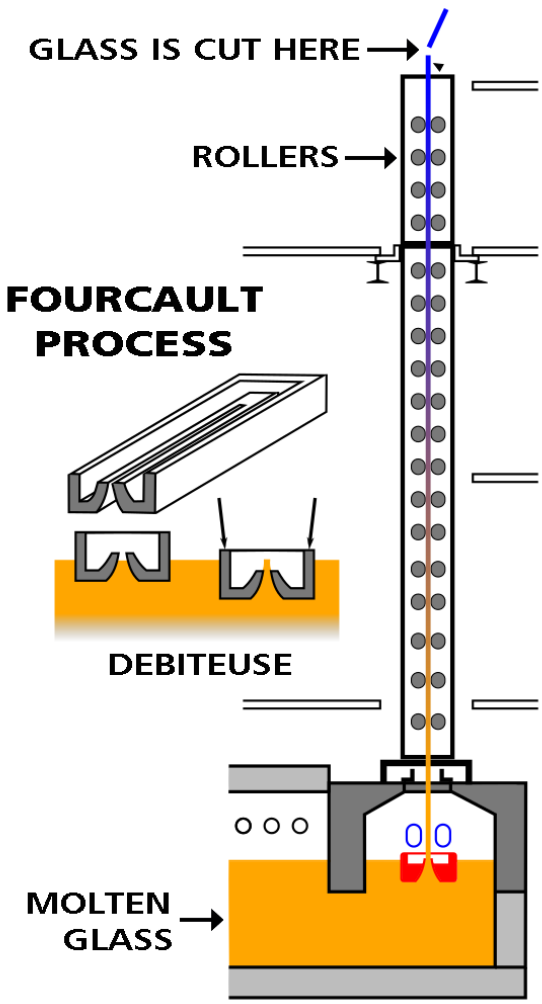

FIGURE 6: The Fourcault Process.

terms of economics and product quality, they were supplanted by the Float process developed by Pilkington. The company was founded in 1826 as a partnership between the members of the Pilkington and Greenall families, based in St Helens in the historic county of Lancashire in England. The venture used the trading name of *St Helens Crown Glass Company*. On the departure from the partnership of the last Greenall in 1845, the firm became known as *Pilkington Brothers.* In July 1894 the business was incorporated under the Companies Act 1862 as *Pilkington Brothers Limited*.

Between 1953 and 1957, (Sir) Alastair Pilkington and Kenneth Bickerstaff invented the Float Glass Process, a revolutionary method of high quality flat glass production that involved floating molten glass over a bath of molten tin, avoiding the costly need to grind and polish plate glass to make it clear. Pilkington announced the float glass process in 1959, but further development work was necessary before the process could be fully exploited commercially. Pilkington decided on a policy of licensing the process to existing major glass manufacturers. At the same time, the company encouraged its licensees to assist in the further development of the float process by granting them free use of any improvements they might make on condition these were also made available to Pilkington itself. The first float license was granted, to *Pittsburg Plate Glass*, in 1962. Others quickly followed. Pilkington stopped making polished plate glass in 1967 and others soon followed suit.

The process is fairly simple (Figure 7):

1) Sand, limestone, soda ash, dolomite, iron oxide and salt cake are mixed together with cullet in the batch plant.
2) The raw materials are then charged into a large furnace to be melted at 1600°C. They combine in a process of physical transformation to form molten glass.

3) A continuous ribbon of molten glass is fed out of the melting furnace onto the surface of an enclosed bath of molten tin at 1100°C. The molten glass literally floats on top of the tin, and as it flows along the surface of the tin bath away from the delivery canal, it forms a ribbon of uniform thickness. Its thickness is controlled by the speed at which the solidifying glass ribbon is drawn off from the bath. Tin, however, oxidizes in a natural atmosphere to form tin dioxide (SnO_2). Known in the production process as dross, the tin dioxide adheres to the glass. To prevent such oxidation, the tin bath is provided with a positive pressure, protective atmosphere of nitrogen and hydrogen.

4) The glass is then lifted from the tin bath onto rollers to the annealing lehr to be cooled down. Despite the tranquility with which float glass is formed, considerable stresses are developed in the ribbon as it cools. Too much stress and the glass will break beneath the cutter. To relieve these stresses, the ribbon undergoes heat-treatment in the lehr where the temperatures are closely controlled both along and across the ribbon.

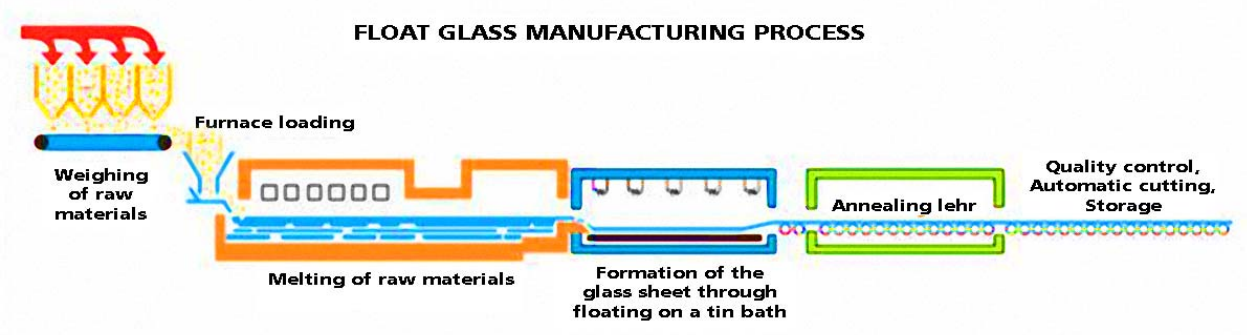

FIGURE 7: The Float Glass Process.

5) Once cooled down and solidified, the glass goes to the cutting area where it is cut into sheets specific to customer orders before being stacked for transportation. The float process produces glass sheets with a uniform thickness and perfectly smooth surfaces that need no further grinding or polishing.

The production techniques used for the manufacture of almost all historic window glass left the glass with a non-plane surface, variations in thickness, and bubbles and other defects within the glass itself. Float glass usually has a perfectly plane surface which distorts neither reflected nor transmitted images (Figure 8). In addition, this glass is effectively free from any bubbles and is of uniform thickness. Almost all flat glass today - including that for aquariums - is made from float glass.

Molten glass floating on tin in a nitrogen/ hydrogen atmosphere will spread out to a thickness of about 6 mm and stop due to surface tension. Thinner glass is made by stretching the glass while it floats on the tin and cools. Similarly, thicker glass is pushed back and not permitted to expand as it cools on the tin. The standard maximum thickness for float glass is 22 mm or 0.87 inches.

FIGURE 8:
Quality of glass and transmitted image, Marygate, York (left modern float glass, right nineteenth-century crown glass).
(Photograph by David Dungworth.)

A final observation: One type of glass manufactured before the development of the float process that was capable of producing glass with aesthetic qualities that approached float glass was plate glass. The polishing process employed in the manufacture of plate glass left it with a perfectly flat surface, making it at times impossible to distinguish from float glass.

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THE EARLY HISTORY OF AMERICAN FISHERIES

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, December 3, 2016)

Culturing fish is actually a centuries-old practice. Historically, the Egyptians raised Tilapia 4,000 years ago and ponds for fish culture were built in the Honan Province of China as early as 1100 B.C. when Wen Fang made the first written reference to fish culture. In 460 B.C., Fen Li described the culture of common carp for food and related the details of his experiments on fish farming in his book, "Fish Culture Classics." In Europe, the Romans had farmed fish and shellfish for at least 1000 years before fish culture began in America.

For more than a century before the Pilgrims arrived in 1620, hardy fishing crews had established temporary settlements on the northern coast. There they salted and dried their catches before returning home to Normandy, Brittany, Devonshire or Portugal. Catholic Europe needed Friday fish that would remain unspoiled for many months, and even Protestant England practiced the no-meat-on-Friday custom to reduce the demand on the national meat supply and to promote the fishing industry. Much of the economy of early America revolved around the exportation of salted fish.

The fishery resources of the New World were very important to England long before fish culture began in America. It has been estimated that England derived greater wealth from fisheries in the New World than Spain did from American gold. However, as early as 1762, overfishing had eliminated striped bass and sturgeons (*Acipenser* spp.) from the Exeter River in New Hampshire. Dams blocked the spawning runs of the alewife (*Alosa pseudoharengus*) and destroyed that fishery at Exeter before 1790. Throughout the New England area, other fisheries were similarly degraded or totally destroyed by habitat alterations or overexploitation.

Indirectly, the fisheries were destructive. As much as a bushel of salt is required to cure 100 pounds of fish, and a salt boiling industry thrived on Cape Cod as long as the firewood lasted. In the late 1790's, at the salt works near Syracuse, N.Y., it took a cord of wood to make 11 bushels of salt from a brine that was many times stronger than sea water.

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Dams blocked the spawning runs of the alewife (*Alosa pseudoharengus*) and destroyed that fishery at Exeter before 1790.

Comfort Tyler and Asa Danforth boiling their first batch of salt on the shores of Onondaga Lake in 1788.

pounds of fish, and a salt boiling industry thrived on Cape Cod as long as the firewood lasted. In the late 1790's, at the salt works near Syracuse, N.Y., it took a cord of wood to make 11 bushels of salt from a brine that was many times stronger than sea water.

Deposits of iron ore were discovered and little settlements in Pennsylvania like Mary Ann Furnace in Berks County and Union Forge in Lebanon County sprang up to smelt and work the iron. The iron industry was notably wood-hungry and a large furnace consumed an acre of forest a day. By 1775, colonial iron production exceeded that of England and Wales combined, and comprised 15 percent of the world promotion. However, the destructive influence by industry on the forests was second to that of the settlers.

To obtain land for plowing and planting, the settlers followed the practices of the local Indians. The large trees were girdled, the underbrush grubbed up, smaller trees cut and piled around the larger trees and burned. The fertile humus of the former forest floor produced good crops for the first few seasons, but eventually the land was abandoned and new areas were sought after farther west. This mining of the soil altered the character of the landscape, and the resulting erosion and silting of the lakes and streams, as well as flooding and fluctuating water levels, had far reaching consequences. The streams were also changed by the erection of dams to power the mills and to operate the bellows and trip hammers of the forges. Dams had destroyed an alewife run at Exeter, N.H. prior to 1790, and overfishing had eliminated the striped bass and sturgeon from the Exeter River by 1762.

The Striped Bass, Morone Saxatilis. By 1762 It was eliminated by overfishing from the Exeter River.

In the early development of this country these were but isolated incidents that were harmful to the fishery resources. While none of the marine fisheries was directly overexploited, the fluctuations in the size of the catch caused concern. While the causes of the decline of the inland fishery resources were not understood, an aroused public demanded corrective action. The most logical solution appeared to be direct action to increase fish stocks. Therefore, the climate was created for the development of fish culture in North America.

THE BEGINNINGS

Fishery science began in the U.S. in 1812 when the Philadelphia Academy of Science was formed and a curriculum in aquaculture was established for undergraduates at Cornell University. Ichthyologists began to travel throughout America to study and describe the nation's aquatic resources, while others sought to transplant and propagate native species. As the public demanded corrective action to restore and maintain traditional fisheries, the culturing and stocking of fish appeared to be the most positive direct action. The very first fish managers in the U.S. were also fish culturists.

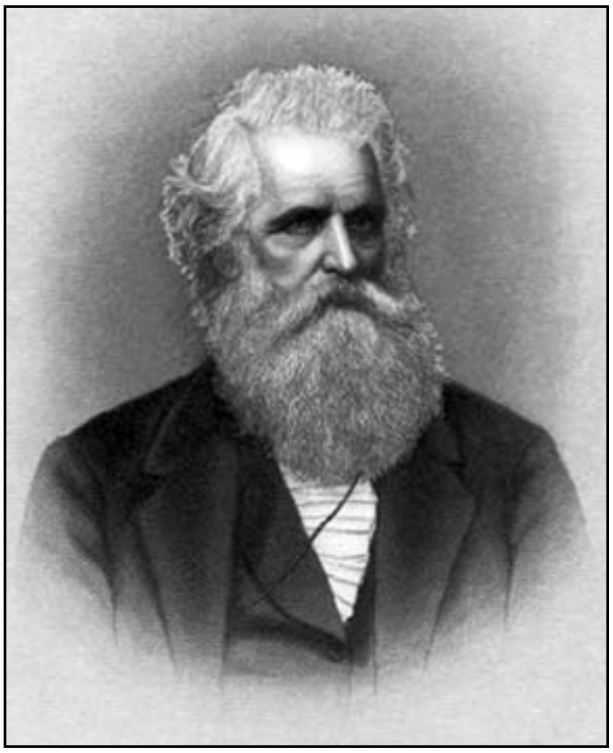
Both state officials and private citizens transplanted fish outside their natural ranges to augment the supply of native fish and to supply fish familiar to new immigrants, e.g., the common carp (*Cyprinus carpio*). As early as 1831, common carp were established by Captain Henry "bully" Robinson, the owner of one of the Havre packets, in a pond at Newburgh, New York, from which some escaped into the Hudson River. In 1832, carp were being reared and sold in Sonoma, California.

The first efforts to restore the fish stocks included the transfer of adult fish into depleted waters to renew the breeding stocks. Fertilized eggs and fry were also collected from spawning areas and transported to depleted waters. Often the eggs or fry were held in incubating devices and given care and attention during incubation and, for a short time, after hatching. In addition, many fish were introduced into waters where they were not native. The European custom of confining and feeding fish in impoundments was also practiced.

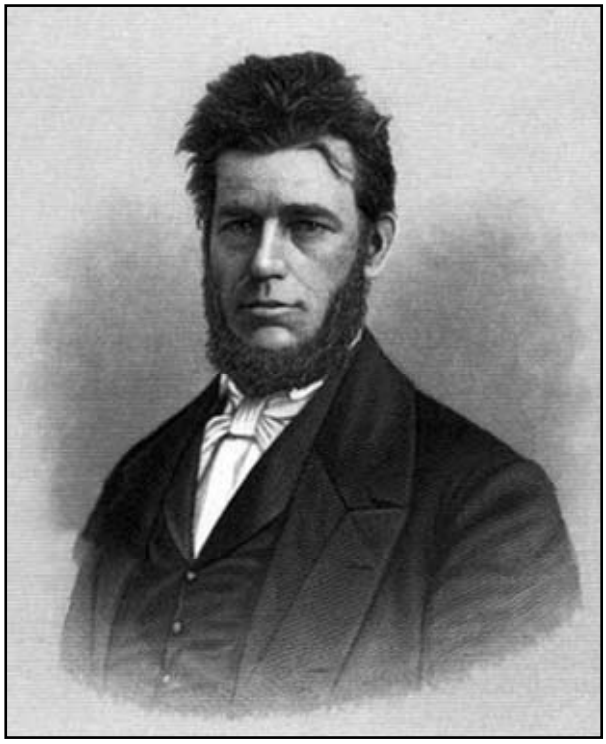
Brook Trout (*Savelinus fontinalis*).

By 1850, fish culture was an established practice in most of Western Europe, the Balkans and in Scandinavia. Various published works, particularly those from France, Germany and the British Isles, were readily available in the United States. After reading these reports in 1853, two Cleveland physicians, Theodatus Garlick (1805-1884), and Horace A. Ackley, accomplished the then amazing feat of fertilizing the eggs of brook trout (*Salvelinus fontinalis*). They displayed the resulting fish at the Ohio State Fair and "received much admiration and many awards" for their demonstration of "practical and economical fish culture."

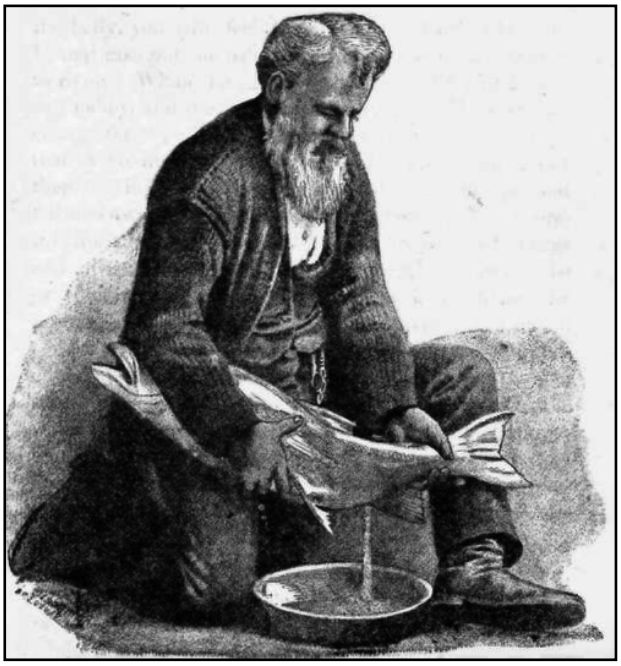
Their establishment on Ackley's farm near Cleveland, Ohio consisted of three ponds totaling less than two acres, a hatching house built over the spring water supply and a convoluted spawning channel between the two largest ponds. Adult brook trout were obtained from Sault St. Marie, Michigan and Port Stanley, Ontario. Spawning behavior among these fish was first observed on November 15, 1853. Five days later a spawning pair was captured, the eggs were stripped from



Dr. Theodatus Garlick (1805-1884).



Dr. Horace A. Ackley (1810-1859).

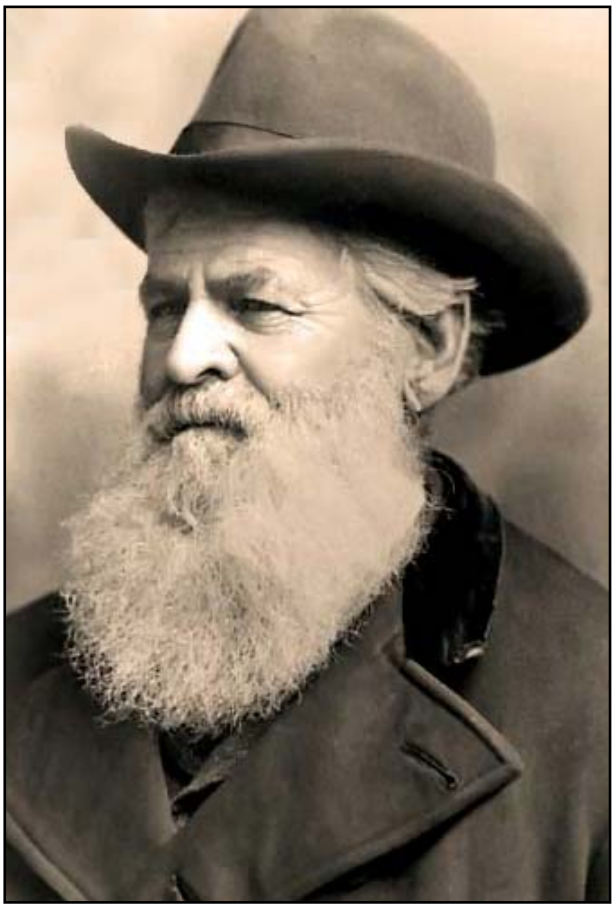


Seth Green stripping eggs from a salmon-trout (Salmo trutta).

the female and fertilized in an earthen vessel with sperm from the male. The eggs were incubated in running water until they began hatching on January 22, 1854. Sediment had smothered most of the eggs, so the remainder were moved to Ackley's office and incubation was completed in a glass jar, the water being changed daily. These results were sufficiently encouraging and, during the next three years, Garlick and Ackley built up a considerable enterprise.

E. C. Kellog and D. W. Chapman began in 1855 at Simsbury, Connecticut by hatching 75 of the 2,000 eggs they had obtained from one female brook trout. (In that same year, Garlick published his treatise on the artificial propagation and culture of salmon and trout.) The second year they hatched "very few" but in 1857 they succeeded in producing 4000 fry. The lucrativeness of hatcheries encouraged a rise in private efforts during the mid-nineteenth century, including a venture from Samuel Colt, whose Colt .45 took on legendary proportions in the West, but his mid-nineteenth-century construction of a Connecticut hatchery received comparatively little notice as one of many such establishments. In 1860, Kellog managed an extensive facility set up by Colt and produced 4,000 fry.

Incidentally, Colt was by no means the only gunmaker who set up a trout hatchery. Retired from a career of developing the famous rifles that bore his name, Christian Sharps' last days were spent sloshing through a secluded brook in the southern part of Vernon, Connecticut. There, thousands of plump trout that he had been breeding for three years were finally ready for shipping to hotels, restaurants and dinner tables nationwide. Historians say the bearded, gentlemanly entrepreneur was on the verge of becoming the nation's most profitable trout farmer when the coughs he had ignored caught up with him. He succumbed to tuberculosis in March 1874, leaving behind trout orders never met, expenses never paid and dreams never accomplished.



Seth Green (1817-188).)

Stephen H. Ainsworth of West Bloomfield, New York, began hatching brook trout in 1859 as a hobby. His water supply was only 5-10 gallons per minute, but he hatched 60,000 eggs and reared up to 2,500 pounds of fish. Sales as high as $500 per year paid his expenses, allowing him to stock nearby streams and ponds, and left ample supply of fish for his own use.

The most notable of the trout breeding enterprises was started just before end of the Civil War in 1864 by Seth Green, with advice and assistance from Ainsworth. For $2, Green purchased a mill site near Caledonia, New York with a water supply of 150,000 gallons per minute. He created ponds by erecting barriers in the forebay (i.e., an artificial pool of water in front of a larger body of water) and millrace (the current of water that turns the water wheel), and captured brood fish from the creek. After one year of operation, he sold a half interest in his hatchery to A. S. Collins. Green's enterprise was immediate success. Green recognized Ainsworth for having shown the practicality of fish culture, but Green proved that trout fanning could be profitable.

Stephen H. Ainsworth (1809-1893). Ainsworth conceived the very ingenious plan of making trout spawn naturally, and at the same time of saving the eggs. This idea he carried out in what is now everywhere known as the Ainsworth Spawning Races.

While Green was eager to learn from of fish culturists, he was secretive about the details of his own operations, he was, however, willing to give lessons in fish culture for $10 per day. His profits were $1000 in 1865 and had increased to $10,000 by 1868 when he sold 800,000 eggs.

The imbalance between supply and demand for eggs, fry and food fish caused instability in market prices in 1868, just as it does today. The price of fish at the Fulton Fish Market in New York, for example, varied from $3.60 to $6/lb. Innovative fish culturists began to look for new market

Dr. Livingston Stone was born in Massachusetts in 1836, graduated from Harvard in 1857, entered Meadville Theological School, and was ordained a Unitarian Minister. In 1866 he resigned his clerical duties and began a career in fish culture. In

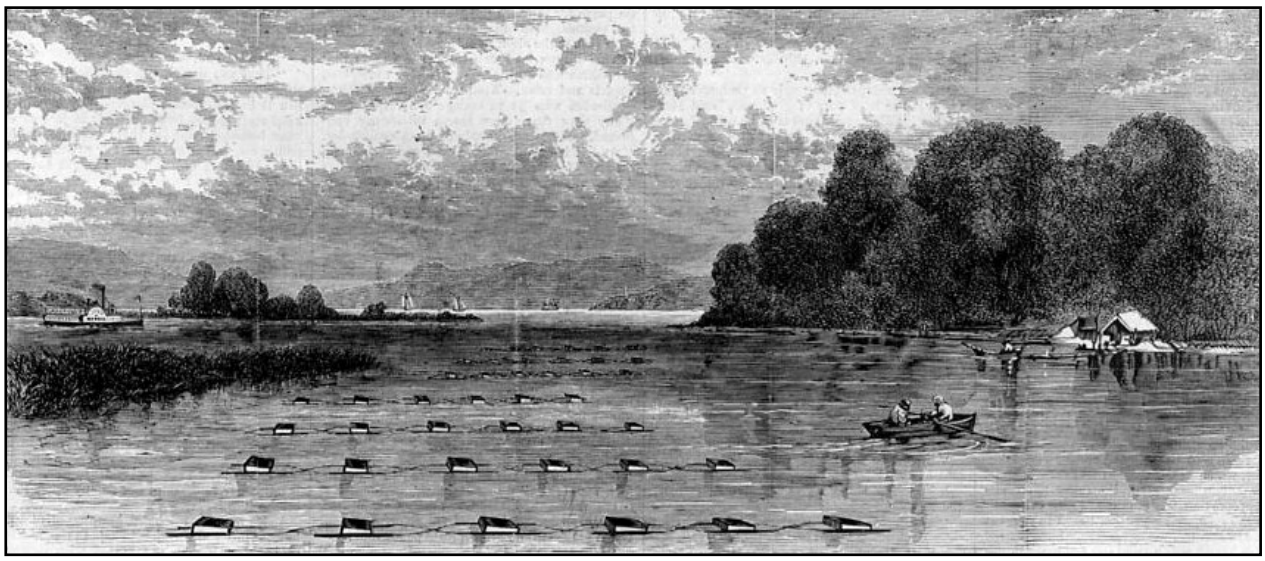
Livingston Stone (1836-1912).

1870, Dr. Stone was one of the founders of the American Fisheries Society, its first secretary and one of the drafters of its constitution. In 1872, he was named U.S. Deputy Fish Commissioner and assigned to establish the Baird Hatchery, the first Federal fresh water fish hatchery located in California. He published the classic fish culture book "Domesticated Trout" the same year and it soon became a standard manual for fish culture. In 1873, he was assigned the task of moving fish across the continent by railroad. In 1898, he was recognized as America's Senior Fish Culturist. Stone early on recognized the interaction between the biological science and fish culture and was the first to recommend and request a trained biologist for hatchery staff.

Stone created a new market when he began selling Atlantic salmon (*Salmo salar*) eggs and largemouth bass fry (*Micropterus salmoides*) for $50 per thousand. By 1870, the culture and sale of brook trout were well established, and six other species— Atlantic salmon, American shad (*Alosa sapidissima*), lake trout (*Salvelinus namaycush*), largemouth bass, lake whitefish (*Coregonus clupeaformis*), and yellow perch (*Perca flavescens*) were being cultured. Fish culture was primarily in the hands of about 200 private citizens until 1870 when it was practiced in 19 of the then 37 states, plus the territories of Colorado and Kansas.

During these early years, fish culturists were making observations and developing techniques that eventually evolved from an art to the science of aquaculture. It was soon recognized that the addition of ice to water extended the time during which live fish could be successfully transported. Seth Green was the first American to use the dry spawning technique (stripped eggs are emptied into a bowl which contains a quantity of water in the wet method; the bowl contains no water in the dry method, thus the eggs reside only in ovarian fluid after expulsion) with which he achieved a 75 to 98% fertilization compared with 25% when the eggs were manually stripped into running water. Although Green offered fish culture lessons, he attempted to keep the dry fertilization technique a trade secret from 1864 to 1879. This technique was the first significant contribution of Americans to the practice of fish culture (although today there is some controversy as to whether the eggs should be stripped dry or wet).

Other culturists soon began to add their refinements to the art of fish culture. Livingston Stone was apparently one of the first to combat fungal growth on eggs, doing so by charring the inside of wooden hatchery troughs. Seth Green painted his wooden egg troughs with asphalt to control fungus. Livingston Stone was also one of the first fish culturists to use salt as a therapeutic for fish. He found



Seth Green's Shad Hatchery on the Hudson.

that salt was useful in the control of fungus, the parasitic trematode *Gyrodactylus*, and the protozoan parasite *Trichodina.* Livingston Stone described a total of 23 diseases on the basis of their signs in fish and determined that the best way to control disease was to improve the environment. He was the first person in the U.S. to apply the scientific method to investigations in fish culture and used controlled experimentation to evaluate the effectiveness of treatments.

Even with Stone's contributions, fish culture in the early 20th century was not a glamorous business. The simple act of feeding fish was not simple; feeds had to be acquired, transported, prepared and delivered to the fish. Early feeds consisted of a wide variety of materials: raw or cooked fish; boiled lean meat; egg yolk; liver; clabbered milk (produced by allowing unpasteurized milk to turn sour at a specific humidity and temperature; over time, the milk thickens or curdles into a yogurt-like substance with a strong, sour flavor); a mixture of ground beef heart, liver, and lungs of beef and pork; and live minnows, worms, and insects (including maggots).

The end of the Civil War in 1865 and the return to a peacetime economy encouraged others to enter the fish breeding business, among them, the Rev. Livingston Stone, Thaddeus Norris and Samuel Wilmot. In 1866 Stone built a large hatchery at Charleston, New Hampshire where he intended to rear trout as a food item. Although the demand for trout eggs and young fish remained high, prices had became unstable by 1868 and he realized that the market would soon collapse. The market for table trout, on the other hand, remained strong and prices in the New York Fulton Fish Market varied from $0.75 to as high as $1.25 per pound. Stone also created a new market by selling Atlantic salmon eggs and bass fry for $50 per thousand.

In my book, *The Toy Fish* (Klee, 2014) I introduced in some detail Fred Mather, the Superintendent of Fish Culture for the New York Aquarium from 1876 to 1879. Henry Dennison Butler was its Superintendent at the time and a picture of the two of them together is shown on page 105. Fred Mather entered the field in 1868 when he purchased a farm near Honeoye Falls, N.Y. He attempted to obtain the advice of his neighbor, Seth Green, but with no success, and eventually learned fish culture by "many expensive experiments and mistakes." Although the most profitable part of trout farming at the time was the sale of eggs and fry, the competition of Green, the largest producer in the business, forced him to concentrate on the production of 8 to 10-inch table trout but the demand for eggs and small fish, created by others desiring to enter this high-profit business prevented him from raising many fish for the table. Mather's name will crop up again later in this essay. Prices per thousand for brook trout were: eggs $8-10, fingerlings $30-40 and 2-year-old fish $250(!). Table trout sold for $1 per pound, at a time when the going wage was $ 1 per day.

Frederick Mather (1833-1900), a founder of the American Fish Culturists' Association, Recording Secretary, 1883-1889, and Vice-President, 1882-1883.

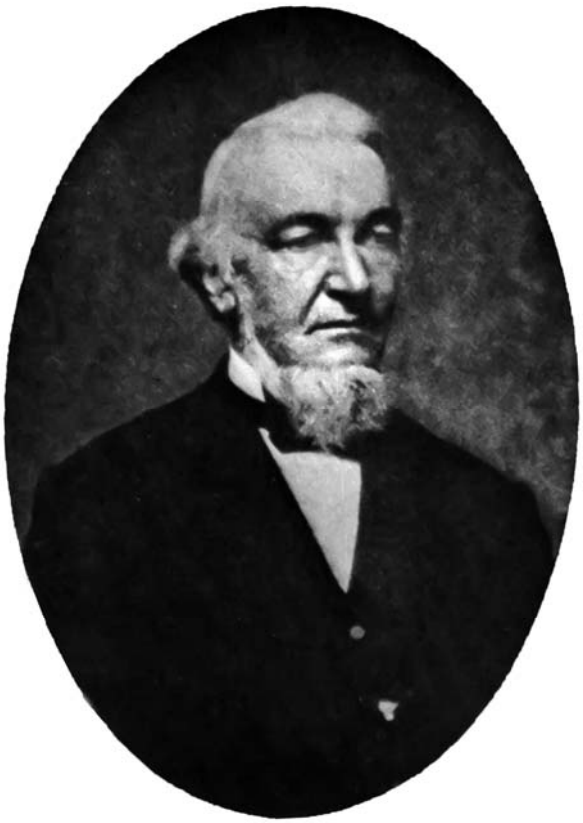
The Connecticut Fish Commission began a large program in 1869 to stock bass in many waters and by 1870 bass had been introduced into five New England states. Bass were transported in the water tank of a locomotive from the Ohio River to the canal basin at Cumberland, Md. in 1854, where they escaped into the Potomac River. Private citizens in Pennsylvania introduced bass into the Susquehanna River about 1869. Undoubtedly, the ease with which bass could be transported allowed innumerable transfers and introductions to lakes and rivers, and to ponds where they were extensively propagated for stocking elsewhere. Other fish introduced into new waters included the walleye, lake trout, brook trout, American eel, alewife, American smelt and lake whitefish.

ORIGIN OF THE AMERICAN FISH CULTURISTS' ASSOCIATION

The founders of American fish culture were, almost exclusively, wealthy and educated men. They could afford the time and expense to pursue what initially was a hobby, but what soon evolved into a lucrative business venture for a fortunate few. As the number of fish culture establishments increased, the highly profitable aspect of selling eggs and fingerling fish diminished. The first organized effort of the fish culturists was intended to protect the lucrative egg and fry market.

In 1870, the federal government was not involved in fish or fisheries, though in the northeastern states scientists and other citizens were expressing concern about the resource. (Their concern would result in federal action in 1871.) Although fish commissions had been established in some states, their financial appropriations were small and their activities largely regulatory. And in 1870, some 200 private persons were practicing fish culture, either as a business or as a hobby.

During the summer of 1870, the Rev. William Avery Clift (for more than a quarter of a century Clift was a regular contributor to the columns of *The American Agriculturist, The Country Gentlemen* and *The New England Farmer;* he introduced the Peking Duck to this country and promoted in many ways the interests of agriculture by introducing or developing improved breeds of sheep, cattle, poultry, fruits, etc. and was an active pioneer in the establishment of artificial fish hatcheries), Fred Mather and J. F. Slack corresponded with A. S. Collins, and Livingston Stone concerning the formation of an association to fix the prices of eggs and fish. Collins, as a partner of Seth Green, was not in favor of setting prices, since as the largest producer of trout eggs, their supply was excessive, and they were already cutting prices. But Collins favored the idea of an organization of fish culturists, as did Stone and Clift.



Reverend William Avery Clift (1817-1890), a founder and first president, 1870-1874, of the American Fish Culturists' Association, predecessor of the American Fisheries Society.

On November 1, 1870, a notice was printed in several eastern newspapers of a meeting of practical fish culturists to be held on December 20 in New York City under the sponsorship of Clift, Collins, Mather, Slack and Stone. The meeting took place in the New York Poultry Society rooms in New York City. Three others answered the call: Dr. M. C. Edmonds of the Vermont Fish Commission, Dr. J. D. Huntington, Watertown, N.Y., and B. F. Bowles, Springfield, Mass. The price of eggs was never discussed. Instead they unanimously resolved to form the American Fish Culturists' Association (AFCA) "to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the association, the uniting and encouraging of the individual interest of fish culturists." A constitution was adopted, annual dues were set at $3 and officers were elected. On adjournment of the meeting they decided to meet again in Albany, N.Y., on February 7, 1872.

The new organization, eager to advance fishery knowledge, was receptive to suggestions from the interested public. Within a year a lively issue was raised by a "gentleman in St. Louis." He wrote to Livingston Stone, the Association's secretary, that in the course of his extended experience fishing in the southern, western and northwestern states, he had noticed confusion in fish names:

The black bass is called, in the southern states, a trout. The rock bass of the east is called a goggle-eye in the west. The silver perch of the south is called in Missouri a croppie, and in Kentucky by still another name. The pickerel of the north is called a jack in the south.

Stone and his colleagues recognized that ambiguity and confusion of fish names were inconvenient and objectionable. But because the custom was so deeply rooted they had little to suggest as a remedy. They were pessimistic about improvement which was long in coming. (When the confusion and ambiguity finally became too much to bear, the American Fisheries Society ultimately began standardization of the common names of fishes and, if not universally accepted, it is one of its notable achievements.)

The underlying intention of the founders of the American Fish Culturists' Association was to fix the prices of their products, but at the first annual meeting it became apparent that future efforts were to be directed towards the promotion of the public good rather than the furtherance of private interests. Motions to fix prices were made in 1875 and 1876, but neither carried. Fish culture alone was not the sole topic of discussion. At the third annual meeting James Worrall reported on his fishway investigations as Fish Commissioner of Pennsylvania, and Charles Hallock of New York spoke of the need for uniform laws to regulate the fisheries.

By 1875, the Association was showing concern about pollution. Frederick Mather, one of the founders, spoke to the annual meeting in New York City:

From all over the land there is a murmur of complaint about the pollution of our creeks and rivers by manufacturing companies, dye-

ing establishments, saw mills, and the like; and while the general Government, States and individuals are working to re-stock our nearly exhausted rivers, lake and streams, this pollution is allowed to go on unheeded and unchecked.

This subject is new to us, but is well worth our attention. So far, we have bent our energies to producing fish in vast numbers, with but little consideration of the many delicate conditions necessary to their future growth; and in my opinion, if the rivers were as pure to-day as when our forefathers landed on Plymouth Rock, there would be the same immense shoals of salmon, shad and alewives ascending our rivers that there were then, multiplied tenfold by our methods of artificial propagation.

The wide variety of subjects prompted the adoption of a motion in 1877 to organize the meeting into four sections:

1. Methods of Fish Culture and Apparatus
2. Fishery Laws and Fishways
3. Natural History and Aquaria
4. Fisheries

George Shepard Page was born in 1840 in Readfield, Maine. He returned east in the late 1870s where, being a gifted businessman, had a profound influence on the gas and oil industry in the United States during the 20 years he was involved in it. Through his involvement with the gas and coal industries and his activities on Wall Street, Page became a millionaire. Page was also a passionate sportsman. He was the founder of Quassaic Sportsmen's Club in his home state of Maine. He also started and maintained Dunrobin Kennels on his estate in New Jersey and could often be found hunting in the fields with his dogs. Page was a keen fisherman and for a time was president of the Chatham Fish and Game Protective Association and vice-president of the American Fish-Culturists Association. He worked for the protection and propagation of fish and was the main impetus behind the formation of the United States Fish Commission.

It was in fact Page's passion for fishing that led to his involvement with dogs. He was responsible for introducing black bass into England and received a gift of two Scottish Deerhounds from the Duke of Sutherland as a token of thanks. The hounds came from Dunrobin Castle in Scotland, hence the kennel name Page went on to use. He was one of the earliest Scottish Deerhound breeders in the United States.

Page was also a great proponent of education. He believed that public education should be non-sectarian, compulsory and free for every child. When he first moved to his home in Stanley, just outside of Chatham, New Jersey, he noticed the lack of a school and immediately founded one, hiring teachers and supplying materials. He went on to spend thousands of dollars to found a school

George Shepard Page (1840–1892), a member of the Society in 1872, Vice-President, 1874-1881 and 1883-1884, and President, 1882-1883).

for children of the poor. The National Education League of England even invited him to give a lecture on the free public school system of America. George Shepard Page died on March 28, 1892 of a heart attack in his home at the age of 52.

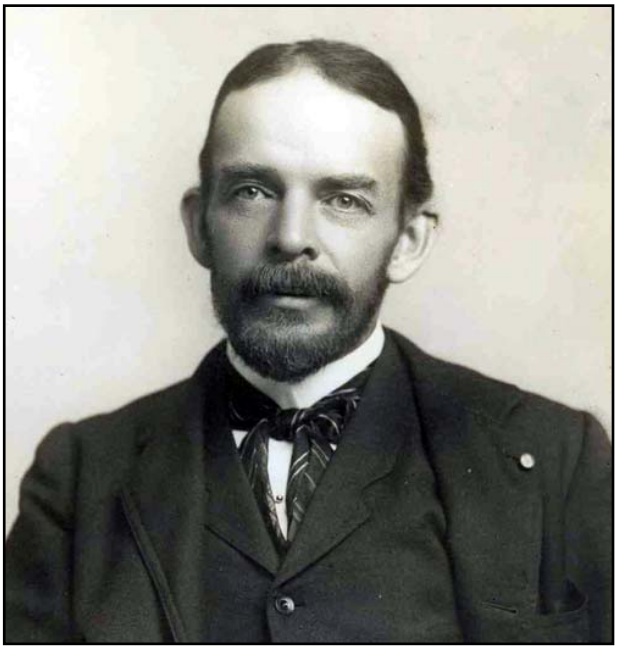
Page was a persistent advocate of broadening the scope of the American Fish Culturists' Association. As early as 1874, he was responsible for amending the constitution to allow "any person" instead of only "fish culturists" to join the Association. Four years later the name was changed to the American Fish-Cultural Association to indicate a broadened outlook. Page apparently was not satisfied with this name and in 1879 he prefaced a paper describing the ravaging destruction by wood boring mollusks with the following remarks.

The name of our Association indicates that its transactions refer solely to the increase of food fishes, and heretofore the papers and discussions have been confined almost exclusively to that department of science; but I have assumed that the information concerning the most destructive of marine animals, and practical appliances for preventing its ravages, would certainly be within our province. As the boundaries of our field of observation and inquiry must rapidly enlarge, permit me to suggest that a change be made in the designation of the Association. Would not "The American Fishery Society" be far more expressive and inclusive? This would correspond to the title of the greatest of the European associations, "The Deutscher Fisherei Verein" of Germany. I deem it of equal importance to instruct our fellow-citizens concerning the vast losses incurred by the unceasing ravages of the destructive denizens of fresh and salt water, as to enlighten them upon the subject of the best modes of propagating trout, bass, shad, and salmon, or restoring depleted public and private waters.

There had already been one change of Association name, though the change was scarcely noticeable. In 1878, the members voted to call themselves the American Fish-Cultural Association instead of the American Fish Culturists' Association. But the subject came up again, this time at the thirteenth annual meeting in 1884. G. Browne Goode proposed the name, the "American Fisheries Association," arguing a closer alignment with similarly named European fishery organizations.

George Brown Goode (1851-1896), was an ichthyologist. In 1872 he started working with Spencer Baird and soon became his trusted assistant. While working with Baird, Goode led research sponsored by the United States Fish Commission and oversaw many Smithsonian displays and exhibitions, for the museum itself and for expositions around the world. Goode effectively ran both the fish research program of the U.S. Fish Commission and the Smithsonian Institution from 1873 to 1887. He was the United States Commissioner for Fish and Fisheries from 1887 to 1888. He authored many books and monographs and wrote more than 100 scientific reports and notes.

After Goode made his proposal for a name change, the president submitted a general request



George Brown Goode (1851-1896).

for the opinions of the members. These opinions, together with a record of the action taken, are summarized as follows:

R. B. Roosevelt [Robert Barnwell Roosevelt, 1829-1906 - was the uncle of President Theodore Roosevelt and the grand uncle of Eleanor Roosevelt], New York Fish Commission, confessed surprise at the proposition to change the name. He did not agree that the proposed name conveyed the purpose of the organization and held that people would regard it as composed of fishermen. "'Fish-Cultural' is a better term. ... I cannot see how anything connected with the study of fish would not come within the limits of a Fish-Cultural Association. . . . The term 'Fisheries Association' would not definitely interpret the aims of this society."

W. M. Hudson, Connecticut Fish Commission, agreed in substance with Roosevelt, but reached an opposite conclusion. "All kinds of fish, lobsters and oysters are described; their anatomy and physiology discussed; their food investigated; their flesh analyzed, and their organizations compared with others. The term 'Fish-Cultural' in all the matters just alluded to cannot be strictly included, and for that reason I believe that 'Fisheries Association' would be more suitable."

R. F. Pike, Connecticut Fish Commission, said that strictly speaking, Professor Atwater's excellent paper ("The Chemical Composition and Nutritive Value of Our American Food Fishes and Invertebrates") would not have been appropriate before an association of persons devoted to cultivating and increasing food fishes. And yet it was one of the most acceptable papers, because the members of the Association have broader and more comprehensive views of the subject of fisheries.

S. G. Worth, North Carolina Fish Commission, stated that "We not only want to propagate fish, but to perfect the system of fishing, and the methods of preparing and marketing them; all of which have direct bearing upon the name by which our Association should be known. The proposed name should be broader and more comprehensive, but I am opposed to calling it The American Fisheries Association. I can suggest nothing better, but there must be some intermediate and appropriate name."

C. B. Evarts, Windsor, Vermont: I somewhat disagree with my friend Mr. Roosevelt. I suggest something covering the same idea, "The Fish Interest Association"—I don't know whether that would be intelligible or not.

L. Stone, U.S. Fish Commission: I think the considerations on both sides are of equal weight. Perhaps I am more sensitive because I drew up the constitution under the old name. If, however, the change is thought to be for the interests of the Society, I don't offer any

Robert Barnwell Roosevelt (1829-1906). He served as a Congressman from New York from 1871 to 1873, and as United States Minister to Netherlands 1888 to 1890. He was an uncle of President Theodore Roosevelt.

objection, but it would be a good plan to let the matter lie for a year, until we have given it more thought.

F. Mather, U.S. Fish Commission, proposed "a name that would embrace the whole purpose of the Association—perhaps The American, Fish, Fisheries, Oyster, Lobster, and Fish- Cultural Association. As a fish-culturist, I do not like to see the idea of fish-culture lost sight of or made to take second place. That was the main purpose of the Association at its birth, and I believe that Mr. Stone and I are the only two original members left. I agree with Mr. Stone's suggestion that the matter die for a year. I object to any change because we are well known by our old name."

T. N. Gill, George Washington University, thought Roosevelt had given a good argument for changing rather than keeping the name, and if the word "association" was retained the organization "would then be on a footing with the American Association for the Advancement of Science, and others."

Theodore Nicholas Gill (1837-1914) was an American ichthyologist, mammologist, malacologist and librarian at the Smithsonian and senior assistant to the Library of Congress, and professor of zoology at George Washington University

H. H. Cary, Georgia Fish Commission, proposed The American Fish-Cultural and Protective Association. "We need protection as much as anything else. There are as many poachers of fish as of game."

Professor Gill aptly summarized the discussion: "The furtherance of the fisheries is the object of this Association and fish-culture is simply a means by which this objective can be obtained. The work of this Association naturally includes a very wide field and the term 'fish-culture' is decidedly too narrow. It seems to me that, if it be desirable to have a name which is expressive of its present aims the American Fisheries Association is decidedly preferable."

Mr. Roosevelt: "I move that the subject lie over for a year, or until the next meeting of the Association."

The President: "Gentlemen, Are you ready for the question? The first vote will be on Mr. Roosevelt's amendment." This was taken and lost.

Mr. Roosevelt: "I recommend the word 'society' instead of 'association.'"

Professor Goode: "I accept this amendment, I and am willing that it should be called 'The American Fisheries Society.'"

The vote on the amendment was taken and it was carried. The name of the association thenceforth became "The American Fisheries Society."

In 1890, a proposal in Congress to change the organization of the U. S. Fish Commission and put its chief and employees under the Department

of Agriculture brought forth a protest by the Society's members at their meeting in May of that year at Put-In-Bay, Ohio. The legislation was described as "directly inimical and prejudicial to the progress and proper consummation of the original intent and present practical and efficient work of the Commission." In short, what the members feared was the possibility of appointments and dismissals of employees for political reasons. The members then voted not only to protest the legislation but also to urge senators and representatives to oppose and defeat such an "obnoxious enactment." The proposed bill was dropped.

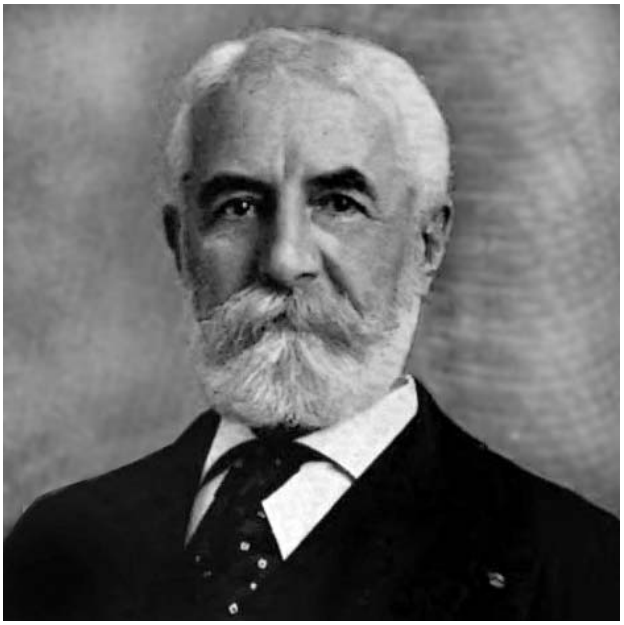
During this period, and perhaps for the first time involving fish and fishing, the subsequently recurring issue of states' rights was aired. Representative Oscar Lapham of Rhode Island had introduced a bill which, if passed, would have done what the Black Bass Act did later; prohibit interstate transport of fish taken in violation of state law. In addition, it would have imposed federal regulations on the mackerel and menhaden fisheries. According to discussion within the Society, a determined lobby was working to get the bill passed.

The stenographer recording testimony before the Merchant Marine and Fisheries Committee was an employee of an association working for passage of the bill, and was described as having been highly selective in transcription of the record. One argument for the bill was the "petty, local nature of these State regulations, conceived in ignorance and brought forth in prejudice. . . ." The concerted effort of certain Society members, with assistance of some state fish commissioners, killed the bill, principally on the grounds of unconstitutionality. There has never since been so close a contest for federal control of fisheries. Though the Lapham Bill itself did not provide for complete abrogation of state control, it seemed clear to many that it was intended as a first step toward nationalization. That first step, of course, was never taken.

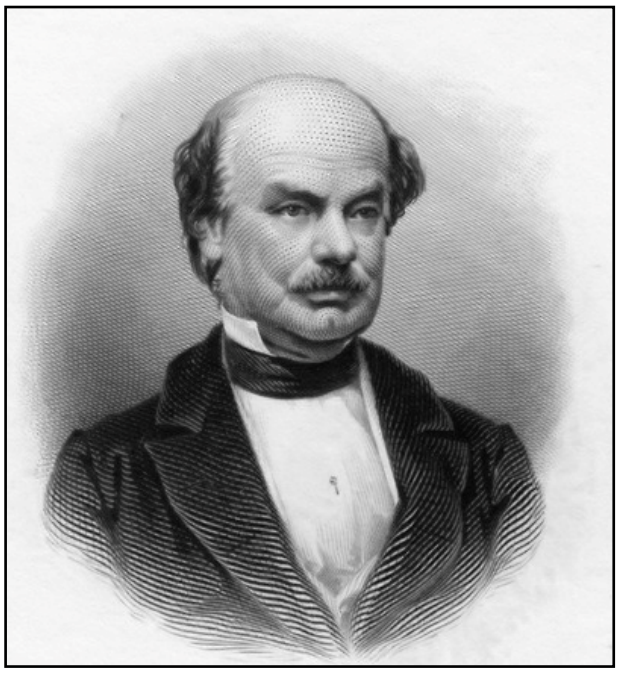
By the end of the Nineteenth Century the Society, though small in numbers, was influential out of all proportion to its size. It was the recognized spokesman for fishery scientists and technologists. It had created an impressive body of literature. It was internationally known and respected, and it helped bring about university instruction in fisheries to educate men and women for the profession.

ORIGIN OF THE U.S. FISH COMMISSION

Federal concern for fisheries originated through the efforts by the Department of State to protect American fishing rights in international waters. It evolved to preserve and maintain the fishery resources from natural and human depletion. Attempts to establish a federal fish culture program began in 1868 when a petition signed by Seth Green and Robert Barnwell Roosevelt of the New York Fish Commission, and F. E. Spinner, United States Treasurer, among many others, requested the Commissioner of Agriculture to apply to Congress for a modest appropriation for the propagation of shad. Green and Roosevelt as individuals



Oscar Lapham (1837-1926) was an American lawyer and politician from the U.S. state of Rhode Island. He served as a member of the Rhode Island Senate and the United States House of Representatives.



Francis E. Spinner (1802-1890) was Treasurer of the United States from 1861 to 1875. He was the first administrator in the federal government to employ women for clerical jobs and he, along with Seth Green and Robert Barnwell Roosevelt , signed the shad petition, the first Attempt to establish a federal fish culture program.

wrote the Commissioner of Agriculture explaining the conditions of the shad fisheries, and stating that if anything of importance was to be accomplished it must be done by the federal government. Also in 1868, the New York Fish Commission, recognizing that cooperation among the states was tantamount to each state solving its problems, called a convention of fish commissioners.

A resolution requesting protection through uniform laws and restoration through propagation was forwarded to the Commissioner of Agriculture by Chairman James Worrall of Pennsylvania. The report of the Commissioner of Agriculture for 1868 pointed out the need for joint state and federal action, but no appropriation materialized.

Had fish culture become a function of the Department of Agriculture, its status today would be altogether different. The result was a federal fish culture agency oriented toward natural resources rather than to the agricultural industry. The precedent was set for the stocking of public waters with fish produced by the government instead of fish purchased from private producers. On February 25, 1871, Ulysses S. Grant appointed Spencer Fullerton Baird as the first Commissioner of Fish and Fisheries for the United States Fish Commission. He would serve in this position until his death.

Already at the age of 27 Baird had an astonishing reputation as a scientist. He had collaborated with European scientists and was personally known and respected in all of the scientific centers in America. His writings were preeminent, and his knowledge of languages and the many fields of science made him respected as an editor. After a delay of three years, the request of Joseph Henry (the Secretary of the Smithsonian Institution) for Baird's appointment as Assistant Secretary was approved in July, 1850. His salary was $1,500, a

Spencer Fullerton Baird (1823-1887).

considerable improvement over the $400 per year he received Professor of Natural History at Dickinson College, Carlisle, Pa.

It had taken three years of active solicitation by Baird and the exertion of considerable influence on the part of a broad spectrum of American science for Baird to obtain a Smithsonian appointment, but it took him a mere 54 days to obtain the approval of both houses of Congress for a new government agency, the appropriation to carry out its programs, and his appointment as Commissioner. During the twenty years between the two appointments, Baird, the scientist, learned well the ways of Washington and the Congress, and became an effective politician in his own right.

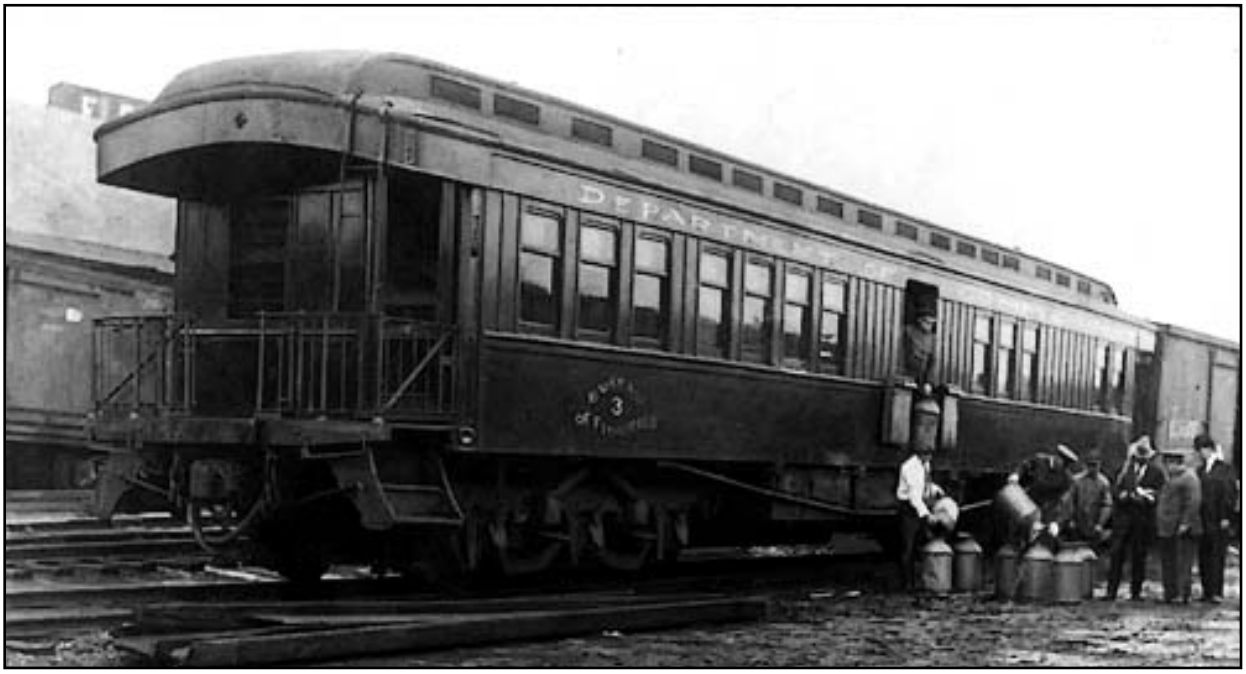
The establishment of the Fish Commission as a separate agency rather than as a part of the Smithsonian set the course of fishery conservation in the United States. As a part of the Smithsonian, the Commission would have been subject to Secretary Henry and dependent upon him for support. As head of an independent agency, Baird was free to lobby on its behalf and direct the course of its programs with no encumbrances other than the Congress.

As passed by Congress, the resolution contained four provisions.

A. The President, with the consent of the Senate, was required to appoint from among the employees of the Government a commissioner "of proved scientific and practical acquaintance with the fishes of the coast," to serve without salary.

B. The Commissioner's primary duty was "ascertaining whether any and what diminution in the number of food fishes of the coast and inland lakes had occurred" and to report to Congress necessary remedial measures to be adopted.

C. The heads of the executive departments were directed to provide "all necessary and practicable aid" to the Commission.



From 1881 to 1947, the U.S. Fish Commission delivered fish to private as well as public applicants throughout the United States on specially designed train cars like this one. The cars had water tanks, aeration devices, cooling systems, and bunks for the attendants, among other things.

D. The Commissioner was authorized to take fish from lakes and coastal waters, regardless of any state law.

The requirement that the Commissioner be a federal employee, experienced in the field of fisheries, was to assure that Baird would be appointed Commissioner. The experience requirement and provision for no salary was intended to prevent the position from becoming political in the future.

The investigation of the inland fisheries was not proposed by Baird, but was included because of the concern for the Great Lakes fisheries and to obtain the support of Midwestern Congressmen, including Senator Zachariah Chandler of Michigan, chairman of the Senate Commerce Committee. The ordering of the executive departments to provide assistance to the Commission was a deviation from the normal procedures of government. Baird fully intended to exploit this provision. He obtained the use of vessels and personnel from several services, and many installations were requested to collect oceanographic and meteorological data. This privilege has not been removed from the U.S. Statutes.

Baird's interest in the collections of the Smithsonian's National Museum of Natural History and his understanding of the required background information necessary to solve the fisheries problems are reflected in the final provision of the resolution which also remains on the U.S. Statutes. It was not his intention to become involved in a dispute with the states over the ownership of fish, but he believed that the Commission needed to function free of the impediments of state laws. Extensive collections of marine plant and animal life would be required adequately to study the ocean environment and enable the prescribing of measures to restore the fisheries; afterwards the collections would be deposited in the National Museum. Baird interpreted the phrase "fish or specimen thereof" to include specimens of any nature and made the most of the opportunity to enlarge the museum collection. The collection cost $4,000 to administer in 1871, but grew so extensively that $163,000 was required 16 years later.

The affairs of the Fish Commission received only a minor part of Baird's attention, particularly while he was director of the National Museum after 1872 and, concurrently, secretary of the Smithsonian after 1878. Outside of his "summer campaigns" to the New England Coast, he conducted affairs of the Commission in the evening hours at his residence in Washington, D.C. In 1875, George Brown Goode, assistant to Baird at the Smithsonian, began to handle most of the administrative affairs of the Commission.

With the new Commissioner in place, the Association sought the assistance of Congress to provide funds for the propagation and introduction of shad, salmon, and other valuable fishes through-

Botany students at Woods Hole, 1895.

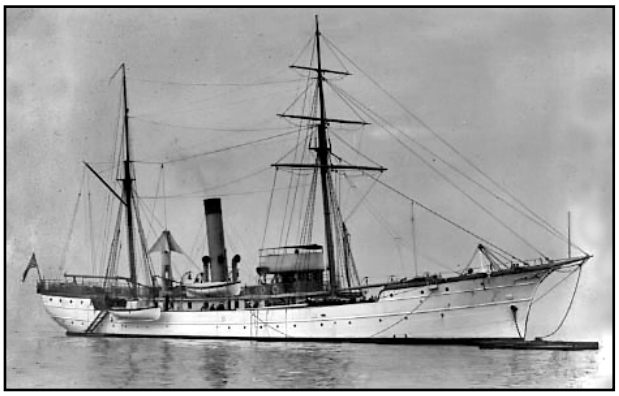
out the country. Congress appropriated $15,000 in 1872 to support these requests, and fish culture by the Federal Government began. Since the Federal Government had no fish culture facilities, The American Fish Culturists' Association asked that the funds be provided to private fish culturists Seth Green and William Clift so they could release shad in the Mississippi River and enlarge Clift's salmon hatchery on the Penobscot River in Maine. The Association also requested that the funds be used to support unspecified work by Livingston Stone on the Sacramento River.

Baird recognized the need for fishery research and established the first Federal fishery research program at Woods Hole, Massachusetts, in 1873. The research program was rather minor compared with the hatchery program and operated primarily during summer when university professors were available for field research. In 1877, David Starr Jordan, a student of Louis Agassiz, with the assistance of Charles H. Gilbert, conducted an extensive survey of the fishes of the Pacific Coast. Similar work was conducted with Commissioner Baird's support, but after his death in 1887, research by his agency received much less emphasis. From 1873 to 1885 the annual budget averaged $70,000 for propagation of fish at Woods Hole, but was less than $4000 for research. Advances in fish culture apparently stagnated even further after the reference book, “A Manual for Fish Culture,” was published by the Commission in 1897. The manual contained descriptions of culture techniques for more than 40 species or groups of finfish, plus lobsters, oysters, clams, and frogs; apparently, in the view of the Commission, it contained all the information needed by fish culturists. At the 1899 annual meeting of the American Fisheries Society, a criticism of the preoccupation with fish culture was made by Hermon C. Bumpus of Woods Hole. Discussing the rise of the U. S. Commission of Fish and Fisheries laboratory there, and its subsequent stagnation and deterioration following Commissioner Spencer Baird’s death, he said:

In the meantime the work of fish-hatching had continued, but only along the old lines and in the perfunctory way that prevails for those who take no vital interest in their work.

I believe that the history of the Woods Hole Station during its dark ages of scientific inactivity will be the history of every station and sub-station that attempts to confine its energies to the merely mechanical work of hatching fish. Close up your drafting room, and your machinist becomes a blacksmith; do away with your schools of design, and the standard of even your so-called practical builder is immediately lowered. More progress has been made in practical medicine during the past twenty-five years than during the previous centuries. Who shall say that the progress is not the direct result of laboratory activity and he application of the scientific method? The scientific and practical work of a fisheries station cannot be divorced.

In 1872, Baird approached Seth Green and W. Clift with respect to rearing shad. Green was really under the gun, as the shad spawning season in New York was about over. Clift, working farther north in Connecticut, where the spawning season began later in the year, had a bit more time. Both men were successful in their endeavors. Green hatched shad eggs for the states of New York and Vermont and provided 55,000 fry to the Commission. The Commission’s fish were stocked in the Allegheny River at Salamanca, New York, and in the Mississippi River near St. Paul, Minnesota.



U.S. Fish Commission Steamer Albatross.

Fish produced by Clift also ended up in the Allegheny River, as well as in the White River at Indianapolis, Indiana, and in the Platte River in Colorado.

The fish culture activities of the U.S. government had developed with amazing rapidity after the establishment of the Fish and Fisheries Commission. By 1874, the Commission was concentrating on shad, alewife, striped bass, salmon (both Atlantic and Pacific), whitefish, and carp. There was also activity with other species. For example. Fred Mather had collected eggs of the black sea bass and fertilized them (a storm terminated that particular experiment). Baird felt that the production and distribution of fish was of extreme importance. He was dedicated to getting the highest possible yields from the nation's waters.

Baird was deeply concerned over providing a source of food fish for the rural areas, particularly in the South where he envisioned that small ponds would provide needed sources of protein. He seriously considered the native species, especially catfish and buffalo fish, but experimentation with the indigenous species had scarcely begun, and rather than waiting until culture methods were available, he looked elsewhere. The culture of carp had been practiced for several hundred years and was a thriving food-producing industry in Europe and Asia. The fish was capable of rapid growth and tolerant of the wide range of environmental conditions found in the United States. Baird, in 1877, stated, "I fully believe that within ten years to come this fish will become, through the agency of the United States Fish Commission, widely known throughout the country and esteemed in proportion."

When he first took steps to propagate carp in 1875, the fish was already established in California and New York. Baird determined that these were either wild or scaled carp, and not the domesticated varieties which had been developed by generations of cultivation in Germany. After two unsuccessful attempts to transport carp to the United States, the German fish culturist Rudolph Hessel arrived at New York in May 1877 with a consignment of 227 leather and mirror carp and 118 scaled carp. Because the Commission lacked pond facilities, the fish were temporarily held at the Maryland state hatchery near Baltimore. Baird made another foray on Capitol Hill and obtained a special appropriation of $5,000 and authority to construct ponds on the grounds of the Washington Monument.

The carp program was modest in relation to the similar shad and salmon programs. Commissioner Baird had learned the value of having constituents request fish through their Congressman. In 1876, one year before the program started, Congressmen had forwarded 3 applications to the Commission; this increased to 20 in 1877 and to 98 in 1878. When the first distribution was made in 1879, the number of applications had reached 324; fish were supplied to applicants in 23 states, most receiving 20 fish. Consignments were also shipped to fish commissions in 9 states. The popularity of the program reached unexpected proportions in 1882 and in his report to Congress Baird took full advantage of it: "This distribution reached applicants in every state and territory in the United States except Montana. Fish were sent into 298 of the 301 Congressional districts and into 1,478 counties. The total number of applicants supplied was 9,872, the total number of fish

The Common Carp.

distributed, 259,000." The freight charge, generally less than $1, was paid by the applicant.

Rather than distributing fry, the Commission raised the fish to a length of 2 to 3 inches, thus greatly increasing their chance of survival. The fish were distributed in the fall when the weather was mild and losses during transit were minimized. Even though the Commission repeatedly warned that carp should not be stocked in waters containing existing populations of other fish, the enthusiasm of individuals and the U.S. and State Commissions saw to it that every body of water imaginable received its share of the young carp. As a result, the naturalization was quickly accomplished. However, early attempts to develop commercial carp culture failed because the fish had little demand in American markets and by 1883, some of the comments received by the Commission were critical of the program.

Thus started repeated attacks and spirited defenses of the introduced carp. As might be expected, the defenders were often representatives of the Commission. Their arguments were on economic grounds (the sales of carp in the big cities) and on angler preference in certain waters of certain sections of the country. There is no evidence, however, that a carp supporter ever converted an unbeliever! In any event, public enthusiasm turned to disapproval, and after 1890 the number of plantings declined and was discontinued in 1896. The success of the carp experiment was forgotten and the criticism of the fish became acute, with farmers, sportsmen and fishery biologists maligning the fish for displacing more desirable species from public waters.

With Baird as Commissioner, the commission sought opportunities to restock rivers with salmon and lakes with other food fish and the depletion of food fish in coastal waters. Baird reported that humans were the reason for the decline of food fish in these coastal areas as individuals with access to shoreline property were using weirs or nets to capture large amounts of fish on the coast, which threatened the supply of fish on the coast. He used the U.S. Fish Commission to limit this human impact through a compromise by prohibiting the capture of fish in traps from 6 pm on Fridays until 6 pm on Mondays. Baird was highly active in developing fishing and fishery policies for the United States, and was instrumental in making Woods Hole the research venue it is today.

Baird's vision with regard to Woods Hole was not fulfilled during his lifetime. To a large extent, this was due to an embarrassing dispute that began in 1885 when an official of the new Administration of Grover Cleveland charged that the Fish Commission's rather elaborate facilities at Woods Hole, which included a residence building and scientific laboratories, far exceeded the intent of Congress in making funds available for a ma-

The Interior of the U.S. Fish Commission's Central Station in Washington D.C. The jars in the background are hatching jars. for eggs. Fish and eggs from all over the world were collected and distributed from this room.

rine fish hatchery. Baird's friends in Congress soon forced this investigation to be dropped, but in the 2 years remaining in his life, Baird was very cautious about undertaking any activity that might be questioned, such as the establishment at Woods Hole of a summer university under the inspiration and guidance of a government agency.

However, a significant part of Baird's dream would be realized in 1888-89 when his long-time friend and summer laboratory associate, Alpheus Hyatt, took a leading role in establishing the Marine Biological Laboratory, an international center for research and education in biology, biomedicine and environmental science in Woods Hole. Although that institution was entirely separate from the Fish Commission, Hyatt suggested that the Marine Biological Laboratory was a direct outgrowth of Baird's educational schemes.

In looking back at Baird's stewardship of the Fish Commission through the first 16 years of its existence, one must be impressed by the continuities between the late Nineteenth Century and our own time. The issues that his agency addressed are familiar ones, including the dynamics of marine populations, efforts to maintain and enhance the productivity of commercial fisheries, direct aid to the fishing industry through improved techniques and exploratory fishing, and finally a vigorous program of basic research. But, in the largest context, Baird perhaps can best be remembered as one of the able institution builders of a century ago who recognized the essential need for universities, museums, and government agencies to support and encourage an American fisheries scientific community that was then in its infancy.

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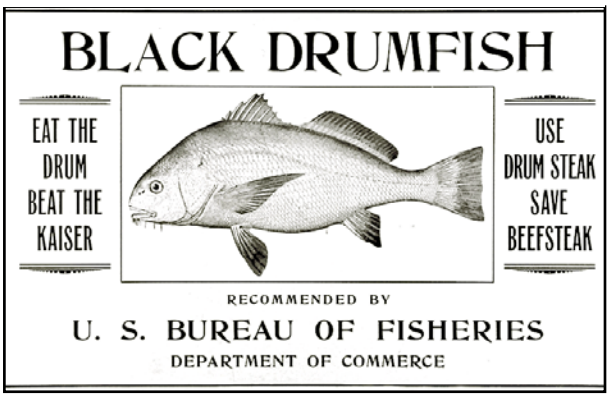


In 1903, the Fish Commission was reorganized as the United States Bureau of Fisheries. This poster appeared during World War I.

THE PRONUNCIATION OF SCIENTIFIC FISH NAMES

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, December 3, 2016)

Carl von Linné (Carolus Linnaeus) once said,

Nomina si nescis perit et cognitio rerum ("If you do not know the names of things, then the knowledge of them dies too").

The positive result of this dictum was that it simplified the naming of our fishes; The negative result was that it complicated pronouncing their names. Thus, aquarists tended to follow the advice of Julius Caesar,

Tamquam scopulum sic fugias inauditum atque insolens verbem ("You should avoid new and unusual words as you would the cliff's edge").

English (and most other Western-European languages) adopted many words from Latin and Greek throughout history because they - and especially Latin - were the Lingua Franca all through Antiquity, the Middle Ages, the Renaissance and later. In their own time, the classical versions of these languages were, like English today, international languages with a dominant effect on the educational systems and culture of the rest of their world. Just as it is hard to think of a world language today escaping at least some influence from English, so it is hard to think of any western European language that has evaded the influence of Latin and Greek at some time in its history. Remember that at some time in their past, all the modern Romance languages were Latin.

It is not correct to say that "English has both Latin and Greek origins." Origin means starting point and English has Germanic origins. However, English has many more words borrowed from Latin than have other Germanic languages, which it owes to the conquest of England by the Normans in the year 1066. A large percentage of English words have Norman French origins, which in turn had Latin origins. The Normans spoke Norman French, which was still much closer to Latin than modern French, especially in spelling. From then on, French was used as the language of administration for a while, and much of this was incorporated into English even as the influence of Norman culture in England waned.

About 80 percent of the entries in any English dictionary are borrowed, mainly from Latin. Over 60 percent of all English words have Greek or Latin roots. In the vocabulary of the sciences and technology, this figure rises to over 90 percent. About 10 percent of the Latin vocabulary has found its way directly into English without any intermediary.

Words of Greek origin have generally entered English in one of three ways: 1) indirectly by way of Latin, 2) borrowed directly from Greek writers, or 3) especially in the case of scientific terms, formed in modern times by combining Greek elements in new ways. The great majority of Greek and Latin borrowings into English date from after the year 1500. They are mostly "learned" or technical words, though many have languages began with the Renaissance and has continued ever since. Even today, Latin and Greek roots are the chief source for English words in science and technology.

THE ORIGINS OF THE ENGLISH LANGUAGE

The history of English is conventionally divided into three periods usually called Old English (or Anglo-Saxon), Middle English and Modern English. The earliest period begins with the migration of certain Germanic tribes from the continent to Britain in the fifth century AD (although no records of their language survive from before the seventh century) and it continues until the end of the eleventh century or a bit later. By that time

Latin, Old Norse (the language of the Viking invaders) and especially the Anglo-Norman French of the dominant class after the Norman Conquest in 1066 had begun to have a substantial impact on the lexicon, and the well-developed inflectional system that typifies the grammar of Old English had begun to break down.

The following brief sample of Old English prose illustrates several of the significant ways in which change has so transformed English that we must look carefully to find points of resemblance between the language of the tenth century and our own. It is taken from Aelfric's "Homily on St. Gregory the Great" and concerns the famous story of how that pope came to send missionaries to convert the Anglo-Saxons to Christianity after seeing Anglo-Saxon boys for sale as slaves in Rome:

Eft he axode, hu ðære ðeode nama wære þe hi of comon. Him wæs geandwyrd, þæt hi Angle genemnode wæron. Þa cwæð he, "Rihtlice hi sind Angle gehatene, for ðan ðe hi engla wlite habbað, and swilcum gedafenað þæt hi on heofonum engla geferan beon."

A few of these words will be recognized as identical in spelling with their modern equivalents - he, of, him, for, and, on - and the resemblance of a few others to familiar words may be guessed - nama to name, comon to come, wære to were, wæs to was - but only those who have made a special study of Old English will be able to read the passage with understanding. The sense of it is as follows:

Again he [St. Gregory] asked what might be the name of the people from which they came. It was answered to him that they were named Angles. Then he said, "Rightly are they called Angels because they have the beauty of angels, and it is fitting that such as they should be angels' companions in heaven."

The period of Middle English extends roughly from the twelfth century through the fifteenth. The influence of French (and Latin, often by way of French) upon the lexicon continued throughout this period, The loss of some inflections and the reduction of others (often to a final unstressed vowel spelled -e) accelerated and many changes took place within the phonological and grammatical systems of the language. The following typical prose passage is drawn from a work of the late fourteenth century called "Mandeville's Travels." In this extract Mandeville describes the land of Bactria, apparently not an altogether inviting place, as it is inhabited by "full yuele [evil] folk and full cruell."

In þat lond ben trees þat beren wolle, as þogh it were of scheep; whereof men maken clothes, and all þing þat may ben made of wolle. In þat contree ben many ipotaynes, þat dwellen som tyme in the water, and somtyme on the lond: and þei ben half man and half hors, as I haue seyd before; and þei eten men, whan þei may take hem. And þere ben ryueres and watres þat ben fulle byttere, þree sithes more þan is the water of the see.

Although may not have as foreign look to us as Aelfric's prose has, it will not be mistaken for contemporary writing either. However, the number of inflections for nouns, adjectives, and verbs has been greatly reduced in this example, and in most respects Mandeville is closer to Modern than to Old English.

The period of Modern English extends from the sixteenth century to our own day. The early part of this period saw the completion of a revolution in the phonology of English that had begun in late Middle English and that effectively redistributed the occurrence of the vowel sounds to something approximating their present pattern. (Mandeville's English would have sounded even less familiar to us than it looks.)

Although learning Latin and Greek might help you understand a lot of difficult English vocabulary, it has little or nothing to do with the origins and early development of the English language.

HOW DID LATIN BECOME SO IMPORTANT?

The Romans had a different attitude toward colonization and conquest than did the Greeks. The Greeks remained an international class of rulers, dominating trade; they were not averse to military conquest, but they did their best work as economic and cultural persuaders. The Romans had the conquer, dispossess, enslave and, if necessary, sow-their-fields-with-salt mentality. As the Romans conquered the Italian peninsula, Gaul (modern France), Iberia (Spain/ Portugal) and North Africa, they tended to take over from its previous dwellers, plant their own soldiers and colonists there and replace local cultures with their own. As a result, we know almost nothing of many pre-Roman languages from these areas, including Etruscan, Ibero-Celtic, and Carthaginian.

The one language that the Romans never uprooted was Greek, largely because Greek was more widely and better established, had a literary tradition that impressed the Romans and made them envious (in an emulating, not a destructive, way), and was circulated over a wide territory that was heavily populated, urban and economically developed. Even though the Romans conquered most of the former Greek empires - colonizing Egypt for example quite heavily - their Latin language was always an alien thing in the eastern Roman Empire. Hence the early association of Christianity in the first century AD was with a dialect of Greek, not with Latin. When the Roman Empire became officially Christian in the fourth century AD, Latin Christians became committed to the translation and preservation of Greek culture. (Greek Christians, naturally, just kept on preserving their own Greek tradition.)

Obviously Greek culture had a massive effect on Roman identity, but how much did the Greek language change Latin (or the precursor to Latin)? The answer is that it didn't. Resemblances between the Greek and Latin languages are cognate - that is, derived from a common (Indo-European) ancestor - and not the result of one language directly imitating the other.

Other than trivial ad hoc exceptions like loanwords (words adopted by the speakers of one language from a different language), there are two broad exceptions to note:

1. From the third century BC onwards, Roman poets started imitating the poetic rhythmic forms used in Greek poetry, and these eventually superseded native Roman poetic rhythmic forms altogether. In this way the quantitative nature of Greek language (i.e., their verse was composed of "feet," defined by short and long vowels, rather than by stressed and unstressed syllables as in English poetry) caused Roman poets to emphasize quantity in Latin in a way they would not otherwise have done.
2. Greek grammarians literally wrote the book on grammar, and Roman interest in the study of grammar was largely based on Greek models. As a result, the way the Romans conceptualized the formal properties of their own language (parts of speech, morphology, syntax, etc.) was based on categories that had been designed for the Greek language.

It should also be noted that the Ancient Greeks were the first to use a "true" alphabet, that is, one representing both vowels and consonants. Indeed, the word "alphabet" is formed of the first two letters of the Greek alphabet, "alpha" and "beta." Incidentally, the Greeks were equally conscious of the sound, pronunciation and diction of their words. This why the word symphony is spelled with an "m" instead of an "n." Syn, a prefix meaning united, acting or considered together, is the original spelling. But to the Greeks the "n" before the consonant "f" sounded cacophonous!

THE USE OF LATIN OVER THE YEARS

Latin evolved over the years into nine different periods, but only these last four are of significance for aquarists:

(a) **Medieval period (600-1300)**. Latin was used as an official written language in all West-European countries. Its vocabulary absorbed a lot of words from the local languages in order to meet the changed intellectual and social conditions.

Authors: mediaeval chroniclers and theologians as the Venerable Bede, Alcuin, Saxo Grammaticus, John of Salisbury, St. Thomas Aquinas and Pierre de Abellard.

(b) **Renaissance period (1300-1600)**. The humanists tried to revive the grammar and the vocabulary of the Classical Latin language.

Authors: Thomas More, Erasmus of Rotterdam, Giordano Bruno, Tomaso Campanella, Nicolau, Copernicus, some works of Dante Alighieri, Petrarca, Boccaccio.

(c) **New period (1600-1900)**. In this period Latin was gradually replaced in literature and administration by the modern national languages. It was used as an international diplomatic language till the 18th century and as a teaching language in the European universities till the late 19th century. A lot of scientists and philosophers continued publishing their works in Latin.

Authors: Hugo Grotius, Benedict de Spinoza, Francis Bacon, René Descartes, Pierre Gassendi, Thomas Hobbes, John Locke, Isaac Newton, Carolus Linnaeus, Mikhail Lomonosov, Immanuel Kant, Leonard Euler, etc.

(d) **Contemporary period (since 1900)**. Latin remained the official language of the Catholic church, though it was replaced in liturgy by the modern spoken languages. Together with Greek, it is the main source for creating scientific terms.

THE PRONUNCIATION OF LATIN

The pronunciation of Latin becomes much less puzzling once you realize that there are at least four rival ways of doing it. The pronunciations you hear in a biology or astronomy class don't match the ones you learned from your Latin teacher, and guess what? That doesn't mean they are wrong. They just reflect different periods in history. Here's an example of the four main methods using the name, Julius Caesar*:*

1. YOO-lee-us KYE-sahr (Classical Roman)
2. YOO-lee-us SAY-sahr (Continental Europe, France)
   YOO-lee-us (T)SAY-sahr (Continental Europe, Germany
3. YOO-lee-us CHAY-sahr (Church Latin in Italy)
4. JOO-lee-us SEE-zer (English method)

The Classical Roman pronunciation is of course what we use when teaching or seriously speaking Latin (see Appendix III). Its biggest peculiarities are that v is pronounced like English *w*, c like k and ae like English *ai* in *aisle*.

The Classical Roman pronunciation wasn't accurately reconstructed until about 1900. Before that, scholars in every European country pronounced Latin as if it were their own language (note how the French and Germans pronounced Caesar in the Continental Europe method above; the German pronunciation, by the way, is the one used in Old French).

Italian Church Latin is the form of the Latin language used in the Roman Rite of the Catholic Church for liturgical and other purposes. It is distinguished from Classical Latin by some lexical variations, a simplified syntax and Italianate pronunciation.. Italy is the country in which Rome lies, and Rome was the first capital of the empire and later became the center of the Church. Pronouncing Latin in the Italian way, therefore, is not difficult. Here is a list of the most important differences between the Italian and the classical pronunciations:

• the letter groups ae and oe are both pronounced like a long a;
• the vowel letter y (which in Latin only occurs in

Greek loans) is pronounced like a long e;
• the letter h is not pronounced at all;
• the combinations ci and cci and ce and cce are pronounced as the first sounds in chilly and check respectively;
• the combination ti before a vowel is pronounced [tsi], as in natio [natsio].

Hence the pronunciation of Caesar as CHAY-sahr . In his *Latin for all Occasions*, Henry Beard writes tongue in cheek:

If you [pronounce Caesar like CHAY-sah], you are going to take some flak from Latin purists, classics snobs, and other assorted lingo bores, but on the other hand, you're going to get a much better table in the Vatican restaurant.

On the revival of the study of the classics in England circa 1490, when every gentlemen was supposed to know Latin and Greek (in a verse eulogy prefixed to the First Folio, Ben Jonson famously wrote that William Shakespeare had "small Latin and less Greek"; in Appendix II, Innes left out some important details in this quote), the ordinary sounds of the letters as used in English were generally given in pronouncing Latin. No one, of course, claims that the sounds given by this method are the same as those given to the same letters by the Romans of Cicero's time, nor that by it alone an elegant or even a correct pronunciation of English can be acquired. There is no language whose pronunciation can be learned accurately by rule. English is particularly full of peculiarities and exceptions. In any event, the method conforms strictly to the rules of Latin in word structure, length of vowels (i.e., the perceived duration of a vowel sound) and accent, but uses the English sound values of the letters.

One place where this pronunciation is heard is in some of the Latin phrases that pepper legal and philosophical talk. If a case is adjourned indefinitely, the lawyers may say *sine die* (literally "without a day") and pronounce this expression something like **sign-ee dye-ee**. We also usually say *habeas corpus* with the first word sounding something like **hay-bee-ass**, and similarly in the case of *modus operandi* , well known to all lovers of detective fiction, as **mow-des oh-per-and-dye**. The logical terms *a priori* and *a fortiori* are usually pronounced with the first word like the name of the letter A and the last vowel like the word I.

The first person to write about the pronunciation of fish names - and it is based upon the English Method - was Judson Cole in an article, "Pronouncing Fish Names," that appeared in the 1934 issue of *Aquatic Life* (see Appendix I). The second was William T. Innis, two years later in 1936 in the First Edition of his book, *Exotic Aquarium Fishes (*see Appendix II).

Innes noted that it was English botanists who decided to modernize Latin and Greek names by giving these English pronunciations to the vowels but, at the same time, they devised a method of simultaneously indicating the vowels to be accented and whether those vowels take the long or short English sound. The system consists of the use of the French acute mark (′) over the vowel to indicate the short and the grave (`) mark to indicate the long sound. Innes followed this system and each of the species described in his book starts with the scientific name of the fish with these marks over the vowels. (These marks, which simply indicate vowel quantity, are called "macrons.") Thus all of the work had been done for aquarists. S*pléndopleùrus* is pronounced **splen'do-plew"riss** (where the single quote indicates the secondary accent and the double quote indicates the stronger accent) and one does not have to consult a Latin dictionary to find the vowel sounds and then consult rules to place the accents.

Innes claimed that this system had continued and was now in practically universal use in all works or books of science written in English. Unfortunately, however, this is misleading since the pronunciation of a fish name is generally found only

in its original description (and this sometimes a problem; in the Myers and Weitzman 1966 descriptions of *Sarcoglanis* and *Malacoglanis* in the *Journal of Zoology*, these marks are present but are over the Greek, not the Roman alphabet) and then not always (e.g., the description of the new species, *Rivulus degreefi*, in the *Journal of the American Killifish Association* for March/April 2016 lacks the pronunciation for *degreefi*, i.e., **deh-grayph'-eye**).

Innes never actually discussed the rules for placing the accents when vowels were long or short. This is important since the major problem most aquarists have with pronunciation is not with the sounds of the vowels (after all, Americans pronounce vowels differently according to where they live), but where to place the stress. He also omitted how the diphthongs were pronounced. Cole, however, did provide this rules and thus his explanation of pronunciation was superior to that given by Innes.

In Ray Cui's *Phonetica Latinae - How to pronounce Latin*, he writes:

There is a third pronunciation system, the so-call "Anglo-Saxon" pronunciation [Cui refers here to the English Method]. It is often abused among British and American scholars, and has remarkable (and in my opinion, bad) influences. Though about 70% of English vocabularies have Latin origins, the English Language belongs to a different linguistic family from Latin; thus they have completely different phonetic rules. Such pronunciation is definitely incorrect - not even close; thus this method should be prevented.

Cui overlooks the fact that a goodly number of local terms have found their way into scientific names; thus the English method is not the only one that encounters difficulties in pronunciation. In any event, choose the pronunciation system that suits you best. There are no Romans around to take issue with you. I personally use the English method for scientific names but when I am reading Latin (which I do out loud as did the Romans), I use the Classical Roman method.

A METHOD FOR PRONOUNCING SCIENTIFIC FISH NAMES

Lacking the kind of macrons that Innes provided in *Exotic Aquarium Fishes*, we have to start somewhere and I suggest first dividing a word into its syllables, a process called "syllabification." Seneca once said,

Longum est iter per praecepta, breve et efficax per exempla (" To learn by rules is a long road, by example a short and effective one").

Except in obvious diphthongs such as au, oe, ei and eu, every single vowel signals a separate syllable, as in English 'recipe' (three syllables).

Although the following rules - with examples - may look daunting, they usually pop into our heads naturally even if we did not know about them:

1. Two contiguous vowels or a vowel and a diphthong are separated: *Danio*, **Dan-i-o.**
2. A single consonant between two vowels goes with the second vowel: *Colisa***, Co-li-sa**.
3. When two or more consonants stand between two vowels, generally only the last consonant goes with the second vowel: *Girardinus***, Gir-ar-di-nus**
4. The so-called "mute plus liquid" pairs, br, bl, cr, cl, dr, gr, gl, pr, pi and tr are generally counted as single consonants and go with the following vowel: *Pseudotrophius*, **Pseu-do-tro-phi-us**.
5. Counted as single consonants are qu and the aspirates ch, ph, th, and should never be separated in syllabification: *Aphyosemion*, **Aph-y-o-se-me-on**.
6. The syllable is divided after the letter x: *Exodon*, **Ex-o-don**.

Since in Latin a word has as many syllables as it has vowels or diphthongs, this can be used as a first step in checking your syllabification. For example, *Aphyosemion* above has six vowels so its

syllabification is **Aph-y-o-se-me-on**.
With regard to accents, the distinction that will be observed here between syllable weight and vowel length, i.e. between metrically "heavy" and "light" syllables and naturally long and short vowels, is relatively recent. Older books use "long" and "short" indifferently for both syllables and vowels, thereby encouraging mispronunciation.

1. The accent is *never* on the last (ultimate) syllable.
2. The stress in words with two syllables almost always falls on the first syllable (the penultimate): *lèvis*, **lee"-vis**.
3. The stress in words of more than two syllables falls on the penultimate syllable if this is metrically "heavy" (i.e. contains a long vowel, a diphthong, or a vowel followed by two consonants), e.g. *pàleàtus*, **pay'-le-ay"-tus** and *Acánthophthálmus*, **A-kan'-thof-thal"-muss** (the short á at the end of the word is followed by the consonants l and m). It falls on the antepenultimate (third from last) syllable when the penultimate is metrically "light" (i.e. contains a short vowel before either another vowel or a single consonant), *plecóstómus*, **plah-cos"-tah-mus** (the short ó at the end of the word is followed by the single consonant m). This pair of rules is natural for English speakers.

Note A: For the purposes of syllable weight, x always counts as two consonants while qu always counts as a single consonant. (Strictly speaking, a syllable can be light even where it contains a short vowel that is followed by two consonants, provided that those two consonants are one of the so-called "mute plus liquid" pairs, br, bl, cr, cl, dr, gr, gl, pr, pi and tr. However, this is really a question of pronunciation; such syllables can be pronounced either **pay"-tris** or **pah"-tris**, tr making one sound.)

Note B: In a word of three or more syllables a second accent is placed on the second syllable before the principal accent, if that syllable is metrically heavy in quantity (e.g., *Cỳnolèbias* = **Sigh'-no-lee"-bee-as**), or is the first in the word; otherwise it is placed on the third syllable before the principal accent (e.g., *Pólycentrópsis* = **Pahl'-ee-sen-trop"-sis**).

With regard to pronunciation, a long y is pronounced like a long i. However, a short y poses pronunciation problems for English speakers and so it is often pronounced like a long e. *Cỳnolèbias* has the long i and *Pólycentrópsis* has the long e. For example, **Sigh'-no-lee"-be-as** and **Pah'-lee-sen-trop"-sis.**

A related problem involves the name *Bärbus*, meaning "with barbels." In the English system, the a should be pronounced as in hay if it is long or as in hat if it is short, making the pronunciation difficult for English speakers in either case. Innes was forced to define a "Broad ä as in bar," making the pronunciation of *Bärbus*, **Bar"-bus,** more easily pronounceable **(**similarly for *gorämy***, go-rah"-mee)**.

The problem now is that we may not know whether the penultimate syllable is short or long. To find out, it is necessary to consult a dictionary. What kind of dictionary? Well, an ordinary English dictionary will often do the job, although a Latin dictionary is also useful (commonly recommended is *Cassell's Latin English Dictionary* but I prefer the *Oxford Latin Desk Dictionary*). In *Cassell's Dictionary* it states that "where helpful," short vowels are indicated by a breve accent like ă and long vowels are indicated by a straight bar like ā. The *Oxford Latin Desk Dictionary* indicates only the long vowels (with a straight bar), so all of the unmarked vowels are to be assumed by the reader to be short. "Where helpful" is not really a helpful term; the method used in the *Oxford Latin Desk Dictionary* is much better as it leaves no doubt as to the sound of all of the vowels.

One should also not forget the Internet as another source for pronunciations. http://www.personal.psu.edu/staff/l/l/llb/PRIVATE/Verbword.htm, for

example, has a "Piscatorial Verbiphile Pronunciation List" that provides the correct syllabification and the primary accents.

An example is *Pántódon* so it is pronounced **Pan"-tah-dahn,** the accent on the first syllable (note that I sometimes disagree with Innes on his phonetic spelling of short vowels). However, The first step is to consult a dictionary for the suffix "panto" (I'll use my Collegiate Dictionary here). I find that both vowels are short and so using Rule 3 for accentuation (the ó is followed by a single consanant), its pronunciation and accentuation is as above.

Now let's try *Aphyosèmion*. The phonetic spelling with the accent is **Aff-ee-oh-see"-me-ahn**. Again, let's assume that we don't have this information. My Latin dictionaries tell me that in "semion" the e is long and the i is short (followed by a single consonant). As mentioned previously, the short i is frequently a problem in Latin and to ease pronunciation it is often pronounced like a long e. Its pronunciation and accentuation, therefore, is as above.

English speakers often have difficulty maintaining differences in vowel quality in unstressed syllables, where vowels tend to be reduced to a short indiscriminate sound often called a "schwa," and this is especially true when the vowels are short. A short e, for example, may sound like a short a or it may be indistinguishable. Thus, I wouldn't worry about the pronunciation of short vowels unless they are accented. I wouldn't worry about secondary accents either as they tend to come naturally. More important is to get the primary accent on the right syllable, along with the correct pronunciation of the vowel there, be it long or short.

THOSE PESKY PATRONYMS

According to the rules of the International Commission on Zoological Nomenclature (ICZN), species named in honor of people (patronyms) are pronounced as the person pronounces his or her name, and this causes the greatest amount of trouble in pronouncing scientific fish names.

A good example is *Mikrogeophagus ramirezi*. Ramírez is a Spanish surname meaning "son of Ramiro," and is the 9th most common name in Mexico. Its correct spelling in Spanish is with an acute accent on the i, which is often omitted in English writing. According to the ICZN rules, it should be pronounced **rah-meer"-ez-eye** but it is often corrupted into something like **ram-ah-reez"-ee**. Another well-known example is *Apistogramma agassizii*, named after Louis Agassiz of Harvard University, a Swiss-American biologist and geologist regarded as one of the greatest scientists of the 19th century. It should be pronounced **ag"-ah-see-ee-eye** but it is often corrupted into something like **ag-ah-see"-zee**.

The problem here is that we have to know how the person pronounced his name; there are no general rules for this as it depends upon the language used by the honoree. Either (1) the original describer of the species included its pronunciation, (2) the pronunciation is found in articles, etc., (3) the aquarist knows how the honoree pronounced his name (e.g., personal knowledge) or (4), our old friend once again, the Internet. The fourth way is usually the fastest and easiest. For example, take the species, *Julidochromis marlieri*. The species is named Georges Marlier (a Belgian ichthyologist) who pronounced his name **Mar-leh -ay";** so using the site: www.pronouncekiwi.com, the proper pronunciation is **mar-leh-ay"-eye** - not **mar"-ler-eye** or (cringe) **mal"-er-eye**.

Another example is *Apistogramma nijsseni*, named in honor of the highly respected Dutch ichthyologist Han Nijssen who pronounced his name **Nye"-szen**. So using the site www.pronouncekiwi.com again, Nijsseni is properly pronounced **nye"-szen-eye**.

Note that in these examples, save for *agassizii*, the patronym ends in a single i; in *agassizii* it

ends with a double-i, a real tongue-twister. The reason for this is a little complicated for those who are not familiar with Latin grammar but I present it here for the curious. The ICZN Code states that genitive case masculine gender patronyms may be formed in either of two ways: (1) By taking the stem, Latinizing it, and deriving the genitive case; the Code gives as an example, the name Cuvier, which is Latinized to Cuvierius, leading the genitive *cuvierii*; (2) By taking the personal name and merely adding *i*; the Code again gives as an example the name Cuvier, leading to *cuvieri*.

The Code also states that: "The original spelling of a species-group name formed under Subsections (i) or (ii) is to be preserved unless it is incorrect." This is further elaborated in Article 32(b), where it is stated that: "The original spelling of a name is the 'correct original spelling', to be preserved unaltered unless it is demonstrably incorrect as provided under Section (c) of this Article..."

There has been prolonged controversy over whether patronyms should have a single or double-*i* as a termination but as I have just shown, the International Code of Zoological Nomenclature clearly indicates that either a single or double -*i* is acceptable and also that the original spelling should be amended only if there are demonstrable errors. There is no scope for opinions on whether a particular author was or was not competent in Latin in determining the acceptability of original spellings of names. Therefore, we have to live with those double-*i* tongue-twisters!

If you are not satisfied with the English method and wish to use the examples used in this essay with their Classical pronunciation, all you have to do is to replace the sounds, nothing else: the vowels are the same as in modern Spanish or Italian, the diphthongs ae, oe, ei and au sound like eye, oy, ay and ow, respectively, and c is sounded like a k. There are relatively few complications. The gu group is pronounced gw: *lingua,* **leen"-gwah**. Similarly, the group qu is pronounced kw: *aqua*, ah"-kwa.

APPENDIX I

Judson Cole, "Pronouncing Fish Names," in *Aquatic Life*, September 1934.

The shark sucker, which uses the shark for a free taxi, is an impediment to the "taxis" comfort, so I'm told. From conversations with fish fanciers I find the proper pronunciation of the scientific names used for fish quite an impediment also, one as hard to shake off as is the hitch hiker on the shark. Eventually, when the method is determined the shark rids himself of the offender and it is possible for one to overcome the handicaps found in scientific nomenclature of fish once they are defined.

Fish names seem formidable for two reasons: first, they seem to have no reason to exist unless one is versed in at least the rudiments of foreign languages - alive and dead. Most of them, in defense, do have a meaning, changeable seemingly but more or less appropriate to the occasion. The second handicap - usually the stumbling block, is the uncertainty of proper pronunciation.

Scientific names, for the most part, are in Latin. If derived from some other language they are expressed in Latinized form. These then, for their proper pronunciation, depend greatly on their derivation, but the proper pronunciation of Latin, if at hand, will minimize the element of error which always creeps in at this point. The rules which apply in the matter are far more exhaustive in nature than a complete issue of AQUATIC LIFE. This being true we must seek some method, less complicated, to complete our purpose.

Some simple rules, of help, in pronouncing scientific names will suffice in the absence of a reliable information source on the subject. These are not offered to make one a complete specialist on the subject for, it is found that even they (the spe-

cialists), in a mixed audience, find themselves completely on edge because of the way in which their pronunciation is received by many of the company assembled. Fish culturists differ more on matters of nomenclature than on any other point.

Teachers claim there are three distinct methods of pronunciation applicable - all alternative. The Roman method, said to agree with that used by the ancient Romans, finds but little following among the English-speaking peoples because, it is said, we know not how they pronounced their words. In spite of this it has found some following in the schools and, to those who have studied this method, it presents a stumbling block when they attempt fish nomenclature.

The English method conforms strictly to the rules of Latin in word structure, length of vowels and accent but uses the English sound values of the letters. When, by this method, a good Latin scholar has determined the proper pronunciation of a word, we have something concrete to our purpose. Few of us have the privilege of such an authority to check our pronunciation.

The last method depends on the fact that many English words are from Latin derivatives, it regards the words as English and completely forgets the derivation and Latin rules. This is really the vernacular method, characteristic of a locality, and has its followers - who swear by a local pronunciation, regardless of how far wrong it may be. As an example take the word cichlid which in and around New York City is almost invariably, by dealer or fancier, pronounced as chichlid.

The English method, the one preferred by the majority, has each vowel or diphthong determine a syllable with all vowels pronounced which also includes the final one, a, i, or e. The final syllable is generally an inflective ending and needs distinct pronunciation to show grammatical construction, the vowel generally has an intermediate or even long value.

Long a is pronounced as in fate, short a as in fat. At times when preceded by r or h it takes the broad sound as in car. Final a has an intermediate sound while long e is pronounced as he while the short e is pronounced as get; long i as in mite; short i as in mit; long o as in note; short o as in not; long u as in dude; short u as in dun; long y as in type; short y as in lynch. The diphthongs, æ and œ are pronounced like the vowel e. [Author's Note: Cole overlooked another diphthong that crops up often in scientific names, i.e., ei, pronounced like "eye."]

Consonants generally are, sounded soft; r and g like in lice and girl before e, i and y and the diphthongs. Elsewhere their sound is hard like in can and gun. J an involvement of i used as a consonant is always troublesome . Sometimes it is used as alternate of y; at others the correct English pronunciation should be followed as in cognate words.

Ch, ph, th, ps are Greek derivations and cannot be separated in dividing a word into syllables. Ch is pronounced like k, ph like f, ps like s, while th is used the same as in English. Sch is pronounced scholar.

"The position of accent is complicated. The syllables of most importance are the penult or one preceding the last and antepenult or third from last. If the vowel in the penult is long the accent is taken by it, otherwise, it goes back to the antepenult.

More than two accents, in succession, are hard to pronounce. Therefore, a syllable near the beginning, in very long words, receives a secondary accent. A short vowel is indicated by an acute accent, a downward stroke from right to left, while a downward stroke from left to right, opposite from the above, is used to indicate a long vowel. These marks appear over the vowel.

In words from two derivations or roots, the connection is usually made by an o for sake of euphony. This connects the two by smooth transi-

tion when o is accented like in *Hyphessobrycon*. [Author's Note: In his description of *Hyphessobrycon*, Innes pronounced this as **Hy-fess'-o-bry"-kon** but allowed that **Hy-fess-ob"-re-kon** was admissible.)

Sometimes Latin gives undue importance to unimportant letters. This is found in personal names in which certain letters are silent. Less-objectionable is the case when the commemoratives are derived from personal names ending with a silent e.

While the above rules, not intended or proposed as complete, will not make one perfect in all pronunciation of fish names, they may well serve as a guide for a start which will make the names have a sonorous rhythm, both euphonious and attractive.

Much satisfaction will be derived from mastery thus far which will give impetus to still further study.

APPENDIX II

William T. Innes, "Pronunciation of the Scientific Names of Fishes," in *Exotic Aquarium Fishes*, 1936.

As "rare Ben Jonson" expressed it, most of us have "little Latin and less Greek," yet we aquarists would like to be able to acceptably pronounce the scientific names of our fishes.

We have therefore consulted leading scientists and scholars. In the main, all agree. The few differences of opinion occur principally as to which syllables in compound words take the accent.

Generally speaking, there is an accepted standard of pronunciation of scientific names. This, however, is not inflexible, nor without its exceptions. As with all languages, it is influenced by popular usage.

And now a word about the modern system. English botanists, so far as we can learn, were the first large group of scientists to address themselves seriously to this matter. Nearly a century ago they decided to modernize Latin and Greek names by giving English pronunciation to the vowels. At the same time they devised a method of simultaneously indicating the vowels to be accented and whether those vowels take the long or short English sound. The very simple system consists of the use of the French acute mark (′) over the vowel to indicate the short, and, the grave (`) to indicate the long sound. This system proved so satisfactory that it has continued and is now in practically universal use in all works or books of science written in English. The phonetic spellings, just below the marked titles, are for the benefit of those readers who have not acquainted themselves with the system of accents just referred to.

It will be noted that in the phonetic spellings, both single and double accents are used. The double mark shows which syllable takes the stronger accent.

The pronunciation of the vowels, long or short, according to the marks are as in the following words:

Long à as in hay; short á as in hat.
Broad ä as in bar.
Long è as in key; short é as in met.
Long ì as in tie; short í as in hit.
Long ò as in toe; short ó as in top.
Long ù as in cue; short ú as in nut.

Aquarists will be relieved to know that the consonants C and P queerly used in the beginning of such words as *Ctenobrycon, Ctenops* and *Pterophyllum* are silent. They represent Greek sounds which have no English equivalents.

APPENDIX III

Henry Beard, "A Brief Guide to Pronunciation," in *Latin for All Occasions*, 1990.

VOWELS AND A FEW DIPHTHONGS

A is pronounced "ah" as in "father."
E is pronounced "ay" as in "they," but the very common words et (and), est (is) and sed (but) should be pronounced like "bet," "best" and "said," and the very common word ending em should be pronounced like "stem."
I is pronounced "ee" as in "Vaseline," but the very common words id (it) and in (in, on) should be pronounced like "did" and "din."
O is pronounced "oh" as in "go."
U is pronounced "oo" as in "crude," but the very common word endings us and um should be pronounced like "puss" and "room" (with the "oo" sound of "cookbook"), and the very common word ut (how, so that) should be pronounced like "put."
AE is a diphthong (a pair of vowels joined together to form a single sound) pronounced "eye."
AU is a diphthong pronounced "ow," as in "luau."
OE is a diphthong pronounced "oy."

CONSONANTS

B, D, F, H, K, L, M, N, P and Z all sound the same as they do in English.
C always has a "K" sound as in "car."
Ch always has a "K" sound as in "chorus."
G always has a hard "G" sound as in "get."
Gu is pronounced "Gw" when it comes after an "n," as it is in English.
I is a consonant pronounced like "Y" when it is the first letter in a word and it is followed by a vowel. The common Latin word iam (now) is pronounced "YAHM."
Qu is pronounced "Kw," as it is in English.
R can be rolled in a sort of Scottish burr.
S always has a hissing sound as in "moose" or "soda," and some very common word endings sound like this: as = "demi- tasse"; es = "ace"; is = "geese"; os = "verbose"; and us = "wuss."
T always has a hard "T" sound as in "tar." In Latin, the word "ratio" is pronounced "RAH-tee-oh."
V is always pronounced as if it were a "W." What Caesar (KYE- sahr) said after he defeated somebody or other (veni, vidi, vici) sounded as if he had just conquered Hawaii: WAY-nee, WEE-dee, WEE-kee.
X is always pronounced "Ks."
J, W, and Y don't exist in Latin.

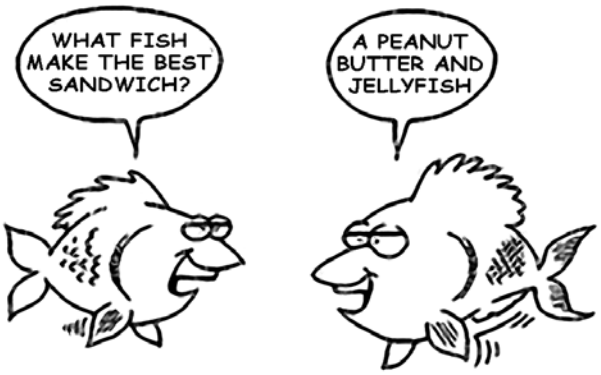
III SYLLABLES

Latin words are divided into syllables in the same way that English words are, but in Latin every vowel or dipthong is a syllable, and every syllable is pronounced separately. If there are two vowels together, and they are not AE, AU, or OE, both vowels are pronounced individually. So, for example, praebat = "PRYE-baht" (ae is a dipthong); speciem = "SPAY-kee-ehm"; and earn = "AY-ahm."

IV STRESS

If a word has two syllables, put the stress on the first one. If it has more than two, put the stress on the second-to-last syllable unless both the second-to-last syllable and the last syllable are vowels. When that happens, shift the stress back one syllable earlier. So, for example, locutionem = "loh-koo -tee-OH-nehm," but lo-cutio = "loh-KOO-tee-oh."

If the second-to-last syllable has an "i" in it and doesn't end in a consonant, the stress is usually moved back one syllable. So, for example, corrigant = "KOHR-ree-gahnt" and dificilissimum = "dee-fee-kee-LEESE-ee-muhm." For the same reason, the very common word aliqui (any) is pronounced "AH-lee-kwee."



A SHORT AUTOBIOGRAPHY

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, February 18, 2017)

Over the years I have had numerous chats with fellow aquarists, where their interest is primarily biographical, over my involvement with the hobby. Sometimes the information requested involved more than just the basic facts like education, work and relationships; sometimes what was asked involved my experience of these life events, including intimate details with an eye to gleaning something of my personality. This is understandable since, to most people, I am mostly a disembodied spirit. Sometimes I am surprised at what I am asked and at other times the tables are turned and they are surprised at what I deliver. This short autobiography, mostly limited to relevancies to the aquarium hobby but not entirely, is designed to fill those gaps not previously widely known.

EARLY YEARS

For starters, I was born on my Great-aunt's farm on January 4, 1929, located in the proverbial boondocks between Budd Lake and Hackettstown, New, Jersey. Although my parents, my brother and I lived in New City, we had stayed over at the farm over the Christmas Holidays when, after being snowed in, my mother went into labor. In those days doctors braved the snow, came to your house and delivered the baby, and this is what happened in my case. I mention this because for all of the years up to entering college, I spent the summers on my Great-aunt's farm where I learned about chickens and pigs (I know the difference between a Poland China and a New Hampshire Red, although I can't really say that information has been solicited much from me over the years) and growing vegetables and fruits. However, since my Great-aunt's farm abutted a forested area, I grew up with an appreciation of nature (and especially how to avoid stepping on copperheads in one's bare feet).

During my early school years we lived near a sound called Pelham Bay; it is not really a bay since it is open to larger bodies of water at both ends, opening onto Long Island Sound and City Island Harbor at the east. Here I collected various marine creatures, including *Fundulus heteroclitus* and other brackish water fishes. I also collected fishes in the Greater New York area such as Dace and small Sunfish, breeding some of them including Sticklebacks and four *Fundulus* species. They were kept in glass jars with no aeration, but water changes were frequent.

After moving back to the City, I once set up a regular tank in the living room at my father's request (he was to regret this later) and populated it with a few local fishes and a slew of tadpoles. One night the tadpoles hatched and jumped out from the uncovered tank onto the floor. Unfortunately, my father came out the next morning and stepped upon them in his bare feet. After picking pieces of frog from between his toes, the tank and

Albert J. Klee - Two Years Old.

all my animals (mostly fish, white rats and mice) were banished to a room in the basement. This was known locally as the "Great Bronx Rodent Migration of 1945."

This was a positive move for me since I could do pretty much what I pleased without my parent's knowing about it. In addition to biology I was also interested in chemistry and I conducted many admittedly dangerous experiments in that basement room. In those days it was easy - even for the youngster that I was - to obtain items like elemental phosphorus, elemental sodium and even potassium cyanide from the well-known chemical supplier, Eimer & Amend, which was then located at the corner of 18th Street and Third Avenue. With the phosphorus (which had to be kept in water) I generated phosphine, a deadly gas (but I burned it as it came out of my retort). The elemental sodium, on the other hand, had to be kept in kerosene. Since it would explode when it came into contact with water, it came in handy for practical jokes, like throwing a piece of it into a water puddle on the sidewalk as pedestrians were passing by. It was a miracle that I didn't burn down or explode the building or myself during these early years.

My last contact with Eimer & Amend came during World War II when my father asked me to procure a small glass still and condenser (legal at that time). During the war, booze was in short supply as distillers converted their production to industrial alcohol to aid in the manufacture of smokeless gun powder and synthetic rubber. My father got a mash going under his bed, using anything that could be fermented, such as raisins, prunes, carbohydrates, etc., and when the time came to distill out the alcohol, I set the whole thing up in the bathtub where there was a supply of running water for the condenser. Unfortunately we only had one bathtub in our apartment at the time, so a strict bath schedule for the four of us had to be adhered to before the process commenced. It is one thing to bum a cup of sugar from a neighbor and quite another to ask to use his bathtub, even though a clean neighbor is a good neighbor.

My interest in foreign languages started when I studied Latin at the Catholic grammar school I attended. Unfortunately, this loused up my classical pronunciation of that language for years afterwards, referring to Caesar rolls rather than Kaiser rolls. My parents were in the habit of speaking German when they did not want my brother or me to know what they were talking about. My Oma (Grandmother on my father's side) lived a block away from us and I visited her regularly and enjoyed hearing her tell me wonderful stories of the "old country." One day I complained about this situation with my folks and, with a smile on her face, said "Well, Albrecht, we must do something about that!" and undertook to teach me how to speak and understand German. I stopped by her apartment every day for lessons and this contin-

Albert J. Klee - Nine Years Old.

ued up to the time I entered High School. By that time I could understand everything my parents said in German, but I never led on that I could, and my Oma never let the katze out of the bag either. Later in life my father took my German accent to task, but I never had the heart to tell him that it was his own mother who taught me!

HIGH SCHOOL AND COLLEGE

At the time there were two prestigious High Schools in the City: Peter Stuyvesant and the Bronx High School of Science, admissions being determined by school grades, an entrance exam and whatever elixirs higher-ups used to make such decisions. I applied, passed the tests and became a Bronx High School of Science student where I majored in pranks. Once, for example, I exchanged the gas tube to the chemistry teacher's Bunsen burner with a tube leading to the water faucet. The bottom of a Bunsen burner has many holes in it for air, set out in a radial pattern, so when he turned it on the water not only got him but the first three rows of my fellow students as well. As an avid reader of detective stories I was never caught, as I knew the value of wearing gloves to conceal fingerprints. I should mention that my father was a great prankster, and drove my mother crazy sometimes with dribble glasses, hand buzzers and plastic flowers that squirted water when one was invited to smell them. This pretty much came to an end, however, when I began slipping exploding loads into his cigarettes. After putting out the fires in his eyebrows and preparing to remonstrate with a belt in his hand, I pointed out that I was just carrying out the old paternal family tradition and from then on, all was quiet on the domestic front

After graduating High School in 1946, I took the competitive admission test for the College of the City of New York and passed that one also, selecting as my major chemical engineering - no surprise there! In my sophomore year we had to take two "elimination" exams since the school's chemical engineering staff and labs could only accept a certain number of students; about 350

New York Public Library Main Reading Room.

students started out in this major but only 32 graduated. Chemical engineering was a five-year course there at the time but by going every summer and intersessions, it could be done in four; I graduated in four years, becoming the first one in my family to graduate from college.

Although the CCNY scholarship included all of my tuition - all I paid was a $5 fee each semester- it did not pay for books and although my family provided my room and board, I needed a source of extra income to make ends meet. In my sophomore year I learned that the main New York Public Library, located at the intersection of Fifth Avenue and 42nd Street (you know, the one with the lions in front of it), was hiring Pages to work the 5 PM to 10 PM shift in the stacks; I applied and was accepted. The library often refers to this as the "Day of Infamy."

The stacks were located below the main reading room (there were seven of them, plus two basement levels) and in the middle was a table where

One of the Library stacks.

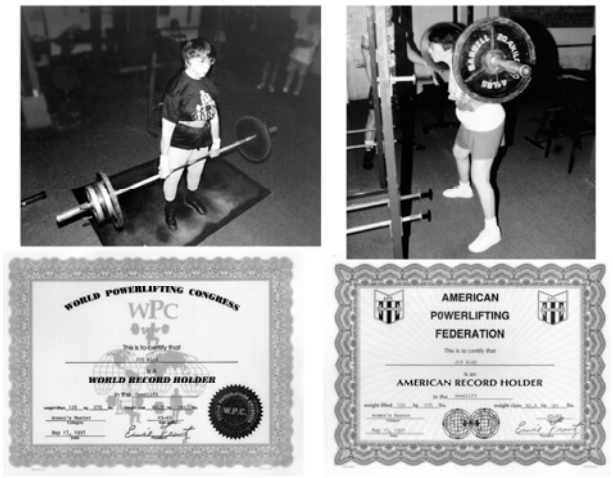
the Page (or Pages) sat waiting and a continuous vertical conveyor belt containing baskets in which books passed to and from the Main Reading Room. When a reader filled out a request slip, it was send down by a librarian to the proper stack through a pneumatic tube where a Page retrieved the books and sent them up to the Reading Room. The slips were time-stamped before they were sent down and also after the books were delivered. At about 9 PM the slips were sent down to Stack 6 where a librarian in charge of the Pages was situated and who averaged the times for each Page.

The lengths of these stacks were extensive and so I brought a pair of roller skates with me to the library one night and broke all records. The skates made a lot of noise over the tiled floors of the stacks, but I only used them when I was the only one assigned to a stack so I was never caught. I also played a lot of pranks while I was at the library, like putting together a false slip that would send a particularly obnoxious Page (he was pretty much of a bully, preying on smaller Pages) down into the bowels of the basement level to retrieve a pile of City Records that not only carried dust on them a quarter of an inch thick, but that weighed so much (each was about three feet in height) that they had to be carried on a cart to a special elevator.

The Page in question - proof that evolution can go in reverse - couldn't retaliate. As a favor to the boxing coach at CCNY (I was a member of the Boxing Club and had a long reach), I once was a sparring partner for Roland La Starza. (La Starza fought 66 professional bouts and won 57 of them, 27 by knockout. He may have come closer than any other boxer to defeating Rocky Marciano.) I had a little discussion with this Page in private and his bullying ceased.

Incidentally, I also did some track at CCNY (I was a miler) and was a member of the Wrestling Club in my freshman year. The latter was a disaster. Wrestlers typically are short and stocky and I was the opposite. As a consequence they would tie me in knots and I got tired of making impressions with my nose in the mats. Unlike Pinocchio whose nose kept getting longer, mine kept getting shorter.

Actually the real athlete in the family was my wife. In 1989 she and I were on an elephant traveling the mountain tops in the Golden Triangle between Thailand and Burma when the neck rope broke loose and the howdah rotated, throwing my wife and me onto the ground. I was stunned but otherwise OK, but my wife broke her left foot and left arm. It took me five days to get her back to the States where she was operated on. Afterwards she rehabilitated at a Sports Medicine center and when that was finished she was advised to continue her therapy at a regular gym. However, the only gym near us was one designed for young men in interested in powerlifting. We knew the coach and he let us use the facilities. The coach had her doing the standard bench presses, squat lifts and deadlifts and noticed she had a facility for the last. He entered her in a deadlift contest and, at age 62, she broke the State record, lifting 255 pounds. Over the next several years she continued to break national and world records in two different powerlifting organizations. Her last contest - at age 69 - she lifted 290 pounds (I have seen her do two replications of 305 pounds in the gym). Not bad for an English teacher!



My wife at work lifting iron at age 67.

Sorry for going off on a tangent (as I am a mathematician I could have gone off on a cosecant, but tangents are more comfortable). In any event, the job at the library was a Godsend for me since after 6 pm things were pretty quiet and I could study and write papers at the Page's desk for four hours each night without much interruption. Pages were paid double time on Saturdays and Sundays, and triple time on Holidays and I took advantage of these opportunities.

THE ORIGINS OF MY AQUARIUM HUMOR

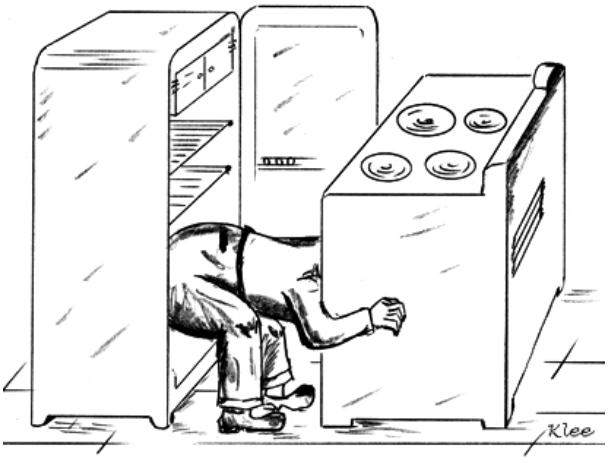
Incidentally, I mention these pranks to show the genesis of my passion for humor in one form or another, although after graduation from college it took a more literary and oral form than physical. Thus I started to inject humor into my aquarium writings and presentations to the extent that I became the hobby's first cartoonist, not that I was the first to draw an aquarium cartoon but the first to draw them (over 120) as a recognizable genre within the hobby. Over the years I have written more aquarium hobby satire than any aquarist living or dead (there are 23 of them in the Second Edition of *The Finny Bone*, satires that is, not expired aquarists). I have included four cartoons in this essay that I did when working for Proctor & Gamble as a statistician.

Sometimes my humor has unintended consequences, one example being my satire on the Yahoo site of the Aquarium Hobby Historical Society of America on the history of plastic bags in the hobby, which I attributed to one "Algernon Fiddle" in the late 1940's. This tale was received by the forum members with laughs but when I followed it up with Fiddle's exploits with undergravel filters, frameless aquariums and electric eels (I have combined these two posts on pages 45-46 of *The Finny Bone*), I got the following response from Alan Fletcher:

Enough fiddle faddle, already. It is getting to be difficult for those of us with only average intellect to distinguish between fact and fiction.

It turned out that Alan was under the mistaken impression that my first post about Fiddle involving plastic bags was a true story and after my second post, he really had trouble figuring out whether I was serious or not. Actually something similar happened to me with a humor column I wrote for the *Lorelei News*, a publication of the Homeowner's Association of Lake Lorelei, a gated community near Cincinnati, Ohio in which I lived. The following appeared in the November 1995 issue:

The Board of Trustees discussed the possibility at last Friday's Board meeting of making every Lorelei street whose name contains an umlaut, one-way. "Something has to be done to relieve the traffic congestion," said one Board member. "Last week a woman with a baby carriage had to wait 6 hours before she could find a break in the traffic to cross Lubeck Road. She was forced to flag down passing motorists and beg for Pampers, talcum powder, and other essentials." The audience in attendance at the meeting quickly arranged themselves into four camps, according to the direction the one-way streets should take. A scuffle broke out between the North/South and West/East groups, and was quelled only after the Lorelei constable resorted to Mace and playing old Lawrence Welk records, the latter quickly emptying the clubhouse.



Definition of a statistician:
On the average he feels just fine!

Unfortunately, one elderly resident of the community thought I was publicizing an actual meeting of the Board of Trustees and had a bout of apoplexy upon reading this, subsequently complaining loudly to the Board for contemplating the idea. I got into a little hot water over that one! In any event, Alan forgave me for fiddling with Fiddle and we have been close friends ever since.

My humor is not of the scathing type, but mostly a matter of satire or quips. The following is an example of the latter; it was sent to Gary Haas (Editor of *The Business Newsletter of the AKA*) just last week after I received his email informing me that I would be dropped from the AKA roster unless I paid my dues:

Gary:
I received your email informing me that my membership expired on 12/31/2015. Some years ago the BOT awarded me a Life Membership. Since I am still alive - barely - evidently I also expired on 12/31/2015. Please correct this paranormal data.
My best,
Al Klee

Gary liked my humor and so "What dreames may come, When we haue shufflel'd off this mortall coile, Must giue vs pawse."

HOW I GOT INTO THE HOBBY

Stack 2 in the Library contained mostly technical books, including those that covered the biological sciences. There were not many calls for books from this section in the late evenings nor was I usually assigned to this stack, presumably because the Librarian wanted to keep a close eye on me to forestall pranks that he suspected I was the mastermind of (I preferred to think of them as "excursions into corporeal humor").

All things were quiet for a few weeks on the prank battlefield so, to my surprise, one evening I was assigned to Stack 2. Things were slow on this stack so I browsed among the books and soon encountered shelve after shelve of books about the aquarium (the New York Public Library at the time was the second largest public library in the United States, and fourth largest in the world). Most of these were in English, a few in German and a smattering of other languages. I saw pictures of Plecostomus and other strange-looking fishes, and also pictures of freshwater fishes sporting fantastic colors, notably killifishes and cichlids, and I marveled that they could be and had been kept in a home aquarium.

I was hooked! I immediately scoured the main fish stores in New York City, looking for some of these fishes and I was successful in obtaining Corydoras, *Apistogramma agassizii*, *Aphyosemion bivittatum* and others that I set up in several aquariums in my room at home. In my spare time at the library I wended my way down to Stack 2, and over time read almost every aquarium book the Library had. During my last two years in college and during the

Albert J. Klee, 1950.

two years that followed, I kept every sort of fish imaginable and by the time I went into the Army in 1952 during the Korean War, I had amassed over 90 tanks in the top floor and in the basement of the house in Cincinnati I had rented after graduation.

During this time I wrote three articles that were published in *The Aquarium*: "Carbon Dioxide in the Aquarium (January 1951), "Geography and Science of the Fundulopanchax Group (December 1951) and "The Fleischmann Aquarium in Cincinnati" (August 1952). Regarding the last, early on I had become a consultant to the Fleischmann Aquarium and in 1952 at the request of the Cincinnati Zoo, I provided them with a formula for artificial sea water. The Zoo had this made up by a commercial chemist and, in order to defray costs, marketed it publically under the name of "Marine Mix," thus being the first artificial sea water mix on the market in this country. I was off to a good start!

THE WAR YEARS

After I was drafted during the Korean War in May 1952, later that year I was assigned to the Officer Candidate School (OCS) in Ft. Riley, Kansas where I was to spend the next 22 weeks. Ft. Riley was in the middle of nowhere and on weekends I was pretty lonely, the only one writing to me at the time being my mother. However, while working as a page at the New York Library, I'd met an assistant stack chief I'd never seen before. Her name was Joy and she worked the day shift so for one hour each day - from 5 to 6 PM - she was my boss. She was an English Literature major with a minor in German at NYU and, since I was a technical type, on the surface it would seem that we had little in common. However, we talked a lot and as the floors were made of marble and hard on the feet, we usually took them off when not retrieving books for the top floor reading room. Thus, I was in the habit of stealing her shoes with her chasing me all over the stack to get them back! A few months later, Joy's parents moved to Lynn, Massachusetts and she followed, transferring to Boston University, and that was that.

At Fort Riley the idea popped into my head that I would write to her, asking how she was and what she was doing. I didn't know whether she was married or going with someone, and the only address I had was her name and her parent's home town of Lynn with no street address. I sent the letter off knowing that it was a snowball's chance in hell that it would ever get to her. Wonder among wonders, her folks finally got the letter (they had moved from Massachusetts to White Plains, New York during this time; God bless the U. S. Post Office!) and forwarded it to her in Mackinaw City, Michigan where she was teaching high school. It turned out that she was neither married nor seeing anyone and, from then on, the letters between us began in earnest, every other day at a minimum.

This went on for two months. Well, I knew what she looked like, I knew something about her personality and she sure could write great letters. So in a moment when I had gathered all of my courage, I proposed by mail. Bear in mind that this was to a woman that I had not seen in five years,

Lt. Albert J. Klee, Company Commander, 501st Chemical Depot Co. Ft. McClellan, Anniston, Alabama.

never had a date with and never even got close enough to for a peck on the cheek!

You can imagine how I was feeling, awaiting her rely. I was lucky I wasn't getting gigged right and left (gigs were demerit marks in OCS) since I hardly knew what I was doing in class or out. Her reply came and I was stunned by her answer. She told me that she had fallen in love with me the day we met and told her mother that "Today I met the man I'm going to marry." In short, her answer was "YES! and this month we will have been married for 63 years.

We decided that she would not renew her contract with her school but would move east to stay with her Grandmother in Jersey City, New Jersey (just across the river from New York City) to be nearer her parents while we hammered out the details of when and how we were getting married. In the meantime, she needed a job and she got one - you guessed it - at the main New York Public Library, this time as a librarian! Incidentally, while she was there she met Ida May Mellen before I did.

My wife had a great influence on me. Among other things, I read all of her college books and discussed English literature with her. She had studied Latin, French and Spanish and, as I have noted, majored in German. Many years later she met Franz Werner in Chicago at an American Killifish Association and I remember Franz clicking his heels together exclaiming "Gnädige Frau!" as I introduced her to him. He was as pleased as all get out when she spoke German with him and had no trouble when *Nothobranchius* and *Aphyosemion* were dropped into the conversation.

So due to my wife, I read Beowulf, Chaucer, Dante, Boccaccio, Aristophanes, Schiller and a host of others I never would have approached on my own, getting a liberal education in the bargain. Furthermore, during the first twenty years of writing about aquarium hobby topics, she edited them or made suggestions before I sent them off to be published; I learned a lot from her about editing as well.

POST-ARMY YEARS

After getting married and being mustered out of the Chemical Corps in 1954 (and glad to say goodbye to handling mustard and nerve gases - I still have the scar on my left arm from a mustard gas - actually a liquid -burn), I secured a summer internship with the Socony Mobil Oil Company in their lube oil refinery in Paulsboro, New Jersey, just across the river from Philadelphia. This filled up the time until, taking advantage of the GI Bill of Rights, I started on my Ph.D. in Chemical Engineering at New York University's uptown campus. I had also secured a Student Assistantship to the Chairman of the Chemical Engineering Department. My wife and I had rented the upstairs of a house in Hillside, New Jersey where she had taken a job as an English teacher in their High School. I had a long bus/subway ride each day to get to school but my thesis advisor was Dr. Robert E. Treybal, one of the country's foremost experts in mass-transfer operations.

During my time at New York University I met

Albert and Joy Klee wedding picture, 1954.

many old-timers in the aquarium hobby such as Hugo Schnell, Aaron Dvoskin and Richard Büttner. Rosario LaCorte lived in Elizabeth, the next town down from Hillside, so we visited him and took a tour through his famous fish room. While at New York University I wrote an article on metals in the aquarium and submitted it to the *Tropical Fish Hobbyist* (TFH) magazine. After several months without receiving even a simple acknowledgement, I submitted it to the *Aquarium Journal* whose editor, James Crawford, immediately informed me that it would be published. The article appeared in the February 1955 issue of the *Journal* but unfortunately it – much to my astonishment – also appeared in the same month in TFH. After this experience I swore that I would never again submit any material to TFH while Herbert R. Axelrod was either its editor or publisher, and I never did. It was, however, the start of a long association with the *Aquarium Journal* and a close friendship with its editor.

When I was about 80% through my first year at NYU my wife became pregnant. I had to find the courses with which to finish with a Master's degree rather than the doctorate I had planned and also to find a job. Unfortunately this was at the end of June and there were no chemical engineering courses scheduled for the summer. I did discover that the Biochemistry Department offered an intensive 6-credit course during the months of July and August (8 hours a day, 5 days a week for two months). This fitted in perfectly with the job I had obtained with the Atomic Energy Commission in Cincinnati where I was due to report in September. The problem was in securing permission to do this.

The Biochemistry Department was OK with it if I could secure the OK from the Engineering Department, the Engineering Department was OK with it if I could secure the OK from the Head of the Chemical Engineering Department, and the Head of the Chemical Engineering Department was OK with it if I could secure the OK from Dr. Treybal, the head of my Doctoral Committee. Treybal was OK with it but there was a catch; I first had to secure the OK from the Head of the Chemical Engineering Department. I was stuck in an endless loop! Having nothing to lose (I figured if they ever caught up with me I would long since be gone), I told the Head of the Chemical Engineering Department that Dr. Treybal had approved it and then worked my way backwards reporting approvals along the way and the loop was broken.

The next two months were pretty rough on me, not really having the necessary prerequisites for the course, but I made it and received my Master's degree in absentia. Treybal thought that the work I had done on my thesis was publishable and together we wrote a paper using my results. It was published in the December 1956 issue of the *Journal of the American Institute of Chemical Engineering* ("Rate of Rise or Fall of Liquid Drops"). Years later, when my son was a chemical engineering student at the University of Cincinnati, I was amazed to find that this paper was the basis for a required experiment in its chemical engineering laboratory. He in effect had to duplicate the results I had discovered twenty years earlier! My son was pretty proud of me and his instructor also was surprised when he learned that the paper was written by the father of one of his students.

"I've got a little data I'd like you to look at!"

THE WRITING YEARS

During the two decades of the 1960s and 1970s I wrote over 600 articles for various aquarium magazines, including *The Aquarium Journal, The Aquarium, All-Pets Magazine, Tropicals Magazine, The Aquarist, Pet Shop Management, Aquarium Illustrated, Killie Notes* and the *Journal of the American Killifish Association* - this does not count the many articles published in foreign magazines - and I was an editor in some capacity of most of them. The bulk of this material - almost 1,000 pages - can be found in the two volumes of my *Anthologica Aquatica* and need not be examined in any further detail. I would, however, like to make some generalizations about this material.

These articles covered a range of topics never equaled before by any other aquarist, dead or alive. I do not claim that my articles were of any particular excellence, just that they were different. They included beginner's topics to those bordering on (or even including) ichthyological material. They also included statistically-based experiments on various fishes, descriptions of old and new species, diseases, nomenclature, travel, collection and water analyses in foreign countries, building of specialized testing equipment such as conductivity, humor, book reviews, genetics, aquarium shop management and history. Some of the topics were unique, such picking pairs of fishes using probability, inducing spawning using the urine of a pregnant woman or introducing aquarists to the word "floccinaucinihilipilificator."

To this end I learned to read and write a number of different languages in addition to the Latin, German and Spanish I already knew; these included Dutch, Danish, Swedish Italian, French and Portuguese. At one time I subscribed to 15 different aquarium magazines in these languages. (I have had formal study in all but Dutch, Danish and Swedish; these I picked up on my own). Thus I have long been interested in linguistics and etymology. In addition to the above, I subscribed to many scientific journals that were of some relevance to the aquarium hobby.

THIS MATTER OF DEGREES

Much to my amusement, I have been known as an amasser of college degrees, but that was not my intention. I have already described my first three - Bachelor of Chemical Engineering, Master of Chemical Engineering and Master of Business Administration - and there is nothing unusual about that. However, the GI Bill allowed for three years at the University level but I had only done two years for the Chemical Engineering and Business Administration degrees, and I wanted to fully utilize all three years. The only way I could do that working full time in Cincinnati was to defer putting in my request for graduation and to continue to take courses. This went along for about two more years, but the Dean of the Graduate School of Business was worried that the school would get into trouble with the Veteran's Administration and kept pressing me to put in my graduation request papers. Finally, he couldn't stand it anymore and put in the papers for me and I graduated with one credit less than two years of full time study (59 credits versus the standard 30 credits). Although I was disappointed, the truth of the matter was that I had difficulty finding any more courses at the University; I had taken almost all of them!

Albert and Joy Klee, 1980.
These were my handlebar mustache days!

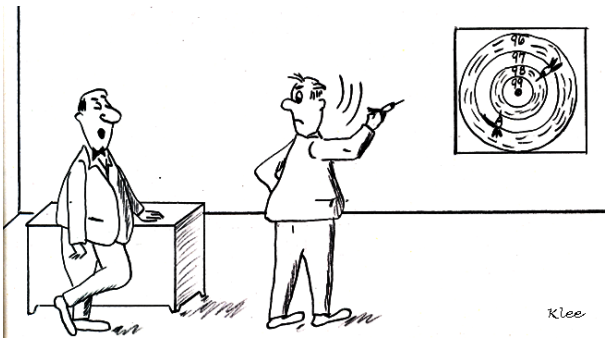
While at NYU a fellow student had introduced me to statistics, in particular least squares curve-fitting, which I used in my thesis. I was the first to use statistics at this level in the Department of Chemical Engineering and it fostered my interest in the subject, leading me to read quite a few statistics books on experimental design and regression analysis. These, however, were "cookbooks" and I had trouble understanding the theory behind them. Nevertheless, while working for the Atomic Energy Commission, I taught my fellow engineers how to plan experiments and fit data to curves, becoming well-known for this, even giving courses at work on these subjects.

Unfortunately for me, I accidentally ingested some uranium oxide while pelletizing the powder. This was to be the feed for a moving bed pilot reactor that was designed to replace the obsolete rotating kiln process used at the time for converting the oxide to the fluoride. This showed up in the urine analysis we had to take each month and I was permanently banned from any work in the plant that involved uranium or its salts.

While I was twiddling my fingers doing some esoteric experiments on fluidized bed reactors in the engineering lab, I was approached by the Plant's Chief Statistician, a good friend of mine. He had just lost his last statistician and offered me the job. This would really be a major career change for me and I had doubts that I could do the job, although he seemed to think I could. I really didn't want the job and so looked for a way to turn him down without hurting his feelings. I devised a plan around a counteroffer that I was sure the company would never accept, i.e., that (1) they would give me time off from work to take a Master's degree in pure mathematics, (2) that they would pay the tuition and the costs of the books required, and (3) that they also would pay me my full salary during this time. Much to my astonishment, they agreed and I picked up degree number four! With this background, I had no difficulty later when things with the AEC slowed down, in obtaining a job with Proctor and Gamble.

I worked at Proctor and Gamble for four years before taking a position with the United States Health Department in the Bureau of Solid Waste Management as a statistician and later as an Operations Research analyst. It was the custom at the Bureau that every year they would send two of their young engineers back to school for one year, and from this they often returned with a Master's degree. One year I criticized this choice, pointing out that the young engineers had just graduated from school and that it was the older engineers that they should be sending back. They compromised and decided to send off one young engineer and one old engineer. I was surprised, to say the least, when the "old" engineer they selected was me (I was in my early forties)! However, I thought it was a good idea since I was getting into more and more areas that needed some academic tweaking, so I planned to take courses at the University of Cincinnati in social psychology, systems analysis and economics. There was no intent for another degree, just coursework relevant to my job.

While at the University of Cincinnati and getting used to being in a classroom again, I recalled a fellow chemical engineer at one of my prior jobs recounting his experiences in going to the highly-ranked Salmon P. Chase Law School in downtown Cincinnati. The school offered a six-year evening program, which lead to a Juris Doctor degree. This provided him with a supplemental income that he practiced out of his home. Xavier University at the time was hosting a sort of law school jamboree where various law schools - in-



"So this is our new random sampling plan, eh, Gridley?"

cluding Chase - discussed their own schools. After these presentations, rooms were made available where interested parties could speak to representatives from specific schools. I attended the one for Chase and was convinced that it was worth a try. I forked over the $20 needed for the LSAT, a half-day, standardized test administered four times each year at designated testing centers and one of them was the University of Cincinnati.

After finishing my first quarter at UC, I found myself one cold December day trudging along the almost deserted campus to the building where the test was to be administered. Along the way I met Dr. Albert J. Simone (almost the same name as mine!), a noted decision scientist and Chairman of the Department of Quantitative Analysis who I had known for several years from various scientific meetings I had attended in the Cincinnati area. Simone immediately tried to talk me out of it, saying that he had a better plan.

The new Chancellor of the University was Warren Bennis, a well-known management expert and proponent of the change agent theory of leadership (a change agent is a person from inside or outside an organization who helps it transform itself by focusing on such matters as organizational effectiveness, improvement and development). Bennis and Simone had put their heads together and had come up with a new kind of degree, i.e., an interdisciplinary doctorate. The idea was to pick three very different areas of study and justify how the degree would be applied in practice. I was very enthusiastic about the concept, having been an interdisciplinary practitioner most of my professional life (my title when I retired from the U.S. Environmental Agency was "Senior Science Advisor"). I signed up and discarded the law school idea, although having paid my $20 I did take the LSAT. (I passed and wrote an apologetic letter to Chase.)

The three areas I picked were Quantitative Analysis as the major (Departments such as these are commonly known as Systems Analysis or Operations Research), Economics (the Economics Department devised a special concentration for me they called "Mathematical Economics") and Political Science, the last two as minors. The Political Science may sound odd but the only class course I took in that department was Comparative Public Administration, which compared government service in various countries and obviously was relevant to my work. The majority of my courses in that department were reading courses, mostly in management theory and also in the statistics unique to public opinion sampling, a special interest of mine. (A reading course is where one meets regularly with a faculty member and discusses assignments made the previous session; since one is quizzed each meeting on the material, one really has to study in these kinds of courses.)

I was forty-one when I started the program, much older than the other students in Quantitative Analysis. Also, I had worked for many years in a research capacity and had many published papers in engineering and scientific journals under my belt, more so in fact than any of my professors. Classwork, therefore, was easy for me and I had the habit of finishing every midterm and final examination much faster than my fellow students. The standard test time at UC was one hour and 15 minutes, and I usually finished in 20 minutes. Thus I acquired a reputation with the faculty as one unlike any other student but I had a lot of fun

Here I am, analyzing fish habitat waters in Columbia, 1966.

in the process. One time after I took an exam in linear programming, the instructor told me that for the first time another student got a higher mark than I did; he got a 98 and I got a 95. When I asked how long he took, he replied "one hour and 15 minutes." I reminded him that I took my usual 20 minutes and he laughed. That was the sort of relationship I had with the faculty.

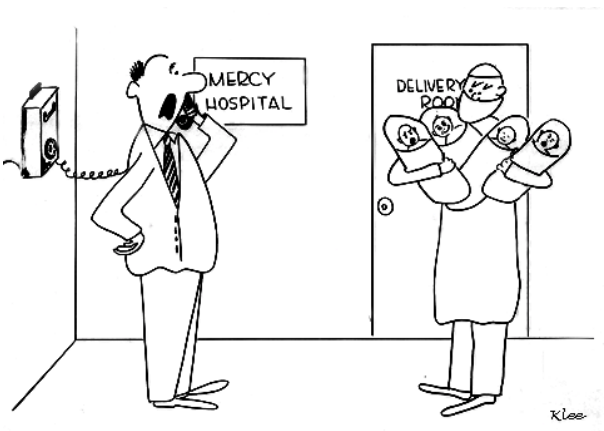
Over time, this even got to be a sort of friendly contest between the faculty and me. On my comprehensive examinations I came across a question in the quantitative analysis section that I'd never encountered before. I solved it with a somewhat obscure technique that I learned during my Master's degree work in pure math and finished the other questions concerned with my two minors. After two weeks and not having heard whether I passed the comps or not, I ask one of the younger fellows on my doctoral committee what was taking so long. He told me that the committee had put their heads together to try to find a question that would stump me, hence the odd question on the exam. Unfortunately, no one on the committee knew the answer and they had spent the time arguing over whether I was right or wrong. They never could decide, so they passed me.

Another incident happened during the oral defense of my dissertation, "Biased estimation as a solution to the multicollinearity problem in multiple linear regression." Doctoral orals are the most brutal of all examinations but I was not particularly concerned because I figured, "who would know more about this topic than I do?" Now for the past year I had been taking a readings course in advanced econometrics and one of the minor things my instructor and I discussed was a certain unsolved problem in the field. We frequently returned to it because by this time, the instructor and I were good friends. The problem interested the both of us and we enjoyed talking together about it.. Neither of us, however, had come up with a solution.

Imagine my astonishment when, after finishing my presentation and ready for the expected grilling, he stood up and presented me with the problem and asked for an answer. I was dumfounded and didn't know what to do since the question had nothing to do with my dissertation. I remembered an old Toastmaster's ploy used when one got an unexpected question and needed time to answer - slowly repeat it or, if one was available, write it on the blackboard. As I was writing it, however, the gleam of an idea came into my mind and when I had finished writing the statement of the problem on the blackboard (I had taken my time) the answer just popped into my head! I suppose it wasn't that unexpected since I had been thinking about it for a year. In any event, Simone jumped out of his seat and yelled, "I told you he could do it!" Yep, the committee had once again deliberately thrown in an irrelevant question to see what I would do.

I finished my dissertation in seven months, the minimum allowable by University rules. The problem then was, since this was an interdisciplinary degree, which of the schools would award the degree? The University mulled this over for a few months and finally decided that it would be the School of Arts and Sciences. I finally got to add a bit of color (orange) to my graduation robes!

I tell this story of my experiences with this degree because the degree was unusual (six tried it but



"Hello Sam? About those probabilities we were discussing a while back…"

only two finished; a Korean exchange student and I) and I thought it might be interesting to readers. It was not meant to show that I was smarter than the average bear by any means. After all, I was older than any of the faculty involved and had twenty years of experience in the real world.

In the introduction to my dissertation I thanked many people, including my wife, to whom I promised this would be my last degree. However, I held Adjunct Associate Professorship rank at both Xavier University and the University of Cincinnati so I was able to take courses at no cost to myself. I took advantage of this and acquired enough language credits for two additional Master's degrees, but in keeping my promise to my wife, I never bothered making it official. I, by the way, never audited a course in my life; they all were for credit. I felt that if I audited a course, I would not apply myself as diligently and would therefore learn less.

AQUARIUM HOBBY HISTORY

I became interested in aquarium history in the early 1950's. However, one doesn't jump into inventing a new genre without doing a ton of research, and this took some years before I felt that I was ready to write about the subject. In the meantime, what did appear in the aquarium magazines almost always concerned goldfish history, only a small portion of the complete picture.

Over a period of close to ten years I amassed a collection of aquarium books and magazines. This was a time when few showed any interest in the subject, save for my good friend, Dr. James W. Atz, the Curator and Dean Bibliographer of the Department of Ichthyology of The American Museum of Natural History. Accordingly, he had a unique opportunity to review the entire literature of ichthyology, including a good many aquarium references as well. Jim loved aquarium history as well as I did and - along with Lee Finley - and I consider these two the most accomplished aquarium historians I have ever known.

Some years before I started writing my history of the aquarium hobby in America, Jim had planned to write such an account and as a title he had intended to use *The Toy Fish*, a term introduced into the hobby by Ida May Mellen over 70 years previously. Because it evoked a certain charm and enchantment that reflected the period covered by my history, without knowing about Jim's plans I used it in the title of my book, *The Toy Fish, A History of the Aquarium Hobby in America - The First One-hundred Years.*

During this time, my work with the U.S. Public Health Service made it necessary for me to travel extensively in the United States and Canada. In every city and town I set foot in, I visited as many book stores - old, new and antique - that I could. In this way I built up quite a collection without spending much money or encountering any real competition with other aquarists. Using the Union List of Periodicals, I tracked down and obtained microfilm of old aquarium magazines that resided in libraries all over the country. Through various sources I also obtained originals of magazines such as *The Aquarium, the Home Aquarium Bulletin, Aquatic Life* and many others.

Dr. Albert J. Klee, Graduation, 1974.

I started writing my history in 1960 but delayed publishing it since I became busy in founding - with Bob Criger - the American Killifish Association and later on in planning, editing and writing for the *Aquarium Illustrated* magazine. (I won't mention the AKA in this essay any further since I have documented my involvement in great detail elsewhere.) The first of what was to become a series was published in the January-February 1964 issue of that magazine under the title, "A History of the Aquarium Hobby in America," and this was continued for a total of eight episodes, the last appearing in the March-April 1965 issue when publication ceased. In November of 1967 I assumed the position of Editor of *The Aquarium*, and in the December issue started the series all over again, finishing the series with the 22nd episode in the September 1969 issue.

Some years later, I gave Ross Socolof my permission to reprint pro bono the history series for the American Cichlid Association, and this was published in 1987. The price of the book was $35 and it sold out in about 90 days, garnering over $7,000 for the ACA. Lee and Aline Finley (mostly Aline) did the physical typing and Lee did the layout. (A minor matter: In their introductory notes they unfortunately erroneously cited the dates of publication of the material in Aquarium Illustrated; for the record I have given the correct dates above.) Ross handled all the printing, binding, sales, mailing and distribution. He also did the cover that contained the caricature of Guy D. Jordan, to whom the book was dedicated.

AQUARIUM HOBBY HISTORY IN EARNEST

After my tenure as Editor of *The Aquarium* - the last issue I edited was December 1971 - I pretty much dropped out of the aquarium hobby to finish my Ph.D., but not completely. I wrote a seven-part article on the guppy in the *Aquarium News* in 1977, an article on the genus *Rivulus* for the *Journal of the American Killifish Association* (JAKA) in 1982, a two-part article on the meaning of "killifish" in JAKA in 1983 and an article on the history of the American Killifish Association in JAKA in 1990.

During this time, however, I was working behind the scenes on a new edition and by 2002 it was completed. I approached the Chairman of the Board of Trustees of the American Killifish Association with the idea of doing with the AKA what had been done with the American Cichlid Association. While this was being discussed, however, Lee Finley wrote to me suggesting that I write a new version, offering to publish it and shouldering all the financial risks. Since this book would be a much more expensive undertaking than the American Cichlid Association version, I decided not to expose the AKA to such a gamble and the book, now titled *The Toy Fish, A History of the Aquarium Hobby in America - The First One-hundred Years*, was published under the aegis of Finley Aquatic Books. For marketing reasons, Lee called it a "Revised & Expanded Edition" but it was, in effect, the second edition of the work. Here I did almost everything: writing it, preparing the layout, providing the captions for the illustrations and preparing the images for publication. My wife helped immensely by editing the text. The book has since gone through two additional editions since and, comparing the Fourth Edition

The largest poisonous snake in the Western Hemisphere, the Bushmaster (*Lachesis muta*), I discovered it in the Peruvian Amazon and brought back to the Cincinnati Zoo in 1964.

with the Second, we have 435/203 pages, 516/ 242 illustrations, 321/119 bibliographic entries and 208,276/75,062 words.

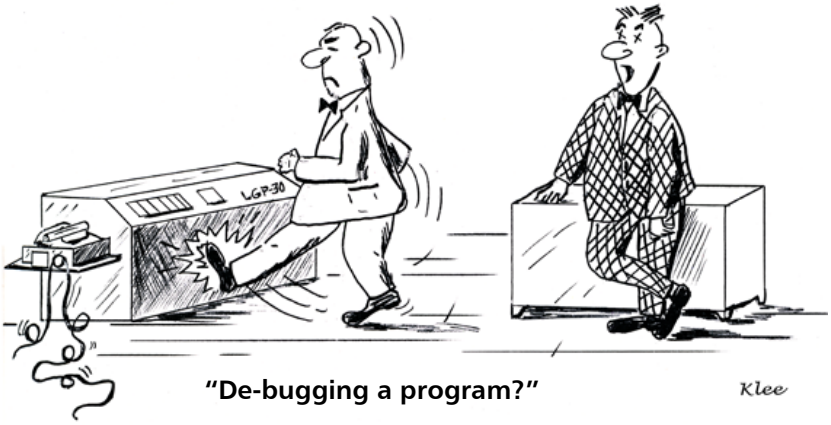
In 2003 I joined the Aquarium Hobby Historical Society of America, a Yahoo Group established just the year before. Yahoo groups - like Facebook groups - allow one to write material to files that are available to group members and I took the opportunity to write quite a number of them. There was an advantage in this in the fact that, unlike an article written for a commercial aquarium magazine, it could be much longer, publishing schedules could be ignored and I was free of editorial excursions into well-meaning but sometimes disastrous editing of my material.

I wrote an article about the Aquarium Hobby Historical Society of America and sent it to TFH but, for some reason, it never was published. It included a picture of Henry Dennison Butler and if the article had been published, it would have been the first image of this important aquarium hobby personage ever seen. I wound up later publishing Butler's portrait in the Third Edition of *The Toy Fish*.

At one point, fearing that if Yahoo foundered this material would be lost, I decided to collect them in a book in pdf format that I referred to as a *Compendium of Aquarium Hobby History Articles*. Later I changed its name to *Essays on Aquarium Hobby History*, using the term Stephen Jay Gould (whom I much admired) favored for his 300 popular articles published in the magazine, *Natural History*. At this writing, *Essays on Aquarium Hobby History* stands at 868 pages, about twice that of *The Toy Fish*.

Printing the second edition of *The Toy Fish* via offset was expensive and Lee barely broke even on the deal. However, I always wanted to do a book on the history of the guppy and in 2003 I wrote the first edition of *The Guppy - 1859-1967*. I did the layout myself and had it printed POD. Print on demand (POD) is a printing technology and business process in which book copies are not printed until the company receives an order, allowing runs of small quantities. POD could only develop after the beginning of digital printing, because it was not economical to print single copies using traditional printing technology such as letterpress and offset printing. In this way I printed other aquarium history books such as *A History of Aquarium Inventions - The First 100 Years, The History of Ichthyology, The Finny Bone and The First Lady of the Aquarium Hobby - Ida Mae Mellen*. For many of these I turned the printing over to Lee Finley who also marketed the book, although I gave the American Cichlid Association the right to publish the Mellen book, the earnings of which went to support the Paul V. Loiselle Conservation Fund.

I have never sought compensation for any of my work, and when I was writing for those various aquarium magazines I was always amazed at getting paid for material I would have gladly submitted just for the joy of writing. To this end I have made available all of my books, large and small, major and minor, freely to all members of the Aquarium Hobby Historical Society of America. As Caecilus Statius (219 -168 BC) - a Roman comic poet, noted for his colorful language, linguistic effects and puns - once said, Serit arbores quae saeclo prosine alteri ("He plants trees which will yield a profit for a later age"). I hope I have planted some for the aquarium hobby.



ANCIENT EGYPTIAN FISH NAMES

by Albert J. Klee

(Aquarium Hobby Historical Society, Facebook Files, May 6, 2017)

To the ancient Egyptians, fish were inextricably connected with the Nile. It is only in two sources from the New Kingdom (18th to the 19th dynasties, 1549 to 1069 BC) that fish from other regions are recognized; the Punt reliefs from the mortuary temple of Hatshepsut at Deir el-Bahri show fish of the East African and Indian coasts and a New Kingdom text lists the names of sea fish (the former is discussed in the Addendum of this essay).

Fishing and fowling scenes illustrate the importance of fish as a source of food. This is also shown by the recorded fish names noted in Figure 1 for the payment of fish for the workers at Deir el-Medina, an ancient Egyptian village that was home to the artisans who worked on the tombs in the Valley of the Kings during the 18th to 20th dynasties of the New Kingdom. We know the hieroglyphics for the eighteen fishes shown at the top; the thirteen below them are known only from the hieratic text of this record, a sort of shorthand used for commercial purposes where the hieroglyphics would take too long to write. However, without the aid of named drawings or textual references that do more than merely record names, little can be done to identify them or other fish that are mentioned in ancient Egyptian texts.

The place of fish in mythology in ancient Egypt was limited. Certain species enjoyed cult worship and were mummified, such as *Lates niloticus* (see Figure 2) and two species (the *ỉn.t*, i.e., *Tilapia* and the *ɜbḏw*, Figures 20 and 21, respectively) were depicted in the heavenly Nile guiding the boat of the sun-god Rē barque in its hazardous journey across the sky, warning of the approach of the Apophis serpent during the underworld voyage. Figure 3 shows an antelope-headed solar barque with a fish leading Horus, who is representing the sun god, sitting on the four pillars of the Firmament. The *ʿḥɜ* fish (Figure 20) and the

Figure 1: Fish eaten by the ancient Egyptians.

ỉn.t were of particular significance, being guarantors of rebirth after death. One species (*ỉtnw*) was especially associated with the fish goddess - Hatmehit (Figure 4) - of the city of Mendes located in the eastern Nile delta.

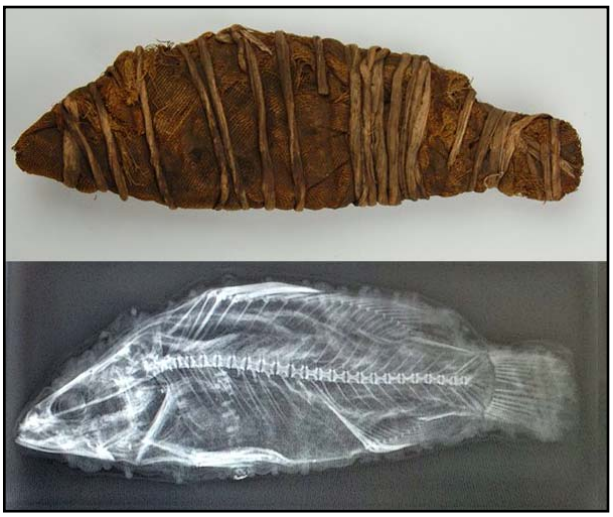


Figure 2: A *Lates Niloticus* mummified.

Figure 3: A tilapia guiding the boat of the sun-god Rē in its hazardous journey across the sky to the underworld.

Figure 4: The fish goddess, Hatmehit.

In ancient Egyptian times, there was a city located about 100 miles south-southwest of Cairo, Per-Medjed (later renamed Oxyrhynchus or "sharp-nosed"), named after the medjed, a species of elephant fish of the Nile River worshipped there as the fish that ate the penis of Osiris (Figures 5 and 6 bottom).

Another city in which a fish was worshipped was "Latopolis" (a city about 34 miles south of Luxor). It was named Latos. The fish actually was the Nile perch, *Lates niloticus*, the largest of the 52 species that inhabit the Nile and abundant in these stretches of the river in ancient times (Figures 5 and 6 top). It appears in sculptures among the symbols of the goddess Neith, associated by the ancient Greeks as Pallas-Athene, surrounded by the oval shield or ring indicative of royalty or divinity. West of the town is a Ptolemaic-Roman cemetery containing great numbers of *Lates niloticus*, mummified either by nature or by art. Cemeteries of the same fish, unassociated with human remains and dating from times at

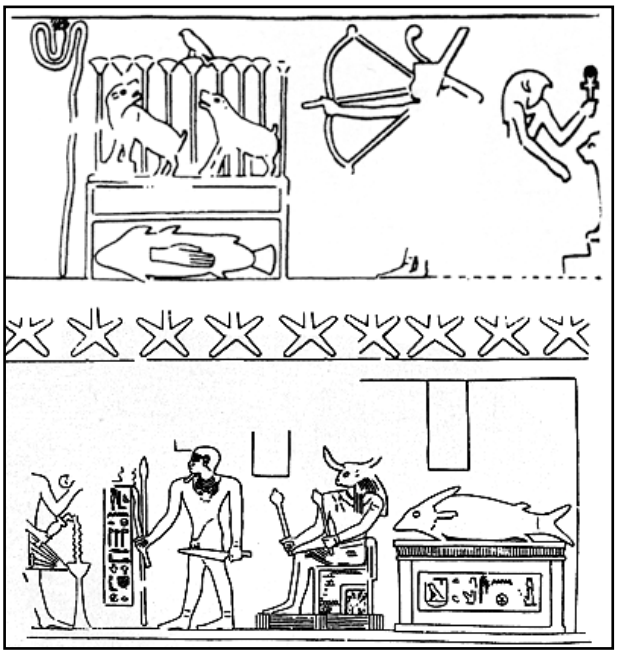


Figure 5: From the Temple of Hibis. Top: Latos. Bottom: Oxyrhynchos.

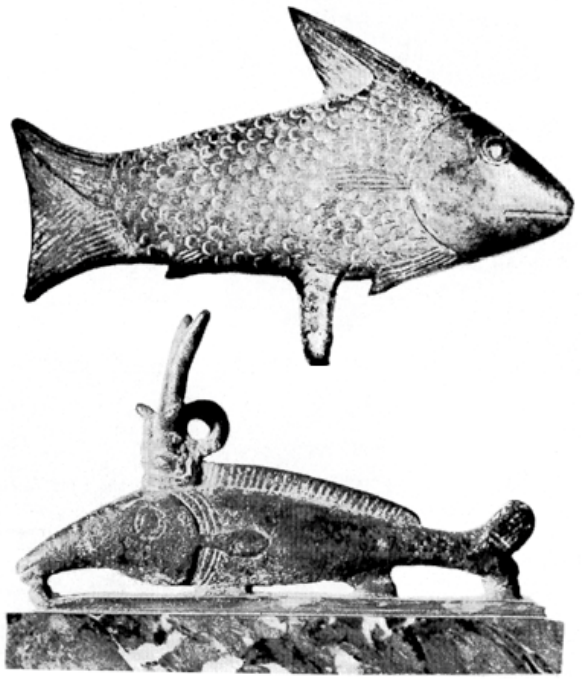


Figure 6: Top: Latos. Bottom: Oxyrhynchus.

least as remote as the 18th or 19th dynasties, have been found elsewhere in Egypt. Oddly enough though, the fish worshiped at Latopolis does not appear portrayed among the symbolic figures that adorn the walls of it temples.

The Temple of Esna in Latopolis conveys a sense of the importance which the Ancient Egyptians placed upon their places of worship. All Egyptians who entered the confines of an Egyptian temple were required to comply with the strict rules regarding ritual purity. According to inscriptions carved on the walls of the Temple of Esna, those who entered this temple were expected to fastidiously cut their fingernails and toenails, remove other body hair, wash their hands with natron (a natural occurring salt), be dressed in linen (they were forbidden from wearing wool), and not to have had sexual intercourse for several days.

Although it is unlikely that the ancient Egyptians were fully aware of all the particular tilapia traits, without doubt the species of Egyptian *Tilapia* were then as now famous for an unusual form of rearing its young where the female tilapia carries her young in her mouth after hatching, thus sheltering them from harm. While more understood as a regenerative power, this unusual trait led Egyptians to exaggerate aspects of tilapia fertility, imagining this as a powerful rebirth tropism, a biological phenomenon indicating the growth of an organism in response to an environmental stimulus.

Like modern fish aquaculture, Egyptians also farmed tilapia in closed ponds along the Nile, and this fish had its own special hieroglyph character, *ỉn.t*, in texts. *Tilapia* were often found in tombs as offerings to the deceased (Figure 7) and its image was also worn as an amulet or on necklaces, not only on pregnant women, but later also sewn into shrouds for the afterlife.

It is possible that tilapia were connected with Bastet, originally a lioness warrior goddess of the sun throughout most of ancient Egyptian history,

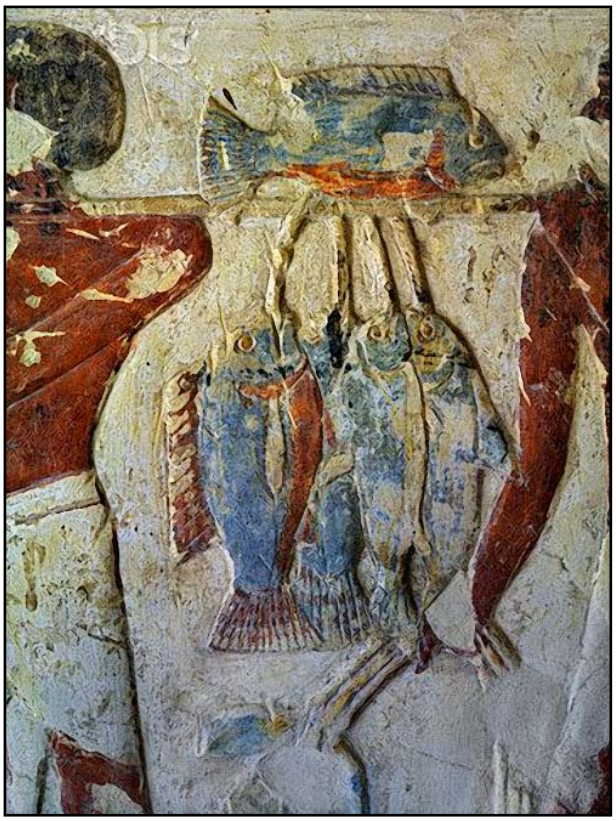


Figure 7. Tilapia being carried to a tomb as an offering to the deceased.

but later changed into the cat goddess that is familiar today. The wooden object A in Figure 8 found in the tomb of *Ḥ^{c}bḫnt* in Deir el-Medina could point to such a relation. On its top point, where one would expect a sacred animal or a divine symbol as in the well-known images B and C, are a quadruped and a fish. The relatively high trunk, the long red dorsal and the tail fin that terminates in a nearly straight edge, argues against identifications with *Barbus bynni* or *Lates niloticus* proposed by some, but rather clearly for a tilapia. The attitude of the animal and the position of its ears as well as its overall formation show clear characteristics of a cat. Although a clarifying inscription does not exist, one can scarcely fail to see that we are looking at the two animals sanctified, and to which the owner of the tomb saw himself especially connected for some reason.

In an article titled "The Fishes and Fishponds of Ancient Egypt" (Klee, 2016), I described how the Egyptians kept fish in ornamental ponds in their gardens, using the tombs of Rekhmire and Nebamun to illustrate their usage in this regard. More to the point of this essay, however, in another article titled "Our First Aquarium Cichlid" (Klee, 2005), I showed that the title fish in question was most likely *Tilapia nilotica* or *Tilapia galilaea*, based upon the bones of fish species from excavations in Egypt (Boessneck, 1988). These were archeological investigations related to cultural studies that, in contrast to the antiquarianism of classical archaeology, were concerned with the explanation of cultural processes such as foods eaten and animals domesticated or farmed. The number of species so found using this approach totaled forty four.

The problem with this type of analysis is that an examination of bones by themselves does not provide the Egyptian names of these species, since these are available only from their hieroglyphs and written language. An exhaustive treatise on fish in ancient Egypt (Gamer-Wallert, 1970) included a lexicographical study of some 70 individual fish names. Also, fifteen names that have recently come to light should be added to Gamer-Wallert's work, making a total of 85 species, more than twice identified from the excavations. However, unless a hieroglyph shows a drawing and a name associated with it, we have no idea of what fish is meant by the Egyptian name alone.

HOW THE EGYPTIANS CLASSIFIED ANIMALS

Research since the 1950s into folk biosystematics (i.e., prescientific man's classification of his biological universe), has indicated a considerable degree of consistency in the ways in which societies categorize the animals with which they are familiar.

The most inclusive category, which corresponds to the English word "animal," is seldom named in pre-scientific classificatory systems, even if the category is perceived, i.e., there may be no single term for plant or animal in a language, although plants and animals are never confused. The next most inclusive categories are almost always named. These life form groups are mammal, bird, fish, reptile and insect.

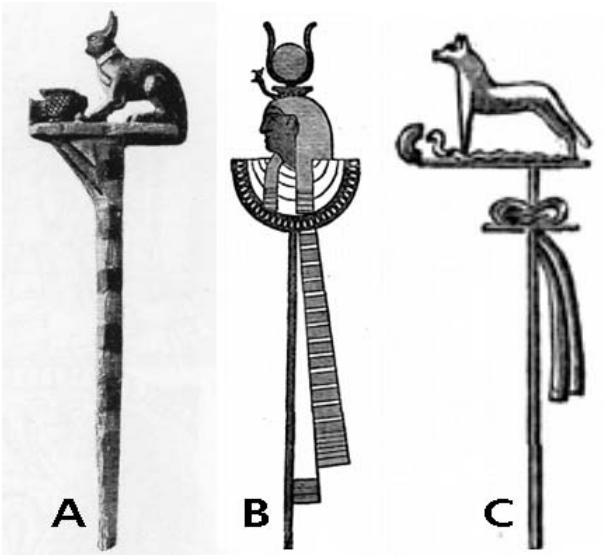


Figure 8: A is the wooden standard found in the tomb of *Ḥ^{c}bḫnt* in Deir el-Medina. For comparison, B and C are typical standards.

Work done on these life form terms suggests that these categories are universally recognized, although not all need be named. The life form classes most commonly named are those focusing on birds, fish and snakes. The next most commonly named class focuses largely, but seldom exclusively, on insects (it may comprise, however, other small creatures such as worms or frogs). The mammal class is encoded last of all, probably because of the greater visibility and (economic) importance of mammals to man; the distinction horse/pig may be as significant to man as fish/bird.

No work has been carried out previously on zoological classifications in ancient languages, though various studies of animal names in Greek, Latin, Akkadian and Hebrew do exist. Despite the disadvantages of using a "dead" language as a data base (there can be no truly objective way of checking evidence, which in itself is distorted by chance of survival) it is of interest to see how closely the ancient material corroborates the modern.

The Egyptians employed a system of five-fold classification, i.e. man, mammal, bird, fish and snake to categorize all living things. The divisions perceived by the Ancient Egyptians within the animal kingdom, might be expressed as follows:

(a) Things which walk (mammals, not including mankind and sometimes excluding cattle);
(b) Things which fly (birds; also bats and certain insects);
(c) Things which swim (fish; also crocodiles, turtles, hippos);
(d) Things which crawl (snakes; also scorpions, lizards).

RECENT RESEARCH INTO ANCIENT EGYPTIAN FISH NAMES

Ingrid Gamer-Wallert is a German Egyptologist who, in 1962, received her doctorate at the University of Munich with a dissertation on the palm trees in Ancient Egypt. In 1962/63 she received a travel scholarship from the *German Archaeological Institute*. She did post-doctoral research in 1968 at the University of Tübingen, writing "Fishes and Fish cultures in Ancient Egypt." Afterwards, she worked at the *Tübingen Atlas of the Near East* (an epochal bilingual German/English collection of geographical and historical maps and scholarly publications on the Middle East), and for many years served as its second spokesperson. She taught as a Professor of Egyptology at the *Egyptian Institute* of the University of Tübingen and from 1990 to 1994 she was its vice-president. Among other things, she was involved in many excavations in Egypt.

Her exhaustive treatise on fish in ancient Egypt (Gamer-Wallert, 1970) included a lexicographical study of some 70 individual fish names and this essay will use this work as a starting point. Figures 10A and 10B from the tombs of *Ṯy* and *Mrrwkꜣ* in Saqqara, show two drawings of fishes in a net below their fishing boats. The 56 numbered fish images are identified (see the bottom of Figure 10B. An additional 32 species included as known to the Ancient Egyptians according to Gamer-Wallert are shown in Figure 11.

THE DIFFICULTIES IN TRANSLATING EGYPTIAN ANIMAL NAMES

Egypt provides unique evidence on the existence and naming of an ancient fauna. Reliefs and paintings, especially those of the Old (3rd to the 6th dynasties, 2686 to 2181 BC) and Middle (11th to the 12th dynasties, 2134 to 1069 BC) King-

Figure 9: Egyptian fish pendant, Middle Kingdom, circa 1878-1640 BC.

doms, illustrate a diverse mammal, fish and avifauna. The hieroglyphic script itself, representing a number of basic sounds with the figures of animals, provides an insight into the importance of the animal world for the ancient Egyptians not offered by other languages.

The use of an ancient language as the basis for any study entails specific problems. Texts (for Egypt there are two: hieratic and demotic) are inevitably limited in number and can be preserved from sometimes widely differing dates and provenances. Dialectal variations may be

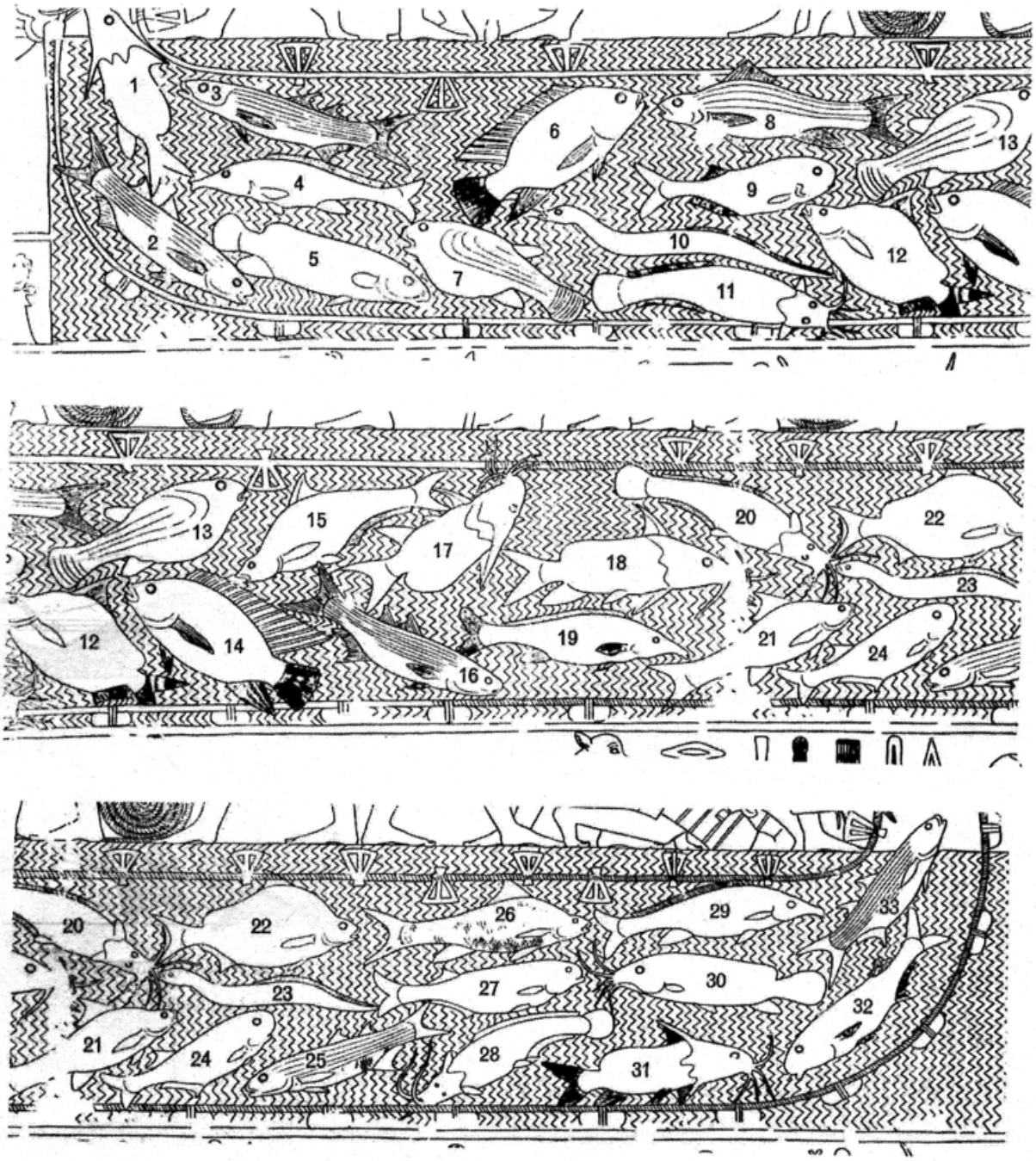
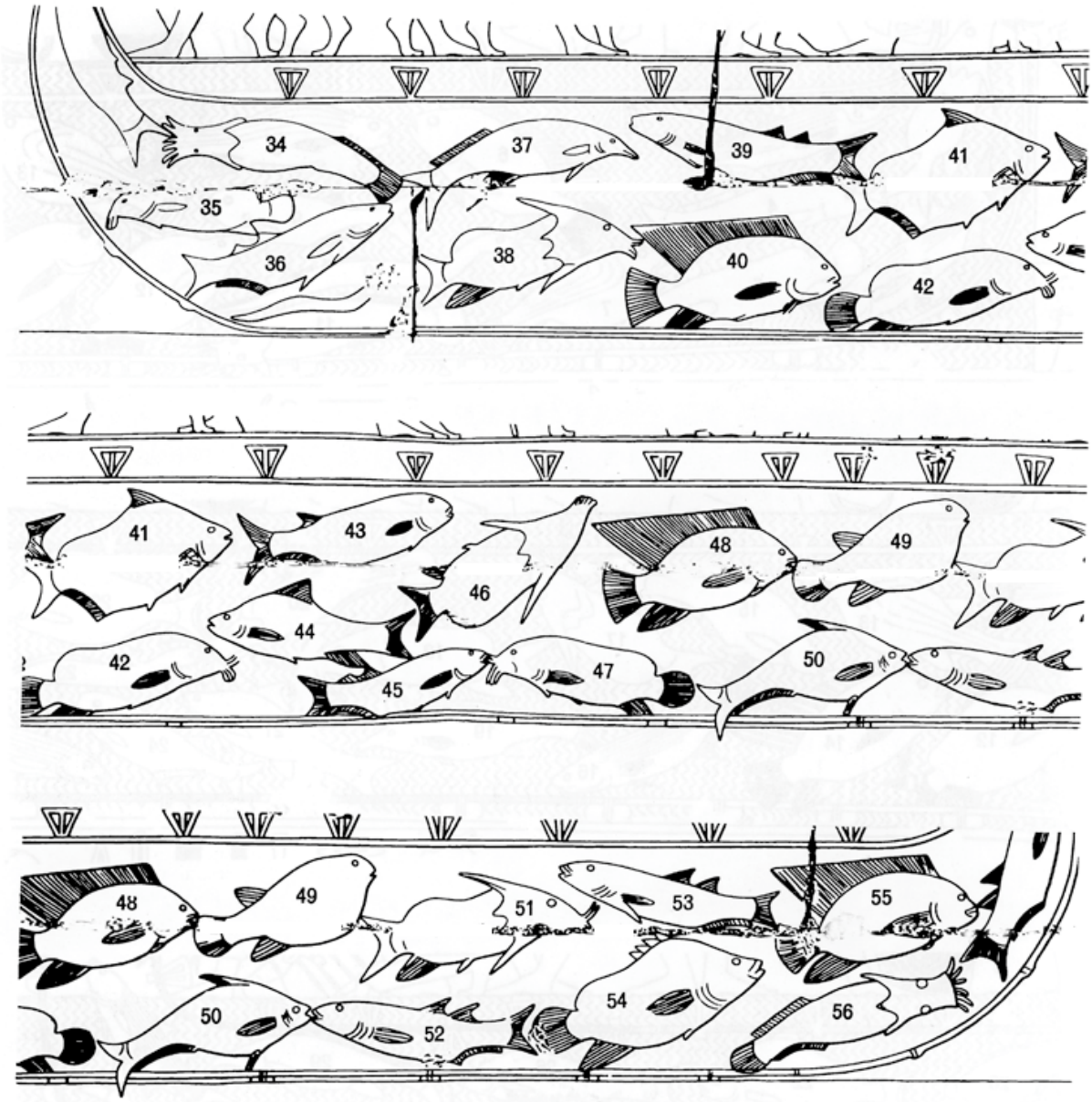


FIGURE 10A: FROM A TOMB IN SAQQARA, FIFTH CENTURY: CATCHING FISH WITH A NET. THE KEY TO THE NUMBERS IS ON FIGURE 18B.



1. Synodontis schall
2. Mugil
3. Mugil
4. Mormyrus caschive
5. Malopterus electricus
6. Tilapia
7. Tetrodon lineatus
8. Labeo vulgaris
9. Petrocephalus bovei
10. Anguilla anguilla
11. Clarias anguillaris
12. Citharinus
13. Tetrodon lineatus
14. Tilapia
15. Schilbe mystus
16. Mugil
17. Synodontis batensoda
18. Synodontis schall
19. Mormyrus caschive
20. Clarias gariepinus
21. Labeo vulgaris (?)
22. Citharinus
23. Anguilla vulgaris
24. Petrocephalus bane
25. Mugil
26. Labeo vulgaris (?)
27. Gnathonemus cyprinoides
28. Clarias gariepinus
29. Mormyrus niloticus
30. Malopterus electricus
31. Synodontis schall
32. Gnathonemus cyprinoides
33. Mugil
34. Clarias anguillaris
35. Malopterus electricus
36. Mugil
37. Mormyrus kannume
38. Synodontis schall
39. Mugil
40. Tilapia
41. Citharinus
42. Malopterus electricus
43. Hyperopisus bebe
44. Barbus bynni
45. Mugil
46. Synodontis batensoda
47. Malopterus electricus
48. Tilapia
49. Tetrodon lineatus
50. Schilbe mystus
51. Synodontis schall
52. Mugil
53. Mugil
54. Lates niloticus
55. Tilapia
56. Clarias anguillaris

FIGURE 10B

undetectable or easily misinterpreted. A word's meaning may change dramatically over a decade, yet translations may rest on only a few records scattered over several centuries. Deduced meanings cannot be checked by asking native speakers.

The search for translations of animal names in the face of these difficulties has often led to the comparison of Egyptian words with those of other languages, notably the Semitic ones, Coptic and, via Coptic, Greek and Arabic. One should be aware of the dangers of being influenced by one's

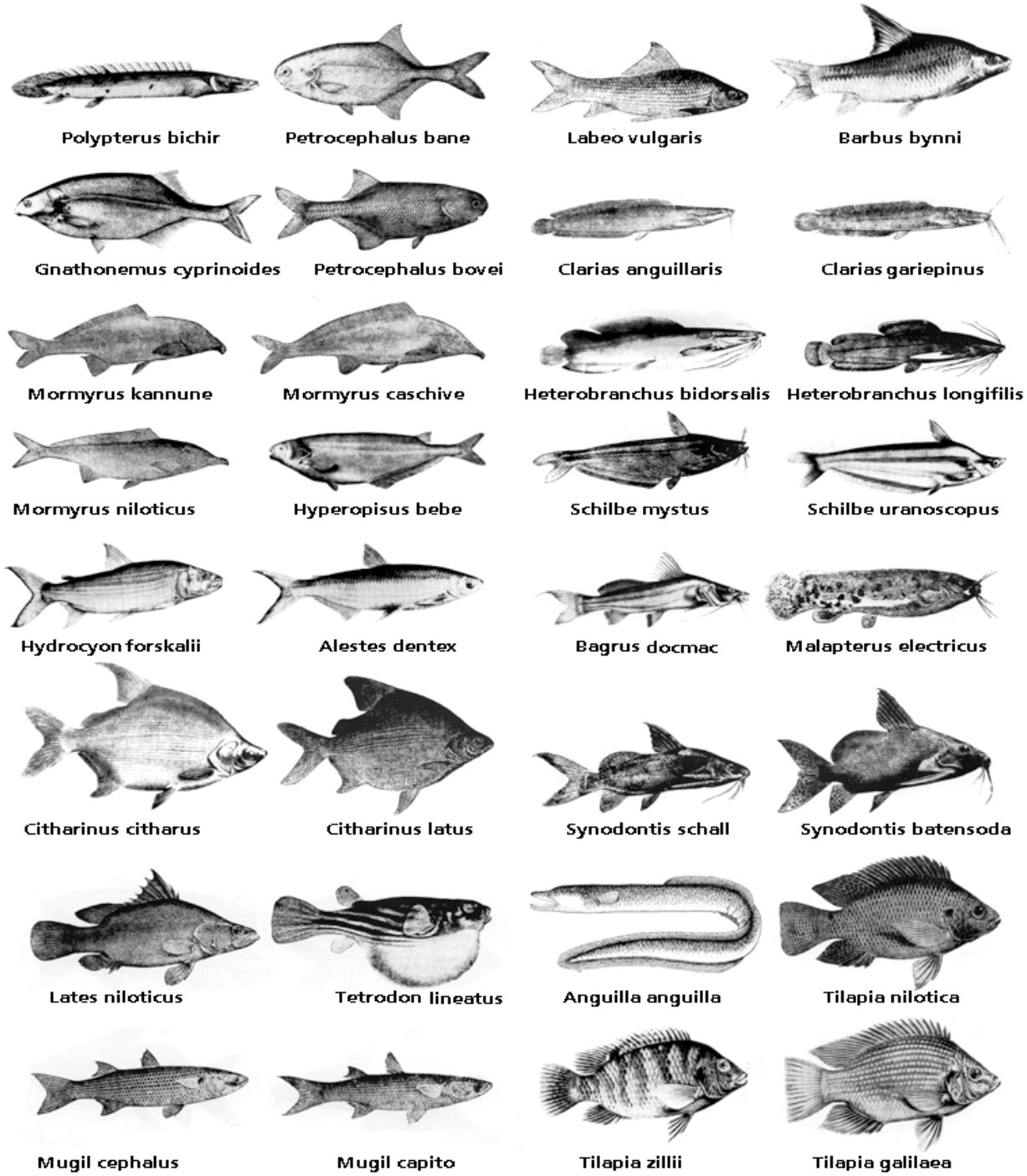


FIGURE 11

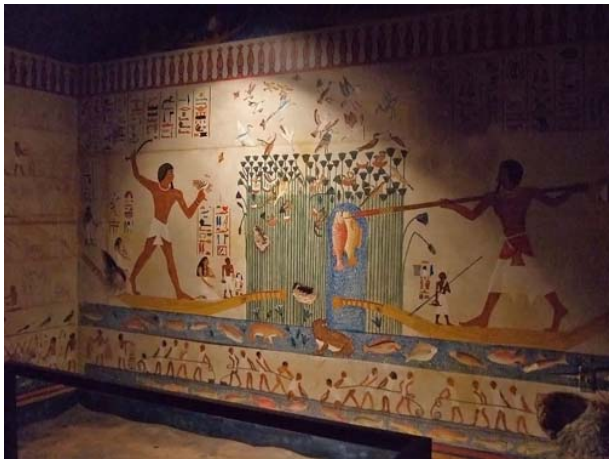


Figure 12: Examples of paintings at Beni Hasan, an Ancient Egyptian cemetery site located approximately 12 miles to the south of modern-day Minya in the region known as Middle Egypt, showing birds and fishes not depicted or named elsewhere.

own culture when attempting translations and the same can be said of the influences of other - even ancient - cultures. The relationship between these languages is extremely complex (and inadequately researched) and simple comparisons do not take into account these complexities, although they may be of some use when all other evidence is lacking.

There is a certain element of chance at work in the preservation of records in any ancient language. Egyptian literature of a religious nature far outweighs other texts surviving from ancient times, and! this will inevitably have restricted the type and number of animal names to have been preserved. Many fish names must have been used which are not to be found in the extant texts. The highly specialized body of medical information contains many terms unknown from other sources and the same can be said of the unusual tomb paintings at Beni Hasan which show birds and fishes not depicted or named elsewhere (see Figure 12). These examples indicate that other specialized texts (had they survived) would also reveal their own specific terms. Many names are found largely, if not solely, in descriptions of kings or gods; obviously not all animals are suitable for such comparisons.

The Egyptians divided the animal kingdom into classes of beings, they did not develop the systematic analysis of the modern Linnaean classification. The animals drawn and named were those of greatest significance; for example, cattle were frequently shown and were assigned a great variety of names but the zoologically vast class of insects received little attention.

In many instances fishes were depicted accompanied by their names, though in some cases it is obvious that the wrong name has been chosen. In other cases, especially when a word is but infrequently confirmed, it can be difficult to decide whether the association of picture and name is to be trusted. In yet other cases the representation itself may be unhelpful, either because it is badly drawn by an inept artist or so stylized that the fish is unrecognizable. In general, the Egyptians did not draw animals purely out of scientific curiosity (the Beni Hasan paintings mentioned above seem to be a notable exception) and this should be borne in mind when interpreting the tomb scenes.

THE ANCIENT EGYPTIAN LANGUAGE

Ancient Egyptian literature was written in the Egyptian language from ancient Egypt's pharaonic period until the end of Roman domination. It represents the oldest body of Egyptian literature. Along with Sumerian literature, it is considered the world’s earliest.

Hieroglyphs were very time consuming to create, so the Egyptians developed a cursive script called hieratic in the early years of hieroglyphic use. The characters of the hieratic script were based on the hieroglyphic symbols, but they were simplified and little resembled their hieroglyphic origins. Hieratic was used for the bulk of writing done with reed pens and ink on papyrus. In the 7th century BC the Egyptians began using a script called demotic, which was even more simplified than hieratic. After this point hieroglyphs continued to be used in carved inscriptions on buildings, jewelry and furniture, but hieratic was used for

- **For everyday use, a script form of hieroglyphics evolved called *hieratic*.**
- *This is from a letter written about 1790 BCE.*

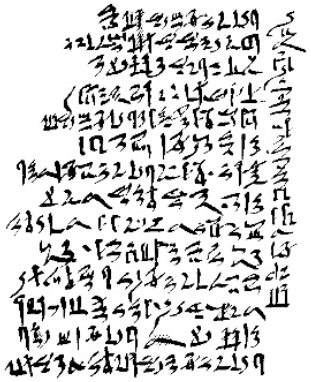


Figure 13: Hieratic Writing.

religious writings, and demotic for business and literary texts. Figure 13 shows an example of hieratic writing.

Writing in ancient Egypt - both hieroglyphic and hieratic - first appeared in the late 4th millennium BC during the late phase of pre-dynastic Egypt. By the Old Kingdom, literary works included funerary texts, epistles and letters, hymns and poems, and commemorative autobiographical texts recounting the careers of prominent administrative officials. It was not until the early Middle Kingdom that a narrative Egyptian literature was created. This was a "media revolution" that was the result of the rise of an intellectual class of scribes, new cultural sensibilities about individuality, unprecedented levels of literacy and mainstream access to written materials. However, it is possible that the overall literacy rate was less than one percent of the entire population. The creation of literature was thus an elite exercise, monopolized by a scribal class attached to government offices and the royal court of the ruling pharaoh. However, there is no full consensus among modern scholars concerning the dependence of ancient Egyptian literature on the sociopolitical order of the royal courts.

Middle Egyptian, the spoken language of the Middle Kingdom, became a classical language during the New Kingdom when the vernacular language known as Late Egyptian first appeared in writing. Scribes of the New Kingdom canonized and copied many literary texts written in Middle Egyptian, which remained the language used for oral readings of sacred hieroglyphic texts. Some genres of Middle Kingdom literature, such as "teachings" and fictional tales, remained popular in the New Kingdom, although the genre of prophetic texts was not revived until the Ptolemaic period (4th century BC to 1st century BC). Popular tales included the "Story of Sinuhe and The Eloquent Peasant," while important teaching texts included the "Instructions of Amenemhat and The Loyalist Teaching." By the New Kingdom period, the writing of commemorative graffiti on sacred temple and tomb walls flourished as a unique genre of literature, yet it employed formulaic phrases similar to other genres. The acknowledgment of rightful authorship remained important only in a few genres, while texts of the "teaching" genre were pseudonymous or falsely attributed to prominent historical figures.

Ancient Egyptian literature has been preserved on a wide variety of media. This includes papyrus scrolls and packets, limestone or ceramic ostraca (pieces of broken pottery or stone - most often limestone - used as notepads as they were a cheaper and more plentiful option than papyrus which was costly and time consuming to make), wooden writing boards, monumental stone edifices and coffins. Texts preserved and unearthed by modern archaeologists represent but a small fraction of ancient Egyptian literary material.

HIEROGLYPHICS

Hieroglyphic writing, which we find on the temple walls and in tombs, is the writing everybody "knows." It is a monumental form of writing which is engraved into stone, even if painted examples exist, notably within tombs. However, etymologically, "hieroglyph" simply means "the engraving of sacred characters."

There are three main groups of glyphs:

1. Pictograms: Stylized pictures that represent

the drawn object. For example, an image of a fish represented a fish.

2. Phonograms: Reused pictograms that represent the sound of the object originally depicted. An example in English is the verb "can" being represented by a picture of a tin can. Some phonograms represented the sound of one consonant, some two and others three.

3. Determinatives: Pictograms can convey meaning about an object, or something related to that object. For example, a pictogram of writing equipment can mean "scribe," "writing" or "to write." To clarify which of these is meant within the context of a certain passage, a determinative sign is added. In my example of writing equipment, when the word "scribe" is intended the determinative of a man is placed after the original pictogram. When "writing" or "to write" is meant, a determinative of a papyrus scroll is added instead. Determinatives then, are the signs, which are placed after a pictogram or phonogram in order to clarify the meaning.

Here is an example of determinatives using the word freight. While the F, R and T in freight sound the normal way, the G and H are silent and the E and I make one sound (long A). There are 7 letters in the word, but only 4 sounds (F, R, long A and T) are heard. So to spell freight with hieroglyphs, you'd use the symbols for those 4 sounds shown in Line 1 in Figure 14. Four different sounds are used to say freight, so four symbols or hieroglyphs are needed to write it the Egyptian way. No more, no less.

Egyptians often used only hieroglyphs for consonant sounds to write their words. Therefore, ignoring the vowels you could now spell freight like Line 2 in Figure 14.

But that's the same way you would spell fort and ferret without vowels. So how do you know which word it's supposed to be? You would have to look at the word in the context of the rest of the sentence to figure it out. Or, you could rely on a special silent hieroglyph, i.e., a determinative.

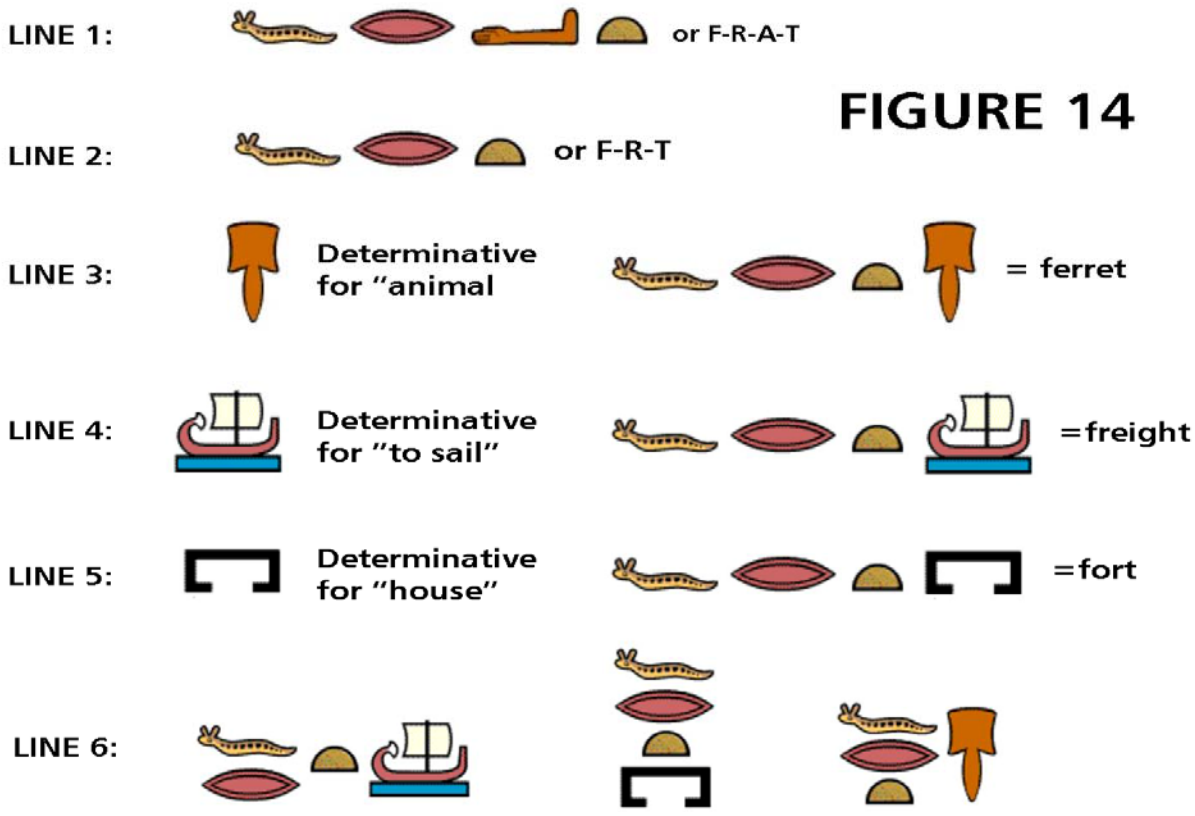


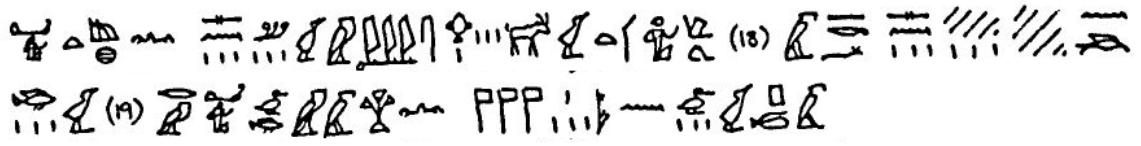
FIGURE 14

Determinatives were added at the ends of words to give the reader a hint about the general meaning. You could use these determinatives to clarify the meaning of F-R-T as shown in Lines 3, 4 and 5 of Figure 14.

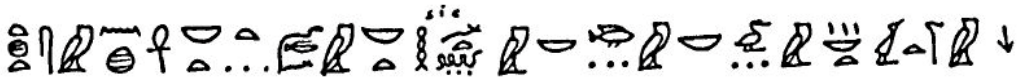
The three components are not found in every word. There are words which are reduced to a pictogram or which are only composed of phonograms. On the other hand, a determinative never exists by itself. They are only written with phonograms. Determinatives are not usually a factor in fish names since they usually have a pictogram to indicate that a fish is meant.

Hieroglyphs could be arranged in both columns and rows, and the direction in which they were read depended upon how they were rendered. This flexible writing system allowed the ancient Egyptians to effortlessly integrate writing with art. In fact, the boundary between art and hieroglyphs appears non-existent!

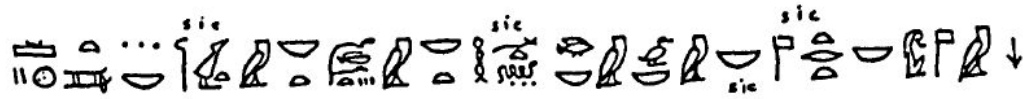
Although the task of reading hieroglyphs from the right direction may seem daunting at first, there is a simple trick that will allow you to easily identify the correct direction from which to begin. Find a figure with a head and start reading toward the front of its head. As you can see, when the figure is facing to the left, begin reading from the left, toward the face on the right. If they are facing to the right, begin from the right and toward the face. An example is Figure 15, which shows three selections mentioning fish from "The Book of the



"I have not driven small cattle from their herbage. I have not snared birds for the gods' harpoon tips. I have not caught fish of therir (lagoons)."



"But every creature likewise that shall die, the whole of them together - even all quadrupeds, all fowl, all fish, all snakes, all worms - living or dead - they are yonder, having passed on, after all the worms have finished (their work)."



"The deceased rots when he has gone to the Shu, as do gods, goddesses, all fowl, all fish, all snakes, all worms, all quadrupeds, the whole of them together."

"The deceased rots when he has gone to the Shu, as do gods, goddesses, all fowl, all fish, all snakes, all worms, all quadrupeds, the whole of them together."

Figure 15: Examples of hieroglyphics mentioning fish from The Book of the Dead," an ancient Egyptian funerary text.

Dead," an ancient Egyptian funerary text, used from the beginning of the New Kingdom to around 50 BC. It was written by many priests over a period of about 1000 years and consisted of a number of magic spells intended to assist a dead person's journey through the Duat, or underworld, and into the afterlife.

Another feature of the Egyptian writing system that you might have noticed is "group writing." Rather than placing hieroglyphs side-by-side, they were arranged in order to reduce empty space: taller signs stand alone, while smaller signs are stacked on top of each other. For example, Line 6 of Figure 14 shows three ways freight, fort and ferret could have been written.

TRANSLITERATION AND THE ALPHABET

Although we have the glyphs that provide us with the pronunciation of the name of the fish (and hence its name), this is not particularly useful since what is needed is a process that facilitates the publication of texts where the inclusion of photographs or drawings of an actual Egyptian document is impractical. The three writing systems, hieroglyphs, hieratic and demotic, while very decorative, are difficult to represent on an internet page and are not very useful to the ordinary reader. Thus we want to convert the glyphs into alphabetical symbols that can be understood and written, either by hand or by using a font. The problem is that although we have the pronunciation glyphs, we do not know how they were pronounced and there are no ancient Egyptians around to help us.

In the field of Egyptology, transliteration is the process of converting (or mapping) texts written in the Egyptian language to alphabetic symbols representing uniliteral hieroglyphs or their hieratic or Demotic counterparts. This process facilitates the publication of texts where the inclusion of photographs or drawings of an actual Egyptian document is impractical. The symbols in the alphabet are called "uniliterals," because they can be represented by a single symbol. There are also biliterals and triliterals, which are represented by two and three symbols, respectively. Figure 17 shows the Egyptian alphabet with its unilateral hieroglyphs and a description of each glyph with its transcription and pronunciation.

It should be emphasized that transliteration is not the same as transcription. Transcription seeks to reproduce the pronunciation of a text. For example, the name of the founder of the Twenty-second dynasty is transliterated as šš*nḳ* but is transcribed Shoshenq in English, Chéchanq in French and Scheschonq in German. Due to the exact details regarding the phonetics of ancient Egyptian not being completely known, most transcriptions depend on Coptic for reconstruction or are theoretical in nature. Egyptologists, therefore, rely on transliteration in scientific publications. Also, the three writing systems, hieroglyphs, hieratic and demotic, while very decorative, are difficult to represent on an internet page and are not very useful to the ordinary reader.

Transliteration gives the reader some idea of how the words may have been pronounced, but nobody really knows how ancient Egyptian, in any of its historical versions, sounded. One of the difficulties is the complete absence of the representation of vowel sounds in the hieroglyphic, hieratic or demotic system. This has resulted in a plethora of ways of how to transcribe Egyptian texts. The god Amen for instance is also represented as Ammon, Amon, Amun, Imen etc. If there are no historical clues, "e" is used as default vowel.

As important as transliteration is to the field of Egyptology, there is no one standard scheme in use for hieroglyphic, hieratic and demotic texts.

Figure 16: An Egyptian Oxyrhynchus amulet, Late New Kingdom, circa 1150-350 BC.

FIGURE 17: THE ALPHABET

HEIROGLYPH	DESCRIPTION	TRANSCRIPTION	PRONUNCIATION
	Vulture	$\mathit{ɜ}$	like "ah" as in "yacht"
	Reed leaf	i	like "ee" as in "feet"
	Double reed leaf	y	like "ee" as in "feet"
	Arm	$\mathit{ɛ}$	like "ah" as in "yacht"
	Quail chick, rope curl	w	line"oo" as in "blue"
	Foot	b	like "b" as in "bed"
	Stool	p	like "p" as in "pet"
	Horned viper	f	like "f" as in "fish"
	Owl	m	like "m" as in "map"
	Water. red crown	n	like "n" as in "neat"
	Mouth	r	like "r" as in "ready"
	House plan	h	like "h" as in "hat"
	Rope	$\mathit{ḥ}$	like "h" as in "hat"
	Unknown	$\mathit{ḫ}$	like "kh" as in "Bach"
	Animal belly and tail	$\mathit{ẖ}$	like kyah" similar to the preceeding sound
	Door bolt	z	like "s" as in "sand"
	Folded cloth	s	like "s" as in "sand"
	Pool	$\mathit{š}$	like "sh" as in "fish"
	Hill	q	like "k" as in "kite"
	Basket with handle	k	like "k" as in "kite"
	Stand for vessel	g	like "g" as in "girl"
	Bread Loaf	t	like "t" as in "tape"
	Tethering rope	$\mathit{ṯ}$	like "tch" as in "chart"
	Hand	d	like "d" as in"dead"
	Cobra	$\mathit{ḏ}$	like "dj" as in sledge"

Some might even argue that there are as many systems of transliteration as there are Egyptologists. However, there are a few closely related systems that can be regarded as conventional. Many non-German-speaking Egyptologists use the system described by Egyptologist Sir Alan Gardiner in 1954, whereas many German-speaking scholars tend to opt for that used in the *Wörterbuch der Ägyptischen Sprache* (Erman and Grapow 1926–1961), the standard dictionary of the ancient Egyptian language. In the scheme introduced by Jan Buurman et al. in 1988, known (in shortened form) as the *Manuel de Codage*, all transliteration characters are taken directly from the English alphabet. However, there is a growing trend, even among English-speaking scholars, to adopt a modified version of the method used in the *Wörterbuch* and this is what I use in this essay. A comparison of the *Wörterbuch* with the *Manuel de Codage* is shown in Figure 18.

A DICTIONARY OF THE EGYPTIAN LANGUAGE

The *Wörterbuch der Ägyptischen Sprache* (*Dictionary of the Egyptian Language*), abbreviated Wb in bibliographic references, is a large German-language dictionary of the Egyptian language published between 1926 and 1961 by Adolf Erman and Hermann Grapow. It is a comprehensive work encompassing 3000 years of linguistic history, including Old, Middle and Late Egyptian as well as hieroglyphic inscriptions of the Classical Greco-Roman period. The dictionary contains approximately 16,000 headwords in five main volumes, two secondary volumes, and five volumes of primary source references. It is therefore the largest and most complete printed dictionary of Ancient Egyptian in existence.

Begun in 1897 as a research project at the Prussian Academy of Sciences in Berlin, the dictionary is also known as the "Berlin Dictionary." Interrupted by both World Wars I and II, the first volumes were published in 1926 and the final volume released in 1961. An example of a page from the Dictionary is shown in Figure 19. The first column contains the transliterated name of the entity. The left-hand hieroglyphic column contains the usual orthography of the word, which is usually also the phonetically correct and the old form. The right-hand hieroglyphic column presents important deviations. In the middle column, the occurrences, meanings, etc., of each word is mentioned. The selection outlined in red shows the transliterated name as *rꜣ-ḏꜣ* and the German text in English is "A type of fish (noted as forbidden food in several regions)."

It will be noted that the fish pictogram differs between the first and second hieroglyphic columns. As I mentioned previously, the ancient Egyptians integrated writing with art so at times, a pictogram might vary in design for the same fish. It also should be noted that the *ꜣ* and *š* in the *Wörterbuch* are often written as two half-circles in the former and a caret or a short vertical line over the s in the latter.

CURRENT PROBLEMS IN IDENTIFICATION

Note: In this section after their Egyptian names I have placed in square brackets the volume of the *Wörterbuch* and the page number on which the fish name is to be found. Also, in Figures 20 and 21 I have shown a number of the entries from the *Wörterbuch* for many of the fish names that are discussed in this section.)

Only a few of the fish names preserved from ancient Egypt are readily translatable (see Figure 20), though even in these cases it is usually not possible

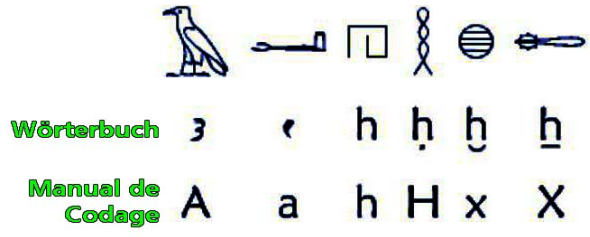


Figure 18: A comparison of the Wörterbuch with the Manual de Codage symbols.

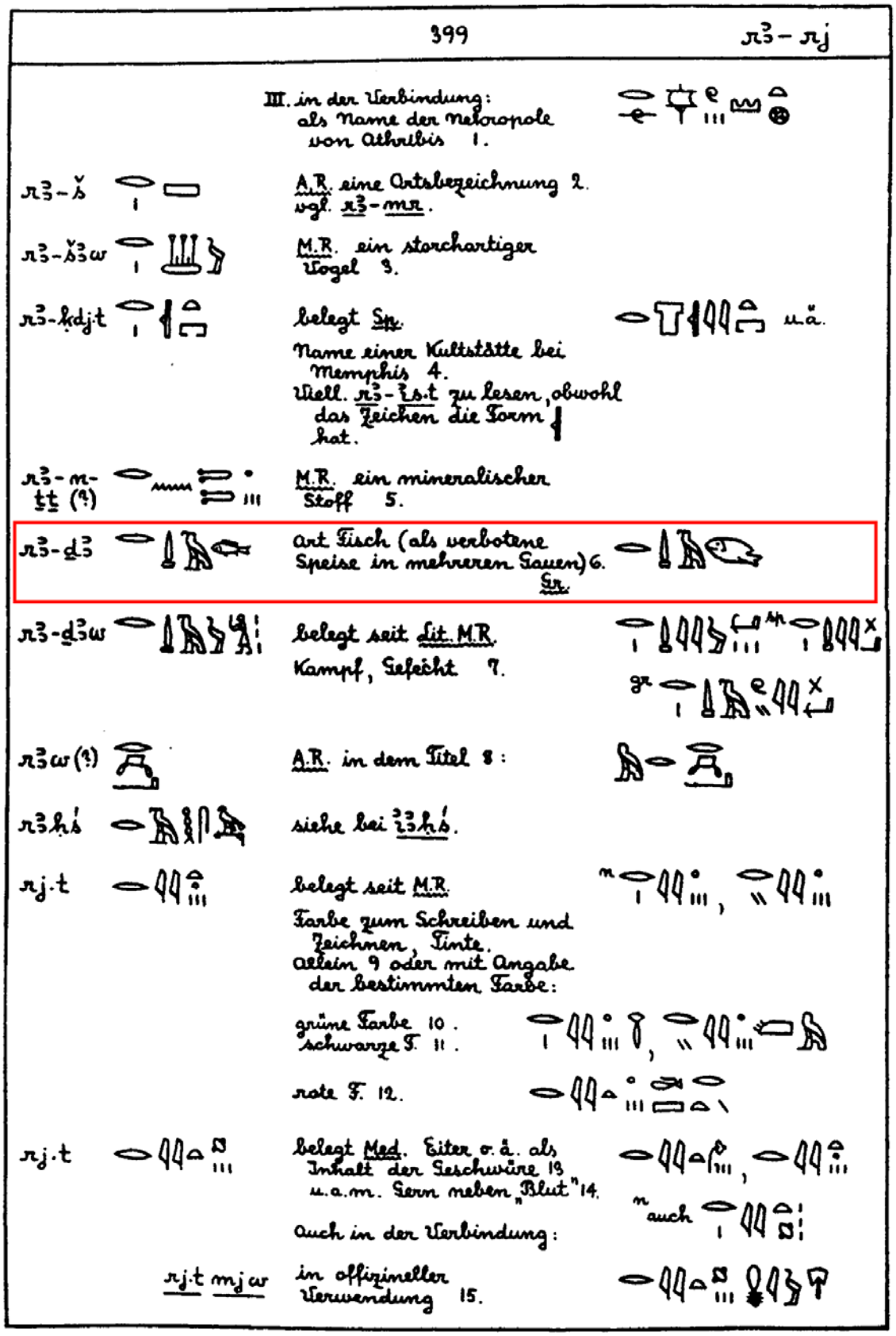


Figure 19: A page from the Wörterbuch.

to identify down to the species level. These include the Nile Perch, *Lates niloticus,ʿḥɜ* [Wb I, 217]; *Clarias* sp., *nʿr* [Wb II, 209]; *Synodontis* sp., *whʿ* [Wb I, 350] var. *ḥwʿ*; and *Tetraodon lineatus, špt* [Wb IV, 453]. The names of these fish are found in lists of fish names and in the medical texts and occasionally elsewhere.

The Grey Mullet has been recorded as the determinative of three words - *ḥbɜ, ḥskmt,* var. *ḥỉslkt,* a*nd bq* - as well as being used as a phonetic sign [*ʿḏ*]. (*ʿḏ* itself is confirmed as a fish name.) Two other fish were common as phonetic symbols and can been identified from the hieroglyphs as members of the genus *Sarotherodon* or *Tilapia,* and *Mormyrus*; these are *ỉn.t* [Wb I, 92] and *ḫɜt* [Wb II, 359] respectively.

Three further fish names were identified by Gamer-Wallert as designating members of the genus "*Tilapia*" (*Sarotherodon/Tilapia*); these are *wḏj* [WB I, 399], also written *wɜḏ* [WB I, 268], *dšrw* [Wb V, 492] and *ỉmskɜ* [WB I, 88].

Both *wɜḏ* and *dšrw* are mentioned together with another fish, *ɜbḏw* [Wb I, 8] in place of its usual companion the *ỉn.t,* and it has been suggested from this that the three terms were synonymous. *Wḏ* appears also in a hymn to Ramesses VI and in association with the baboon. *Dšr* occurs in association with Horus.

A fish named *w3ḏ-nfr* is depicted on an ostracon from Deir el-Medina; only the hind part remains, and shows a tail fin shaped like those of the *Sarotherodon/Tilapia* genera. It was this, together with the pattern on the tail, which prompted Gamer-Wallert to regard *wɜd* as synonymous with *ỉn.t*. The *wɜd* is elsewhere described as being red, though its name suggests that it was green. That a "green" fish should be described as red would, according to Gamer-Wallert, suit the shimmering colors of *Tilapia.* Keimer (1938) also believed this to be the case, noting the variety of the color of the stones on which figures of *Tilapia* were made. However, both *ỉn.t* and *w3ḏ* appear together in another text, which suggests that the words denoted separate species (or at least different types). In any case an early text gives *wɜd* a different determinative from *ỉn.t*. *ʿImskɜ* appears in parallel with *wɜd* and *ỉn.t* and cannot, therefore, be entirely synonymous with these.

Despite being depicted mummified in the tomb of Khabekhnet (Theban Tomb No.26, Figure 22) *ɜbḏw* has resisted identification. It is partly obscured in the tomb scene by the figure of Anubis who is attending to its mummification; only the tips of the dorsal and anal fins and its tail are visible. It is described in the accompanying text as

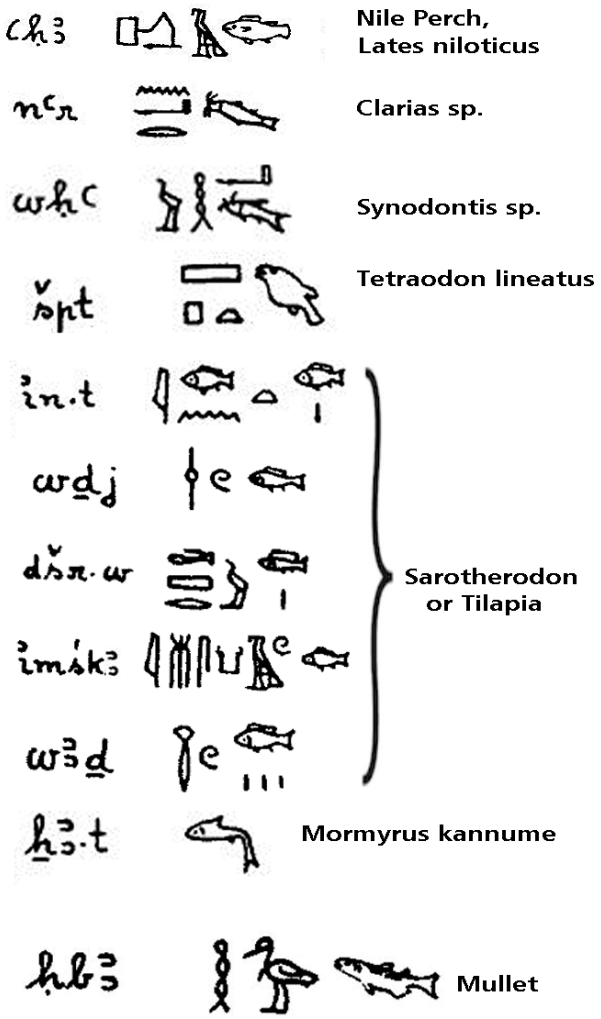


FIGURE 20

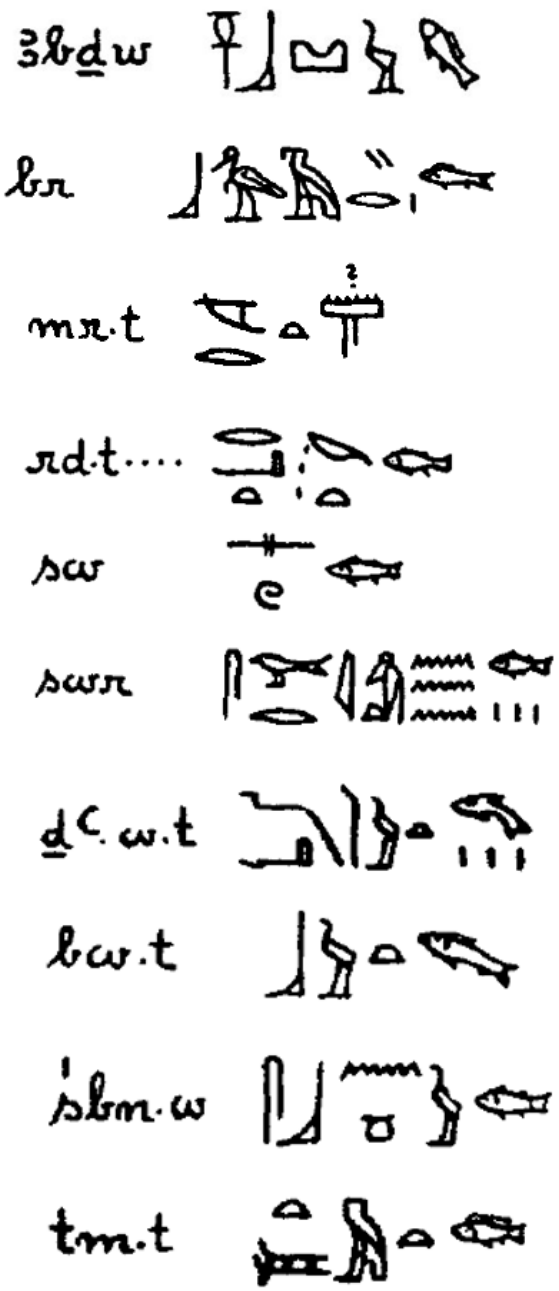


FIGURE 21

the "*ꜣbḏw* of lapis lazuli"; elsewhere "*ꜣbḏw* of gold" is a more common descriptive name.

The original translation of *ꜣbḏw* from a comparison with the Coptic and Arabic terms for "turtle." Many texts, however, mention the *ꜣbḏw* (alone or with the *ỉn.t, dšr* or *wꜣḏ*) as accompanying the bark of Rē, and representations of this scene show two types of fish guiding the boat. In scenes showing the deceased tomb owner spearing fish the *ỉn.t* fish is accompanied by the Nile Perch, *Lates niloticus,* but the name of this fish is *ʿḥꜣ,* and it clearly differs from the *ꜣbḏw* of Khabekhnet and the second fish of the solar bark drawings in having a rounded rather than a slightly indented tail.

The problem of the identification of *ꜣbḏw* was addressed at some length by Gamer-Wallert who rejected various species as being different in some degree from that fish as depicted: *Labeo niloticus, Barbus bynni, Schilbe mystus, Polypterus bichir* (a suggestion of Ebers, 1889), *Lates niloticus, Petrocephalus sp*. (because of the characteristic lip of this fish), *Mugil sp*. (though this remains a possibility). This difficulty in identifying the *ꜣbḏw* with any known species has led to the suggestion that the *ꜣbḏw* was a purely mythical beast. It was closely associated with Rē, Amun (because of this it has been identified as an eel), Horus and other deities and is found in magical texts. Nevertheless it also appears in a number of rational texts - on ostraca and on weights. A further text states that this fish should not be eaten on certain festival days, and it was used in medicine, as well as in magico-medical remedies. *ꜣbḏw,* therefore, evidently denotes a real fish.

As mentioned above, the mullet has been named as the fish which determines the words *ḥbꜣ,*

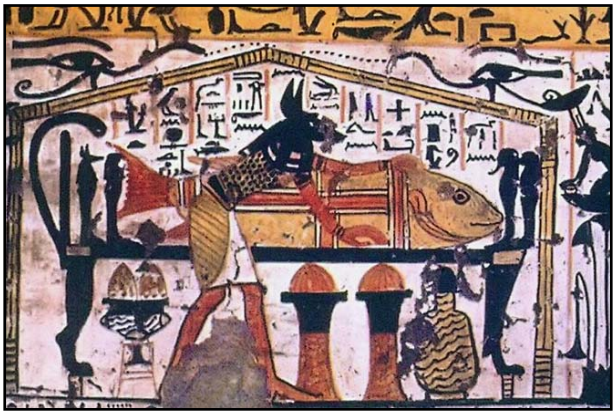


Figure 22: Wall painting of a mummy depicted as the fish, *ꜣbḏw*, Tomb of Khabekhnet, Deir El Medina, Western Thebes.

ḥskmt, a*nd bg* and writes the phonetic group *ʿḏ*. Another fish, *br* [Wb I, 465], has also been identified as this fish by comparing the Coptic and Arabic terms for "mullet." As one text records *br* as a marine fish, this may be possible. (Likewise the New Kingdom term *sɜr*, (cf. Arabic *šɜl*, *Synodontis schall*) was held to denote the fish originally called *whʿ*.)

This profusion of terms apparently denoting the same fish has received considerable discussion. Edel (1961, 1963) presumed that, in the Old Kingdom, *ʿḏw* was a generic term for mullet, with *bg, ḥbɜ* and *ḥskmt* denoting the three species *M. cephalua, M. capito* (now *Liza ramada*) and *M. auratus*. In the Middle and New Kingdoms, he believed *ʿḏ* was the only definite term for the genus *Mugil* (the terms *ḥbɜ* and *ḥskmt* are found only in the Old Kingdom), though he presumed that *br* was a "spezielle Bezeichnung" for a type of mullet. This opinion was also accepted by Gamer-Wallert.

In two New Kingdom Texts both *br* and *bg* appear together in addition to the *ʿḏ* and would, therefore, seem to denote different types of fish (cf. *ỉn.t, wɜḏ* and *ỉmskɜ* above). Whether they denoted different genera, species or subspecies is difficult to say. The deduction of the meaning of *br* via Coptic and Arabic is by no means a certainty, and *bg* written in an Old Kingdom relief showing a market scene may not refer to the fish (a mullet) being handled. It is not impossible that *ʿḏ* designated both the genus and the most abundant (typical) species as is the case in other languages. If the three words did all refer to the same species this would constitute a rare case of "overdifferentiation" (a phenomenon described by anthropologists from modern primitive languages in which animal categories are subdivided further than the species in Linnaean classification) in the ancient Egyptian zoological nomenclature, paralleled by the earlier examples of *ʿḏ, ḥbɜ* and *ḥskmt*. This practice was recognized by Keimer (1938) in modern Arabic, in which he noted different words for fish which had spawned and those which had not, for larger and smaller fish, and for males and females.

ʿỉtn is frequently found and was associated with the deity of Mendes, Hatmehit, "Foremost of Fish." The word was considered a miswriting of

Figure 23. Fishing scene, painted relief, Mastaba of Princess Idut, Old Kingdom, 6th Dynasty.

ỉn.t by Montet (1928) in a study of various texts of the Ptolemaic Period, though earlier examples are provided by the Cairo Calendar (an ancient Egyptian calendar with a 365-day year) and the Papyrus Sallier IV (a hieratic literary text in the British Museum). The term also appears in a passage relating the evil deeds of Seth and is recorded in another text among the fish of the *wꜣḏ-wr*.

The texts written on the walls of the temple of Edfu in Upper Egypt, the Cairo Calendar text and the Papyrus Sallier IV text all associate the *ỉn.t*-fish with the city of Busiris (= Mendes), and the Papyrus Sallier IV and the Calendar text mention also the deity Hatmehit. The nome sign (ancient Egypt was divided into autonomous city-states called "nomes") for the Medesian nome shows a fish which has been identified as a dolphin, and the text numbering the *ỉn.t* among the fish of the sea has been taken to support this proposal. Engelbach (1988), on the other hand, compared the fish of this sign with the fish which determines the word *bwt* and the *ḥꜣ*-fish (*Mormyrus sp.*) and concluded that the fish of Mendes was the same as that determining the word *bwt*, the fish often called "Schilbe" in Egyptological literature (probably *Schilbe mystus*. though *Eutropius niloticus* is also possible].

A further few fish names have been deduced from words which show fish determinatives, notably *bwt* [Wb I, 453] though from the texts quoted it is difficult to tell whether it was the fish and not some other taboo food which was meant; *srḳ* (not in Wb as a fish determinative); *sbnw* [Wb IV, 89] var. *bsnt* [not in Wb] and *bs* (not in Wb as a fish name).

Two words originally believed to be fish names are *pḥ* and *tmt* [Wb V, 306]. However, these should be understood as "hind-part" and "whole" respectively, and the following fish hieroglyph in the texts read *rmw* "fish." This is also the case with *pꜣḫnt*, recorded by Gamer-Wallert as the name of a fish. It appears to be a personal name with (in some cases) the "seated man" determinative not written; the fish sign following must in all cases be read *rmw*, as other examples from the ostraca show.

Finally, a number of fish names which have recently come to light should be added to Gamer-Wallert's work; most of them occur so seldom that they cannot be identified:

ỉtn [Wb I, 145]
ỉmt [not in Wb]
ỉrṯ [not in Wb]
bꜣy [not in Wb]
mrt [Wb II, 105]
rdt [Wb II, 469]
sw [Wb III, 426]
swr [Wb III, 429]
šᶜt [not in Wb]
sṯpw [not in Wb]
šdy [not in Wb]
kwỉꜣ [not in Wb]
ḏᶜwt [Wb V, 535]
sꜣ [not in Wb]
ḥꜣ [not in Wb].

Figure 24: Bowl with fish and lotuses, New Kingdom, 1450–1400 BC. Sometimes called "marsh bowls," they usually alluded to concepts of fertility via aquatic imagery.

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ADDENDUM: THE PUNT FISHES

The time to the end of the Old Kingdom must have been a period of restless observation and exploration. At that time, the essential knowledge of the morphology of a fish was acquired in Egypt. The first attempts at devising a system for classifying the rich world of fishes were made and important observations were made on the specific characteristics of the biological behavior of certain species.

Significant new ichthyological knowledge presented itself again in the 18th dynasty. Egypt was now on the way to becoming a world power and its kings pushed with their armies far over the northern and southern borders of the country. Egypt's horizon was widening, and hand-in-hand with it, a whole new interest in foreigners, their inhabitants and also their flora and fauna was awoken.

Recall the onomastics (the study of the history and origin of proper names, especially personal names) that have been written down since the Middle Kingdom, in which the "names of all things that have existed" were recorded in a kind of inventory. Thutmosis III did the same in recording the foreign plant and animal species which he had encountered in his campaigns, and which he had inscribed in the walls of Karnak. But this was not the first time in Egypt. Foreign animal species were to be seen on the Theban west bank in the terrace temple of Queen Hatshepsut, the immediate predecessor of Thutmosis III. As part of the report of her expedition to the land of Punt, this queen had her scribes record the plants and animals in relief that, unknown in the Nile, had been encountered by the Hatshepsut on her journey south: giraffes and baboons, to name but a few, and strange fishes that had not appeared in the great fish representations of the Old Kingdom.

Unfortunately, the most exact reproduction of nature had long since passed in the New King-

dom. This was true with the Punt reliefs. One cannot help getting the impression that the artist, in his endeavor to picture these new alien types for an Egyptian, was only too fond of his own imagination and influenced with a certain exuberance of the far-traveled. From this point of view it is understandable why, in contrast to the fish specimens of the private tombs of the Old Kingdom, a systematic investigation of the Punt fishes was missing until recently. From just a glance at these fishes, one can see among them representatives from tropical seas, such as found in the diverse group of coral fishes. It is, therefore, natural to look for the natural models in the Red Sea and south of it.

Figure 25 shows four of the actual images of the Punt marine fish in the temple. Figure 26 shows all of the images, in outline form, of the Punt marine fish pictured on the walls of Queen Hatshepsut's terrace temple - the ones denoted by the integers from 1 to 17 - and for comparison, living representatives - the figures with decimal places - that are close to the represented fish. The four with question marks refer to pictured fish for which no living representatives have been suggested; in place, fish families have been proposed.

The Land of Punt was an ancient kingdom. A trading partner of Egypt, it was known for producing and exporting gold, aromatic resins, blackwood, ebony, ivory and wild animals. The exact location of Punt is still debated by historians. Most scholars today believe Punt was situated to the southeast of Egypt, most likely in the coastal region of modern Djibouti, Eritrea, northeast Ethiopia, Somalia and the Red Sea littoral of

Figure 25: Images of the Punt marine fish pictured on the walls of Queen Hatshepsut's terrace temple.

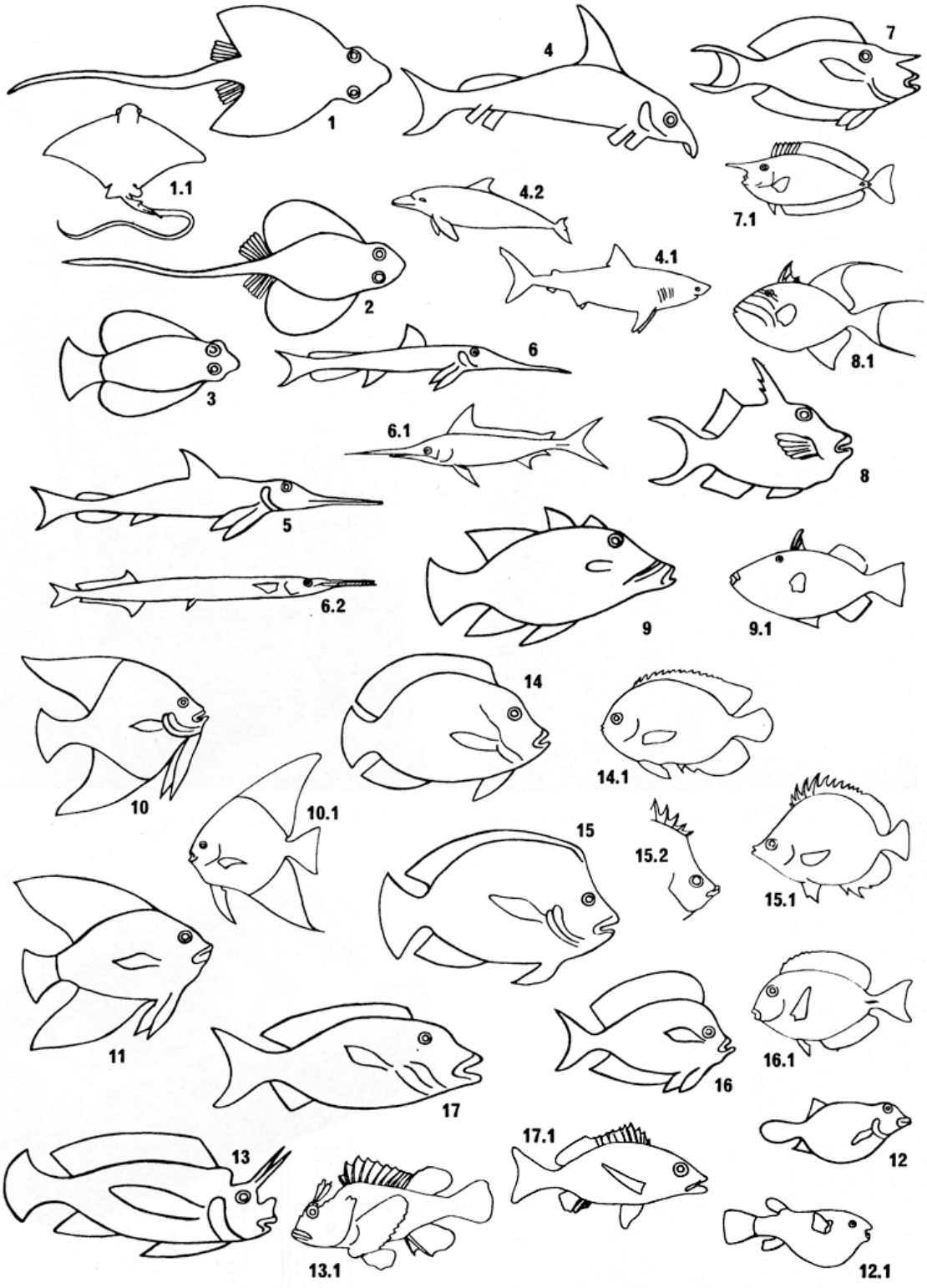

FIGURE 26

1. 1 Myliobatis aquila
2. Aetobatidae (?)
3. Sebastidae (?)
4.1 Carcharodon carcharias
4.2 Delphinus delphis
5. Xiphiidae or Tylosuridae (?)
6.1 Xiphias gladius
6.2 Ablennes hians
7.1 Naso brevirostris or N. unicornus
8.1 Balistes vetula
9.1 Rhinecanthus rectangulus
10.1 Platax pinnatus
11. Ogcocephalidae (?)
12.1 Chelonodon patoca
13.1 Scorpaenopsis gibbosa
14.1 Centropyge bispinosa
15.1 Chaetodon melannotus
15.2 Chaetodon lunula
16.1 Acanthurus lineatus
17.1 Lutjanus kasmira

Sudan. However, some scholars point instead to a range of ancient inscriptions that locate Punt in the Arabian Peninsula. It is also possible that the territory covered both the Horn of Africa and Southern Arabia.

Thus the question that has always interested the viewer of the Punt reliefs, and which has given rise to bitter controversies in research, is the more precise geographical position of that mysterious country. No one has been able to find any essential support in the fish presentations, but clearly there are clearly definite species with a narrowly restricted area of distribution. From the standpoint of the Egyptologist the most important conclusion reached by ichthyologists does not permit us to locate the Land of Punt. According to their unanimous opinion, these marine fishes belong to the Indian Ocean, Red Sea fauna. We can only say with certainty that the Punt fishes were not present in the Egyptian pharaonic time (i.e., from the 1st Dynasty in 3000 BC to the 32nd in 30 BC).

Figure 27: From the tomb of Mereruka, a vizier to the Pharaoh Teti (2323 BC). Fish species include: Tilapia, eels, puffer fish, catfish, elephant fish, mullet, carp, Nile perch, upside-down catfish and moonfish (a citharinid).

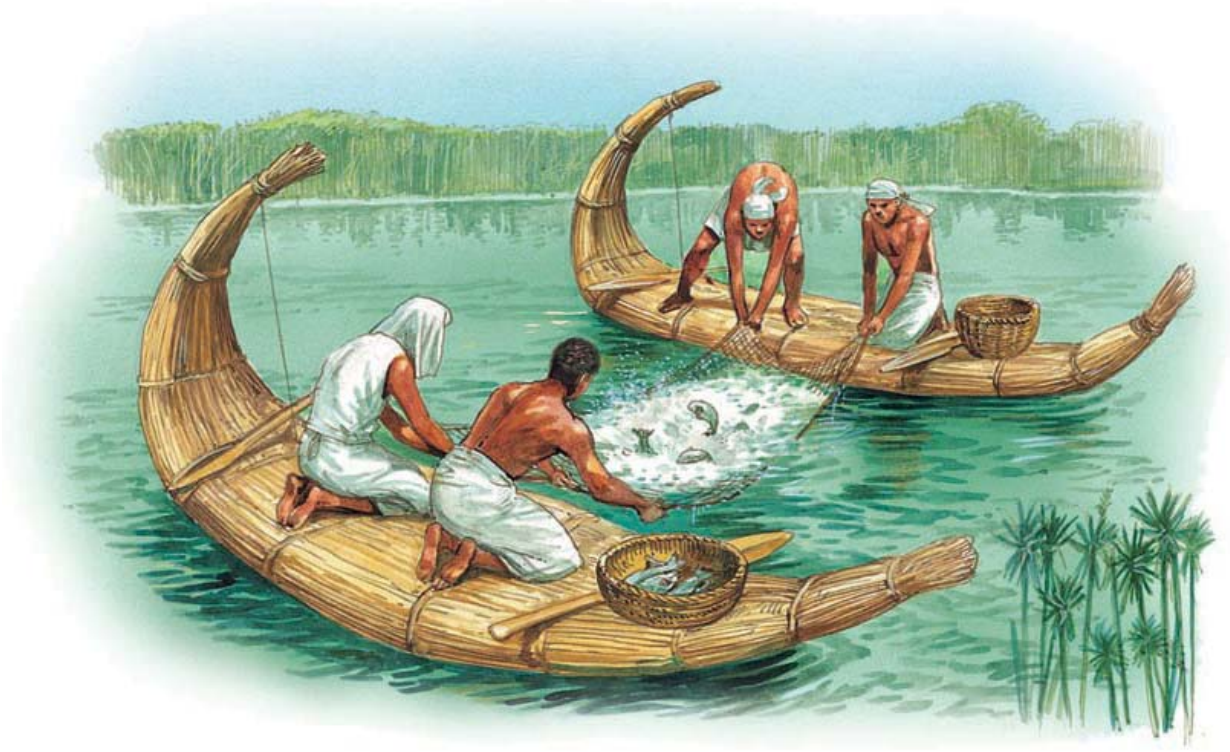

Figure 28: An artist's rendition of Egyptians fishing from small boats made of reeds.

A HISTORY OF THE IMPORTATION OF THE GOLDFISH INTO WESTERN EUROPE AND THE UNITED STATES

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, June 10, 2017)

The following excerpts are examples of the assertion that the goldfish arrived in Portugal in the year 1611. If true, this would mark the first importation of the goldfish into Western Europe.

In William Yarrell's "History of British Fishes" (1836) he writes:

THE GOLD CARP.

The date of the first introduction of the Golden Carp, or Gold and Silver Fish, as they are more frequently called, is differently stated by authors: 1611, 1691, and 1728, are each recorded as the particular year in which they were first brought over… A correspondent in Loudon's Magazine of Natural History, vol. iii. page 478 [September 1830] considers "that they were probably introduced into Portugal at an early period, after the people of that country had discovered the route to the East Indies by the Cape of Good Hope, as they appear to be now completely naturalised there, and abound in many of their streams, whence they are brought to us by trading vessels from Lisbon, St. Ubes, &c. in large earthen jars, and may be had at a very easy rate before they get into other hands. They have also been introduced and naturalised in the Mauritius by the French, where they now abound in fishponds and streams, and are served up at table as agreeable food, with the other fresh-water fishes, to the brood of which they are thought to be very inimical, by destroying their spawn and young fry."

The correspondent cited by Yarrell was J.T. Cork and his letter was dated March, 1829. In François de Schaeck's "Histoire du Poisson doré" (1893) he wrote:

It is believed that this fish was brought to Europe at the end of the seventeenth century. Madame de Pompadour received the first copies which were introduced into France. But soon they abounded there. For the culture which was practiced throughout the south, especially in Portugal, succeeded admirably, and supplied the whole of Europe.

In William Houghton's "British Freshwater Fishes" (1895) he wrote:

The date of the introduction of these "sportive" fish into England is uncertain; 1611, 1691, and 1728 are each recorded as the year in which they were brought over; it was not, perhaps, till the year 1728 that Goldfish became generally known, when they were brought over in large numbers and presented to Sir Matthew Decker, Lord Mayor of London, who distributed them to various friends over the country. The Goldfish appears to have been introduced into Portugal at an early period ; it is now completely naturalised in many of the waters of that country, and a great number of these fish, so commonly exposed for sale in the well-known glass globes of the London and other dealers, have been and are now, I believe, brought into England by trading vessels from Lisbon and other Portuguese towns. In France the Goldfish is said to have been unknown till the days of Louis XV., whose mistress, the Marchioness de Pompadour, had received some as a present.

In Hugo Mulertt's "The Goldfish and its Systematic Culture with a View to Profit" (1883) he wrote:

The first introduction of the goldfish into Europe is variously dated, the years 1611, 1691 and 1728, A. D., each having claims for that honor; it may be said also that the variety introduced was the poorest and cheapest the Chinese had.

The first seen in France, however, were those imported for the famous Madame de Pompadour. Soon afterwards they became quite common, as it was found that they throve well in the waters of Southern Europe, especially in Portugal, where they sprang from a few small fish, said to have escaped from a vessel newly arrived from China. In that country they are now considered a delicacy for the table. It was not long until several streams in the neighborhood of Lisbon absolutely swarmed with them, and it is from this source that all Europe became stocked with them.

In Gustave Loisel's "Histoire des Ménageries de L'antiquité à Nos Jours" (1912) he wrote:

About the year 1500 the small goldfish was introduced into Japan from the town of Sakai, which was then the principal port of the Empire. From there it spread throughout the country, where Japanese women and children love it today as much as in China. It then appeared in England in the year 1611, then came to Portugal, where it was very much in favor during the whole of the eighteenth century, in France, where fashion was prescribed by the Marquise de Pompadour, and finally in Germany and Italy, This last country being the only one, we believe, where the breeding of this fish and some of its varieties is now being carried on in Europe.

With this list of references it is not surprising that the idea that Portugal received its first importation of the goldfish in 1911 has persisted up to modern times [see Zhong-ge (1984), Brunner (2005) and currently Wikipedia, often a font of erroneous aquarium hobby history]. In addition to the 1911 date, many of these references specifically mention that the goldfish quickly established themselves in that country and were the source of importations to other Western European countries.

TRACKING DOWN THREE DATES: 1611, 1691 and 1728

James Petiver (1665-1718) was a London apothecary, a fellow of the Royal Society, and a member of London's informal Temple Coffee House Botany Club, famous for its study of botany and entomology. A collector of examples of natural history, his extensive collection became known as the Museum Petiverianum. He was especially anxious to ensure that his collection would facilitate further research and, in the period 1696 to 1709, produced a steady stream of material designed to alert fellow scientists to new discoveries.

He engaged the captains and surgeons of ships to bring him specimens, enabling them to select proper objects by printed directions that he distributed among them. By these means his collection became so valuable that, sometime before his death, Sir Hans Sloane offered him four thousand pounds for it (about $907,000 in today's currency). After his death, it was purchased by Sloane, and some of it is now in the Natural History Museum in London where it is frequently resorted to for the sake of ascertaining obscure synonyms, his plates being so generally cited by Linnæus but in many instances insufficient to express the precise object intended.

In Petiver's 1711 edition of his **"**Gazophylacii Naturae et Artis" ("The Treasury of Nature and of Art" - the book was written partly in English and partly in Latin, although he was not very proficient in the latter) there are illustrations of two goldfish brought alive from China (Figure 1). As the plate was on sale in 1706 (a common practice at the time), it is reasonable to assume that the

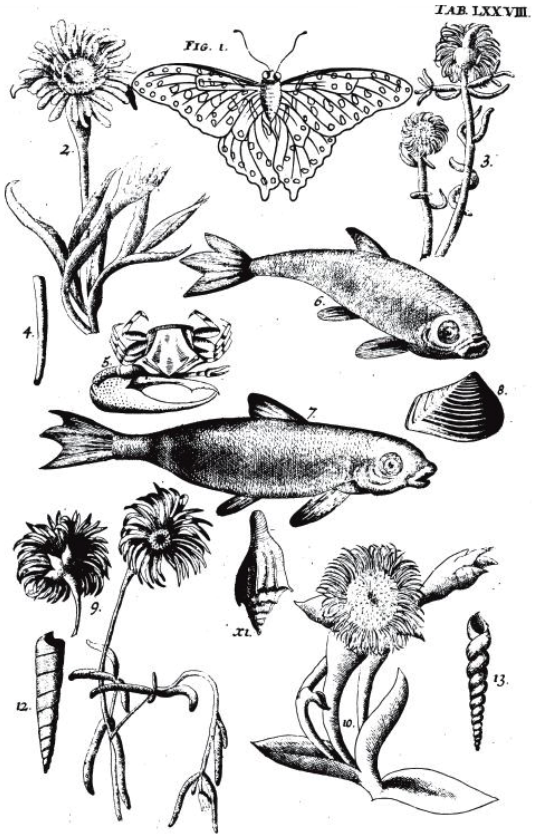

Figure 1:
A Plate from Petiver's 1711 edition of his *Gazophylacii Naturae et Artis*.
Numbers 6 and 7 are the goldfish bright back alive from China.

fish were in Petiver's possession in 1705, thus inducing Hervey and Hems (1968) to consider this date as marking the first importation of the goldfish into England.

In Edwards' "A Natural History of Birds" (1751), in the section "The Gold-Fish from China" there appears the following footnote:

His Grace the late Duke of *Richmond* had a large *Chinese* earthen Vessel full of these Fish, brought alive to England. I drew some of them for his Grace, who permitted me to make Draughts for myself, with Leave to make them Publick. The first Account of these Fishes being brought to *England* maybe seen in *Petiver's* Works, published about *Anno* 1691. See his *Catalogue*, 186, *Piscis Chin. Caudâ argenteâ*, Plate 78, Fig. 6. and *Catalogue* 187, *Piscis Chin. Caudâ aureâ*, Plate 78, Fig. 7. They were not generally known in *England* till the Year 1728, when a large Number of them were brought over in the *Houghton Indiaman*, Captain *Philip Worth*, Commander, and presented by him and *Manning Lethieullier*, Esq; to Sir *Matthew Decker*. Since which Time they have been propagated in Ponds by several curious Gentlemen, in the Neighbourhood of *London*. They may be esteemed a Domestick Fish; they vary infinitely in their Colours and Marks, as do all Domestick Animals; they have been propagated and greatly increased in the Island of St. *Helena;* from whence they are now brought by all our *India* Ships that touch there. They keep them in small Ponds and Basons in *China*, for the Amusement of the Ladies, and other curious Persons. Those propagated with us are generally of a deader Colour than what are brought from *China*, or St. *Helena*. In a few Years it is probable, we shall have them in our Rivers. The last Author that has mention'd this Fish is *Linneus*. See his *Fauna Sveciae*, published at *Leyden*, 1746. See his Figure of it, *Tab*. 2. Fig. 331, which is like it, but seems fore-shorten'd, which makes it appear thick and short. He calls it *Cyprinus pinna ani duplici, cauda trifurca, exoticus, Piscis aureus Chinensium*.

Edwards, however, states (erroneously) that Petiver's book was published about 1691 instead of MDCCXI (1711). Hervey and Hems (1968) postulate that Edwards made the simple mistake of transposing the X and the C to produce MDCXCI (1691). In any event, along with the reference to the importation of the goldfish into England in 1768, Edwards is responsible for two of the three most common importation assertion dates of the goldfish into Western Europe in the literature - 1691 and 1728. This information was copied by Pennant (1776):

They were first introduced into England about the year 1691, but were not generally known till 1728 when a great number were brought over, and presented first to Sir Mathew Dekker, and by him circulated round the neighborhood of London, from whence they have been distributed to most parts of the country.

Marcus Elieser Bloch (1723-1799) was a physician who began to devote himself to ichthyology at the age of 56. Bloch was no stranger to the goldfish, having described a subspecies, Carassius auratus gibelio in 1783 (and known variously as silver crucian carp, golden carp, crucian carp, goldfish, giebel, prussian carp, common goldfish, wild goldfish, silver crucian, brown goldfish, and giebel carp). Bloch also wrote a book titled, "Naturgeschichte der ausländischen Fische ("Nature story of Foreign fishes"), 1785-1795. In his "Oeconomische Naturgeschichte der Fische Deutschlands" (1785), he states:

At present goldfish are esteemed not only in England, Holland and Denmark, but also in different cities of Germany. They were brought to the first country in the year 1611, and in 1728 they were already widely known.*
******Penn.* **Britt. Zool. III, p. 374.**

Thus he also credits Pennant but in his dates makes the error of recording the latter's 1691 as 1611, thus introducing the last of the three most common importation assertion dates of the goldfish into Western Europe into the literature: 1611, 1691 and 1728.

THE PORTUGAL ASSERTION

As I have shown at the beginning of this essay, one of the most common assertions is that the goldfish arrived in Portugal in 1611. We know that the 1611 date is a typographical error, but when was the goldish imported into Portugal? In Carlos Almaça's "Fish Species and Varieties Introduced Into Portuguese Inland Waters" (1995) he discovered that in the zoological literature, the goldfish was first mentioned as found in Portugal by Vandelli in his 1797 book, "Florae et Faunae Lusitanicae Specimen," under the scientific name *Cyprinus auratus* and the common name "Peixe da China" (suggesting a probable introduction into Portugal from China).

The goldfish was not mentioned in Baptista's prior 1789 account, "Ensaio de huma descripçao, fizica e economica de Coimbra, e seus arredores." If, as many of the assertions claim, streams in the neighborhood of Lisbon absolutely swarmed with them, certainly Baptista would have mentioned these goldfish. This suggests that the introduction of the goldfish to Portugal occurred sometime between 1789 and 1797, and not 1611.

It is now time to explore dates earlier than 1705 for the importation of the goldfish into Western Europe.

THE FIRST IMPORTATION OF THE GOLDFISH INTO WESTERN EUROPE

The following entry made by Samuel Pepys in his diary on May 28, 1665 is well known among aquarium hobby historians:

Thence home and to see my Lady Pen, where my wife and I were shown a fine rarity: of fishes kept in a glass of water, that will live so for ever; and finely marked they are, being foreign.

Aquarists have tried to pin down the fish in question, the first being William Alford Lloyd in 1876 and, much later, Cristopher Coates. Lloyd stated:

The Chinese kept gold and silver carp for amusement long before they were introduced into Europe during the second half of the seventeenth century. It was probably some such fish as these which are alluded to by Pepys in his Diary…, and doubtless vegetation grew, and was encouraged to grow, in the glass and porcelain vessels in which these household pets were kept, and so constituted them in some measure as "Aquaria."

For two reasons, however, this view was not held by all aquarists: (1) Some could not believe that the goldfish was introduced into England as early as 1665 and (2) others could not believe that goldfish could live in a glass of water for an extended period of time in the England of that era. In their 1968 book, "The Goldfish," Hervey and Hems write:

It is unlikely that these fish were goldfish, and Dr. C. W. Coates, of the New York Zoological Society, has expressed what he calls the 'educated guess' that the fish were Paradise Fish (*Macropodus opercularis*), which is finely marked in the sense that the word 'finely' would be used by a seventeenth-century writer, and which by reason of its supplementary breathing organ, would be able to live for a very long time in a small container. Certainly, at this time, goldfish were not generally known in England; for Willughby (1635-72), old Izaak Walton (1593- 1683), and others do not mention them, especially, they are not mentioned by John Ray (1627 -1705) in his *Synopsis Methodica Piscium*, posthumously published in 1710.

Note: It should be noted that although Coates had no doctorate, earned or honorary, he let the assumption go uncorrected on a number of occasions. Coates was a mediocre aquarist at best but an excellent publicist for The New York Aquarium. He was best known for his work with electric eels, the exhibits drawing thousands of visitors to the Aquarium who were enthralled by the sound and the voltages produced by the eels that were seen and heard by the electronic equipment Coates had devised.

In my essay, "The Mystery of Lady Pen's Fish" (2016), I refuted all of these objections so I won't repeat the details here. However, I would like to cite the following from Dr. Malcolm Peaker's blog (zoologyweblog.blogspot.com) that appeared shortly after my essay was published on Facebook. Dr. Peaker, by the way, is a Fellow of the Royal Society and a former Vice-President of the Zoological Society of London.

Dr. Albert J Klee has published an essay in which he questions what has become the standard dogma for the identity of Lady Pen's fish. He has shown that goldfish were imported into Europe earlier than claimed by Hervey and Hems and that the Paradise Fish first arrived much later. He also notes the close ties between Lady Pen and family in the Netherlands, where goldfish arrived with the Jesuit, Martinus Martini, in 1653. He, and I, see Coates's point about survival in a small vessel to be irrelevant. Even large goldfish have survived for decades in small goldfish bowls. I knew of one which had been in the family for twenty or more years; the water was changed every day.

The only real description of the fish was in Pepys's 'finely marked'. Klee points out that this could have meant any number of things, not just in the sense of 'with fine markings'; attractively distinctive might just as well have been Pepys's meaning. Indeed he could have described any of his lady friends as 'finely marked'.

I have never been content with the notion that Lady Pen had Paradise Fish. While they are relatively hardy and would have survived indoors during a London summer they are not that hardy. Lady Pen must have had the fish before Pepys and his wife visited their neighbours on 28 May (7 June in the present, Gregorian, calendar) and had they been sent from the Far East would have had to have survived at least part of the European winter and spring. That winter and spring were known to have been exceptionally cold, as those seeking the cause of the outbreak of The Great Plague of London in that year, recorded and noted. English houses were, and some still are, unless within a few yards of an open fire, freezing cold in winter. Too cold, I would suggest, for Paradise Fish but not for goldfish.

Figure 2: The goldfish pictured in Edwards' *A Natural History of Birds*, 1751

Peaker's last point really puts the paradise fish theory to rest. With regard to Pepys's "finely marked," I draw reader's attention to the four Kinyu-type goldfish images taken from Edward's 1751 book and shown in Figure 2. Clearly these goldfish could easily be described as finely marked.

All that remains now is to show that goldfish were imported into Western Europe prior to Pepys' visit to Lady Pen. In my Yahoo Aquarium Hobby Historical Society of America group post Number 1465 dated May 13, 2004, I first reported the following:

It is of some interest to note that in 1643, Jesuits established themselves in Hang Zhou, China, where their church was located close by a "local farm of red fishes." This took the fancy of a man known only by his last name of Martini, who took an interest in the fish and brought back 10 of them to Holland.

The following is from Addendum II in my 2016 Pepys essay after I had uncovered additional information about Father Martini Martini:

In 1650 the superior of the mission sent Father Martini to Rome in order to explain and defend the missionary approach encultured of China Jesuits. Chinese customs that are not contrary to the Christian faith were respected and even encouraged by the missionaries, but that was not the view in Europe, especially by the Franciscans and Dominicans. The travel was long and dangerous. The route passed through the Philippines on the way to Amsterdam where he arrived on August 31, 1653. In Amsterdam, Antwerp, Vienna and Munich he met with printers and prepared the edition of three important books including his famous *Novus Atlas Sinensis China*. He finally arrived in Rome in the spring of 1655.

We now have a very definite date for the first importation of the goldfish into the Western Europe, i.e. August 31, 1653. Finally, I would like to quote the following excerpt from Martini's *Description Géographique de l'Empire de la Chine*:

The mountain of Cinking is near Changhoa, where there is a lake, which, although not being the greatest, occupies three hundred acres of land. It is famous and renowned for the small golden fish within it, and because their skin shines between lines edged in gold, the Chinese have named this effect Kinyu. The whole back is like strewn with gold dust and they are no longer than a finger. They have a tail with three points, sometimes two, sometimes it is simpler and a little large; they are curious to see. The Chinese make much of their existence and feed them with great care in their houses and in their pleasure gardens, in vessels that are made just for this purpose. The great Lords give them some time to eat from their hands and often play with them as if the fish knew their masters, and they show that they like the pleasure and diversion they receive, when they honor their presence. When

they have all the right markings that the Chinese desire, one of these small fish is worth two or three gold crowns.

This is probably the first reference to the Kinyu (also known as Chin-yü; in Japan it is Kingyo) or common goldfish in a Western publication in addition to providing an explanation of the name. Martini does not indicate that the locals bred these fish found in the lake but he does mention that the more prized (because of their markings) were kept by the Chinese in their houses and in their garden pools.

THE FIRST IMPORTATION OF THE GOLDFISH INTO THE UNITED STATES

The following is an account of the goldfish kept in the ponds of Col. Godfrey Malbone (1695-1768), a wealthy Newport, Rhode Island merchant. Malbone was one of the chief Newport merchants of the 1700s. He settled in the town about the year 1700 and from there engaged in successful enterprises, including fitting out privateers in 1740 during the French and Spanish war. Malbone was a rough, bold, sea-faring man, ready to trade in slaves or rum, and to send privateers to the Spanish Main. He is best known for financing the construction of Trinity Church in 1725. The following is from *Harper's New Monthly Magazine*, August 1854:

Noble mansions, spacious and elaborate gardens, arose and adorned the island and the town. The country-house of Col. Godfrey Malbone, which was commenced in 1744, was famous as the finest residence in the colonies. It was built of stone, two stories high, with a circular stair-ease leading to the cupalo [*sic*], the cost of which was reputed to be equal to that of an ordinary dwelling-house. The house was within a mile of Newport, and the farm of six hundred acres sloped gently toward the bay. According to tradition, this garden was elaborately laid out; ranges of banks and terraces alternated with plots of flowers, and hedges of shrubbery, and groups of rare trees; silver and gold-fish swam in artificial ponds; while over this mingled beauty the eye swept across the bay to the blue line of the opposite shore, or saw the sea flashing over the rocks and cliffs at the entrance of the harbor."

Malbone, by the way, had an underground tunnel built down to the sea from the house so as to receive contraband goods without paying customs duties on them. The house was completed no later than 1747 (Charles Pym Burt wrote to Malbone from London in 1747: "**It gives me the deepest Concern, to find that your new Habitation proves so very disagreeable to you, but I hope you will soon be reconciled to it."** Assuming that the grounds were completed at the same time Malbone took possession and moved in, 1747 marks the earliest reference to goldfish in America.

In Job Baster's "*Natuurkundige Uitspanningen, behelzende eenige waarneemingen, over sommige zee-planten en zee-insecten, benevens derzelver zaadhuisjes en eijernesten*" (1762-1765), he writes:

Some of these Fishes were sent from China on a British Ship to the Island of St. Helena. From here the first goldfish in England were brought in 1728 by Philip Worth, Skipper of the East Indian Ship, *The Houghton* , and presented to the well-known Merchant, Sir Mathew Dekker. Since then, they have come across on various ships, and in fish ponds in England they were bred and sent to Europe where they became known.

Although Hervey and Hems question the 1728 date because the records show that *The Houghton* sailed from England only at the end of 1728 and did not return until 1730, it is most likely that the goldfish received by Malbone were later bred in England from this source.

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ADVENTURES IN AQUARIUM HOBBY HISTORY RESEARCH

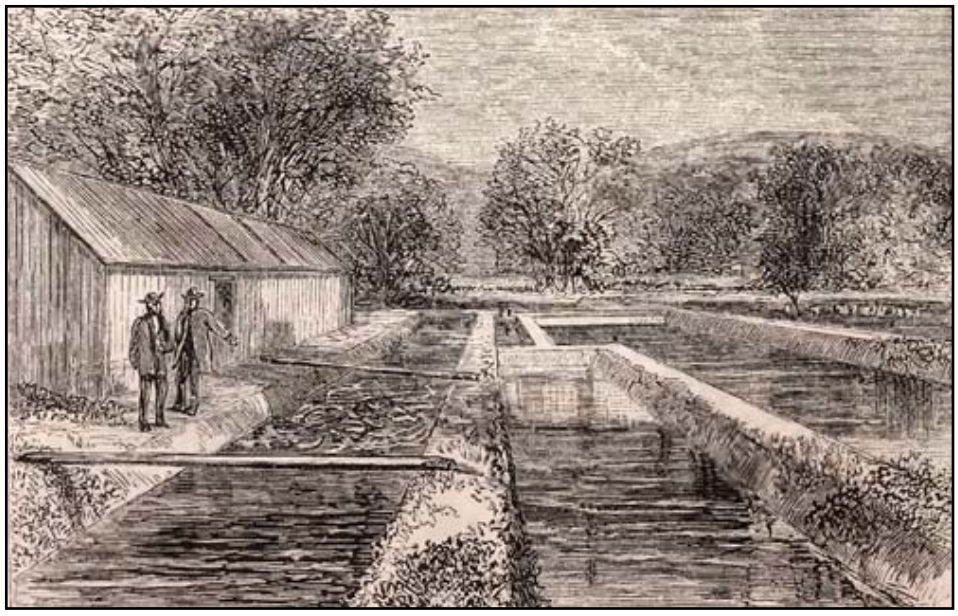
By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 15, 2017)

I have always preferred doing research by starting from the most recent documentation to the oldest. For one thing, the most recent documentation usually has a pretty good bibliography providing me with references that I never knew existed. A good example is my recent essay on ancient Egyptian fish names. I started with a doctoral thesis awarded to Belinda Ann Wassell in 1991, titled "Ancient Egyptian fauna - a lexicographical study." Although it did have a small section concerning fishes, it did not examine the derivation of names, which was my major objective. However, it did reference Ingrid Gamer-Wallert's 1970 doctoral dissertation, "Fische und Fischkulture im Alten Ägypten." I ordered a copy from Germany and found that it was just what I was looking for, plus the fact that it had an extensive bibliography that I also found useful.

Another example but with a slight twist was my search for the first horticulturist to use the word aquarium, since this was the genesis of the word used by Warington to refer to his invention of the flat-sided tank or the aquarium as we aquarists know it today. Because I knew that the origin of the world was Roman, here I reversed my usual procedure and started with Cato the Elder around 160 BC. This, however, came to naught since at no time did the Romans use aquarium or its cousins in the sense of a container; rather, it was either meant as water or a place (but not a vessel) that held water. (Klee, 2015). Thus I returned to my usual system and started with the plans for the aquarium of the Marquis of Whiteknights published in 1806. It was safe to assume that the word was used in the 1700's so I doggedly consulted a long list of horticultural dictionaries written (mostly in German and French) of that century. After drawing a number of zeros, I finally hit pay dirt with Carl Linnaeus' 1742 *Hortus Upsaliensis* (Klee, 2014).

In February of 2014, a member of the Yahoo *Aquarium Hobby Historical Society of America* asked if they knew who first used beef heart as a fish food and I decided to try for the answer, thinking it would be fast and easy. A number of the members of the forum were quite certain that it was either the *Bureau of Fisheries* or the *American Fisheries Society* no but documentation was offered by them.



The Troutdale Fishery Fish Ponds, Bloomsbury, New Jersey , 1838.

I decided to start in the 1920s and found the following from M.C. James's "More about fish food" (James, 1928):

At least 35 different items were being fed as the 1920s were ending. Included were sheep plucks and liver; beef heart, spleen, and lungs; pig liver, milts, plucks, hearts, and lights; horse and cow meat; fish meal; salted and fresh salmon; condemned canned salmon; herring and other species of fresh fish; middlings; red dog flour; beans (including pinto and soybeans); and cod liver oil. Less frequently used food items included blood, boiled eggs and potatoes, milk (including buttermilk), shrimp, shrimp heads, and fish processing waste.

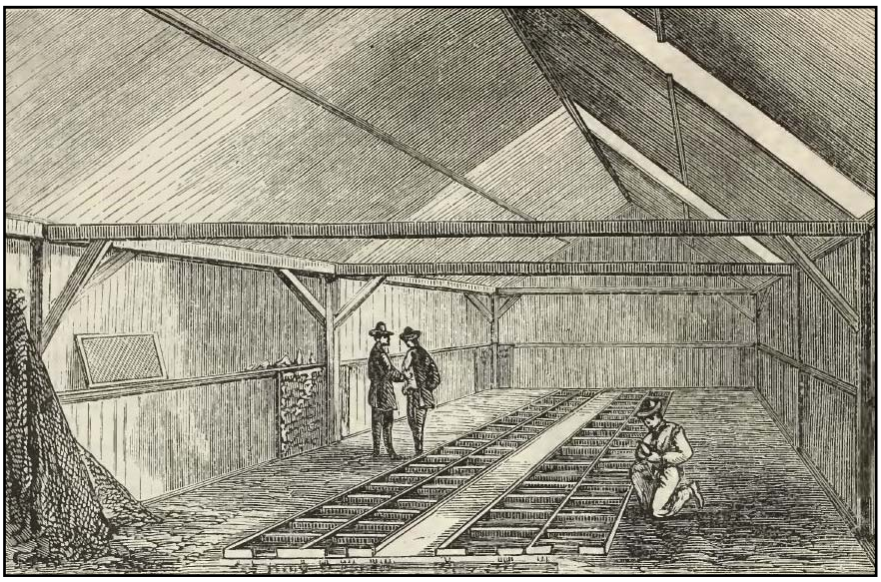
Then I found the following from the *Bureau of Fisheries Service Bulletin, Department of Commerce,* Washington, No. 46, March 1, 1919:

Liver vs. Heart as Trout Food.
An interesting experiment has just been undertaken at the Wythevllle (Va.) station in the feeding of beef liver and beef heart to young rainbow trout. In each of two 14-foot troughs 10,000 fish just ready to take food were placed. The water temperature for the first 30-day period was approximately 55° F., and a flow of about 7 gallons per minute was maintained. All the fish included in the experiment were selected from the same lot and their treatment in the troughs was identical in every way with the exception that those in one trough were fed on heart and those in the other trough on liver.

The results of this experiment were that the rainbow trout fed on beef heart suffered less mortality and also gained slightly in weight as compared with those fed on beef liver.

This, however, did not answer the question since fish farming in this country started in the 1800's and surely beef heart was used then. I then consulted Fred Mather's "Modern Fish Culture in Fresh and Salt Water" (Mather, 1900), and found that he had mentioned beef heart in two places. (Note: Among other things, he was Superintendent of Fish Culture at the New York Aquarium from 1876 to 1879, working under Henry Dennison Butler.) In preparation for his book, Mather constructed a questionnaire and distributed it in the summer of 1891. One of the questions involved a trout epidemic and the following was one of the answers received:

Six years ago, about the same disease appeared among my trout from April to July. In June they died in great numbers, from twenty-five to thirty every night, and I was discouraged. One day I saw that a great many more would die and thought that the cause might be from feeding stale beef hearts. I stopped feeding for ten days and then began giving them live minnows, and in a week's time the mortality stopped and I have lost very few trout since. *Albert Rackow, Elmont, Long Island.*



The Troutdale Hatching-House.

Since the responses to the questionnaire were received in 1891, Rackow was feeding beef heart in 1885.

Incidentally, Rackow thought the problem might be in the stale beef heart he was feeding at the time. In 1891 he was actively feeding a combination of beef heart and minnows to his trout. The response to the questionnaire as to what trout farmers fed included the following:

Albert Rackow, Elmont, Long Island, N. Y., says: "'I feed my trout on beefs' (sic) hearts and minnows; growing 8,000 trout every year, and it pays a profit."

These reports led to a spirited discussion on the Forum of the merits of feeding beef heart to aquarium fish. This, however, was not relevant to the member's question. However, remembering that long list of horticultural dictionaries written in the 1700's that I perused without success when searching for the origin of the word "aquarium," I decided to look a bit more. The book I found was published in my own back yard, "A Helping Hand for Town and Country; An American Home book of Practical and Scientific Information" (Draper and Croffut, 1870):

When they are two months old they should be fed occasionally with curds, or beef's heart, or liver minutely hashed. Toss this to the fish a little at a time, so that they can catch and devour it before it reaches the bottom of the trough; no more should be given than the fish will eat, because if any is left it will settle on the bottom and foul the water, and the fish will sicken and die.

At this point I ceased my beef heart investigations, only to revive them three years later. My next finding was an article on fish culture in America that appeared in *Harper's New Monthly Magazine* (Shanks, 1868):

The best substance for this purpose is beef's heart, chopped into minute fragments, sifted through a fine wire sieve, mixed with water, and fed to the fish by means of a small syringe of about one ounce capacity.

Care must be taken that no more be placed in the trough than can be immediately devoured; but at the same time the fish should be fed until he is thoroughly satisfied. Nature made the trout a true cannibal, and he cannot eat too much for his own good. It is for reasons of cleanliness - as absolutely necessary to fish as food - that too much food should not be put into the boxes. If it is not immediately eaten it soon fouls the boxes and kills the fish.

The problem with the Draper/Croffut and Shanks references is that although the dates are useful, neither helps in identifying the person who first used beef heart. Certainly it was not the authors. Lyman C. Draper was Secretary of the Wisconsin Historical Society and W.A. Croffut - along with

Securing the Trout Eggs.

his coauthor - was the author of “The History of Connecticut” and a series of biographies of American pioneers. William Franklin Gore Shanks (1837 -1905) was war correspondent for the *New York Herald* (1861–65) and subsequently joined the *New York Tribune* where during this time he was imprisoned for refusing to divulge the name of a writer of an article in the paper. Besides his contributions to periodicals, he published: “Recollections of Distinguished Generals” (1865)"; “Bench and Bar” (1868); and a play, “A Noble Treason” (1876). None of these three men were fish culturists themselves and therefore not responsible for the introduction of beef heart as a fish food..

The farther back one goes into the literature, bibliographies are less often found so I decided to bite the bullet and to examine the following seven books, arranged in order of publication, to learn what these pioneering fish culturists had to say about feeding (Stone and Slack are tied for fifth place)

1. FRY 1854
2. GARLICK 1857
3. NORRIS 1868
4. GREEN 1870
5/6. STONE 1872
5/6. SLACK 1872
7. GREEN and ROOSEVELT 1879

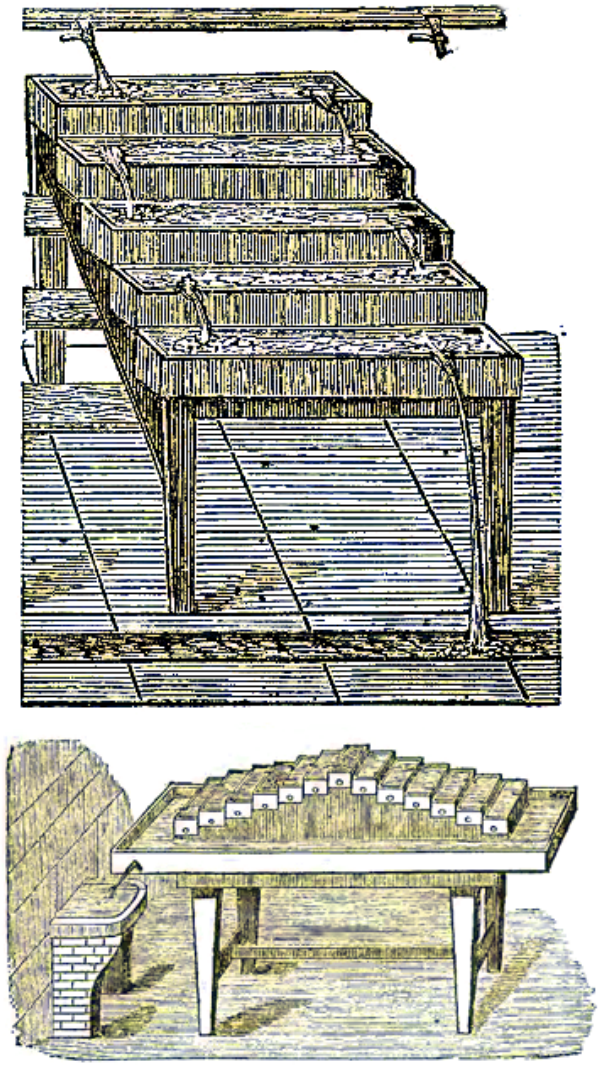
The following are the relevant excepts from each of these books:

1. FRY 1854

As early as 1849, as appears by a memoir on the domestication of fish and the formation of ponds, I had proved by actual experiments, that very young fish could be fed upon the raw flesh of domestic animals, hashed, and that they would thrive and grow rapidly on this diet.

The operation of reducing muscular raw flesh to minute fibrous particles, small enough to be readily swallowed by exceedingly little fish, is one that demands considerable time; and the further difficulty of separating and properly dispersing in the water the compact mass of flesh resulting from this operation, led me to seek some more expeditious mode of feeding.

To Mr. Chantrant, under whose charge is the hatching apparatus of the College of France, is due the idea of replacing raw by cooked meat. This substitute has had all the success I hoped for, and has enabled me to feed easily, and at small expense, and to bring up in a space 55



Top: A single flight of hatching boxes. Bottom: A double flight of hatching boxes. The water enters from a two-inch pipe directly from the hatchery spring into the boxes and from the last box into a trough on the floor.

centimetres long, 15 wide, and 8 deep, as many as 2,000 young salmon at once. The muscular flesh of boiled beef, which, by being pounded, grated and cut, is reduced to particles proportioned to the size of the little animals it is to nourish, flesh reduced to that state that it will stick together in a mass but can be with greatest ease separated into the smallest particles, I have found, up to this time, the most suitable food for very young fish just beginning to feel hunger.

2. GARLICK 1857

It has been ascertained that the lean flesh of animals, when boiled, is an excellent article of food for young fish, or even old ones. As the young fish are very small, it is necessary, to hash it up into very fine particles, or they will not be able to swallow it; in fact, it should be pounded or grated very fine, but as they increase in size, it may be given, in coarser particles. The flesh of other kinds of fishes, where they are plenty, would be an excellent substitute for the flesh of animals, either cooked or uncooked; I think this kind of food, preferable to any other.

3. NORRIS 1868

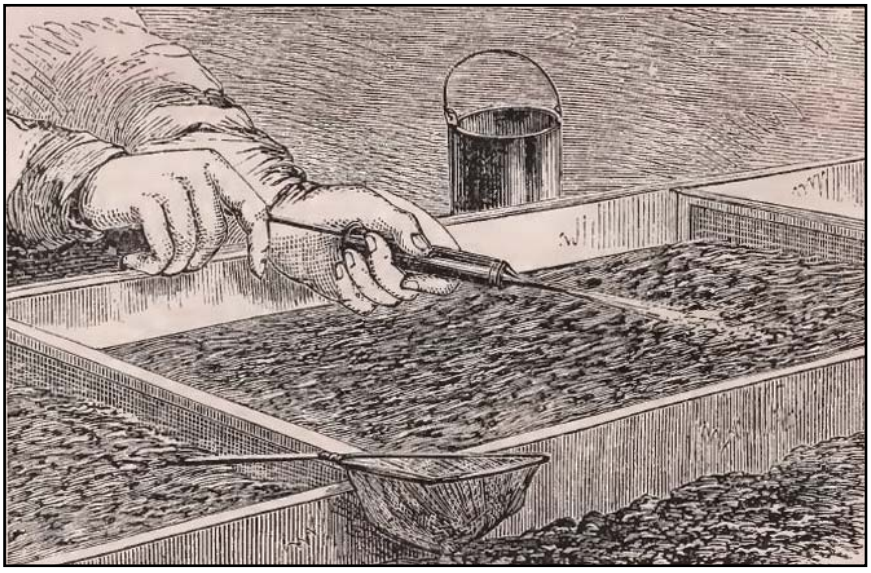
Four or five different kinds of food have been recommended. Liver or lean meat boiled hard and grated ; the yolks of eggs boiled hard and reduced almost to a powder; raw liver chopped fine with a long sharp knife; fresh or coagulated blood; fresh shad or herring roe, raw or boiled; thick milk or bonny-clabber (In Irish Gaelic, bainne clabair means 'thickened milk.' In English, the equivalent word is bonnyclabber), and curds.

4. GREEN 1870

In this country we pursue a cleaner method. The pluck of animals killed (that is the lights and liver) is obtained from the butchers. This food can be obtained fresh at least once or twice a week in most localities and kept fresh by means of an ice house. We feed meat to them raw. They have never been used to cooked food in their natural state and we do not see that it is any better tor them. The lights (lungs) should be given to the larger fish as it cannot be chopped so fine as the liver and is more apt to hang in strips or strings. The liver which can easily be cut into small pieces may be fed to the smaller fish.

5/6. STONE 1872

I think the best food for them at first is liver, and curd made from sour milk, mixed in about equal proportions, or, still better, with two parts liver and one part curd. The young fish at this age, as may be supposed, can take only the finest particles of food. The curd, therefore, should be made as fine grained and moist as possible. The liver should also be reduced to the smallest possible particles. This is accomplished in various ways, but the way that I have found the most satisfactory and the most expeditious is to grate the liver on a common tin lemon-grater or cheese-grater. You must be careful to have the holes small enough at first to admit only very fine parti-



Feeding the Young Trout.

cles; they should not be over one tenth of an inch in diameter.

5/6 STACK
To be discussed later.

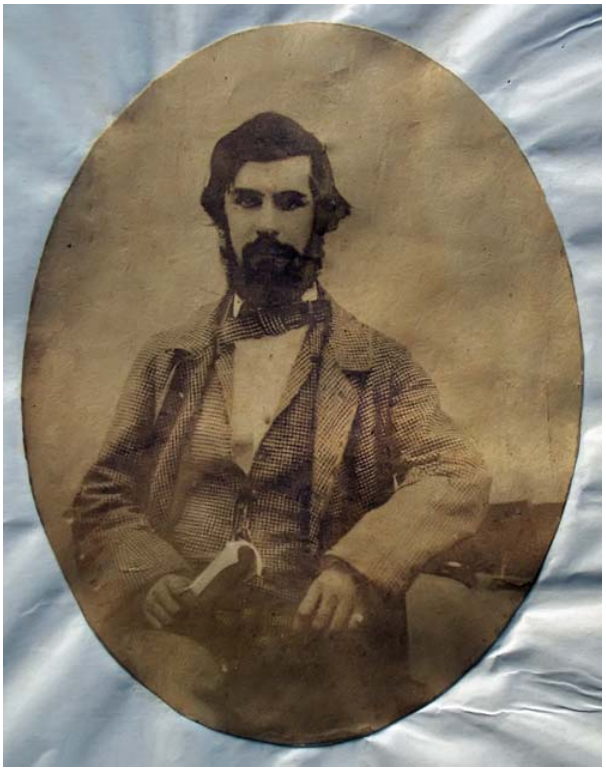
7. GREEN and ROOSEVELT 1879
It is supposed that a trout is very fond of grasshoppers, but the trout in one of our ponds which we have fed for a long time with beef lights, will not look at grasshoppers, and will turn up their noses at the fattest and juiciest worms, while the trout fresh caught out of the stream, which we have put in a pond by themselves to educate, will for weeks refuse the daintiest bits of lights and liver. Hunger will after a time drive them to change their food; but with the young ones we cannot wait for this, as they will die off before they learn. As the fish grow older and stronger more food must be given to them; when six months old, a bowl full of liver will answer for a thousand. While the fish are young, feed often; six or eight times a day for the first two or three months; three times a day will do after three months until they are a year old.

As can be seen from these excerpts, six out of the seven authors did not mention the use of beef heart as a food. It is now time to say more about John Hamilton Slack.

William Henry Fry, Theodatus Garlick, Thadeus Norris, Seth Green, Livingston Stone, R. Barnwell Roosevelt, Fred Mather: these are well-known names in American fish culture. But John H. Slack? Although he was author of *Practical Trout Culture* (1872), a founder the *American Fish Culturists' Association*, a deputy U.S. fish commissioner, and a key player in a nationwide campaign to introduce nonnative species to new waters, few know much about him. In my own essay, "The Early History of American Fisheries" (Klee, 2016), I gave him but brief mention twice. I intend to remedy this omission now.

JOHN HAMILTON STACK

John Hamilton Slack (1834-1874) was born and raised in Philadelphia. His family seems to have been reasonably prosperous and after graduating from the Department of Arts of the University of Pennsylvania in 1856, he made a tour of Europe, Northern Africa and the Nile. Upon returning in July, 1857, he was elected a member of the *Academy of Natural Sciences of Philadelphia*. During the same year he presented valuable specimens of Egyptian natural history and antiquities, for which the thanks of the *Academy* were formally returned. The next year he presented for publication a paper, which appeared in the *Proceedings* under the title " Catalogue and Notes on the Egyptian Antiquities in the Museum of the Academy." In the spring of 1850 he graduated from the Medical Department of the University, and at once applied himself to the practice of his profession and the study of natural history. From this time until his removal from the city he was an active and enthusiastic worker in the *Academy*. His name appeared in the *Proceedings* as a constant contributor to the museum and library, and also as the author of three papers on



John Hamilton Stack (1834-1874).

Mammalogy, the most important of which was a monograph of the Prehensile-tailed Quadrumana of South America. Slack was elected Librarian of the College of Physicians in December, 1864, and served until December 31, 1867.

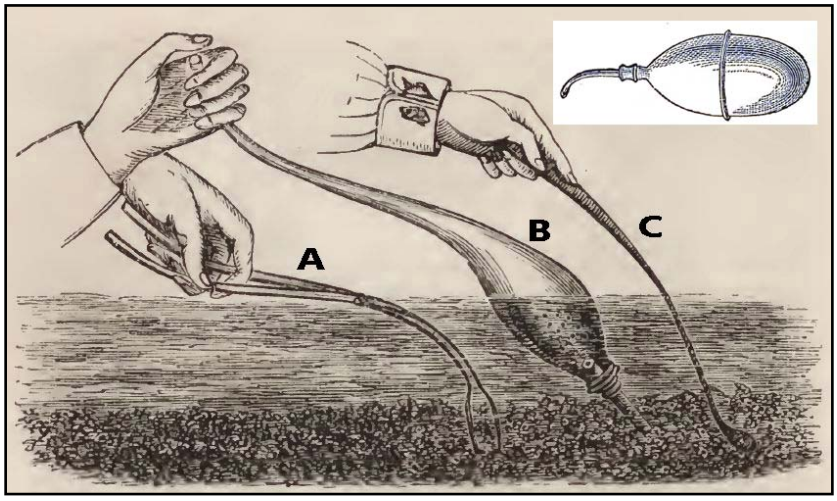
He was a gentleman of unusually varied attainments, a true Renaissance man. Although he was most devoted to the natural sciences, he exhibited an active interest in literature and art. His obituary says he was "a painter of some ability" but he also possessed talents as a musical composer which, if cultivated, would have secured him a wide-spread reputation. As it was, his arrangement of "Home, Sweet Home" was a favorite in thousands of Victorian parlors and rendered his name familiar to thousands who knew nothing about his life-work. he was also an amateur printer who, on a home press, produced handmade volumes of prose and poetry in a "sumptuous style."

Slack was struck by pisciculture as practiced in Egypt but he also was a fisherman and so it is reasonable to assume that he patronized the Philadelphia tackle shop of rod maker and angling *eminence grise* Thaddeus Norris. "Uncle Thad," also known as "the American Walton," was a generation older than Slack. The companionable Norris enjoyed the company of younger anglers, and at some point it is likely they struck up a friendship. At the very least we know they were acquainted.

Norris was interested in the developing science of fish culture and looking for suitable property for building a hatchery. He found just such a place near Bloomsbury, New Jersey. Norris later recorded that he started the hatchery in May 1866 and sold it sixteen months later "in an uncompleted condition to Dr. J. H. Slack."

In the summer of 1867, Slack took possession of 169 acres bordering the lower Musconetcong, in a valley of gently rolling farmland and neat stone houses. Troutdale Ponds, the hatchery itself, took up several acres adjacent to the river. Its outstanding natural feature was a limestone spring gushing a thousand gallons a minute of pure 50-degree water, winter and summer. The spring fed into the single pond dug by Norris and stocked with a few hundred anemic trout. These "died by dozens," wrote Slack in a recollection of his first year of on-the-job training, while "our spawn from want of proper knowledge of the theory of impregnation, and the sickly condition of our parent fishes, perished by thousands." Thousands more washed away in a flood, and thieves absconded with the few healthy adult fish.

Slack persevered. Setting out immediately to make improvements, he added more ponds, with raceways connecting them, and a hatching-house for fertilizing and incubating eggs. On a rise overlooking the hatchery, he built a handsome two-story frame house for himself, his wife and their two small children; two more children soon followed. In the spring of 1868, everything was



Early instruments for removing dead eggs and debris. A is a pair of pincers with pointeds blades; B is a pipette, while C is a scoop to be placed beneath the egg, whch I to be thrown out by a sudden turn of the wrist. Although these worked they were slow and by no means sure. Slack replaced then with the rubber bulb device shown in the inset.

ready in Troutdale. By now, three ponds nurtured a thriving population of trout segregated by size.

In the wake of pell-mell commercial development following the Civil War, states began creating fisheries commissions to promote conservation. New Jersey's was established in 1870, with Slack and fellow physician Dr. Benjamin P. Howell of Woodbury, New Jersey, as charter commissioners. In their first annual report, the New Jersey commissioners noted that the river appeared to be "suitable habitat" for Atlantic salmon and would be stocked with a thousand fry "hatched by the artificial process." The state legislature hadn't authorized funds for stocking, and the commissioners stated they would be doing this at their own expense. Soon enough, however, they found a reliable underwriter in the federal government. Slack and several other hatchery owners had recently founded the *American Fish Culturists' Association*, which successfully lobbied Spencer Fullerton Baird at the newly established *U.S. Commission of Fish and Fisheries* to sponsor a national stocking effort, for which Congress appropriated $15,000.

Troutdale was a busy place. It had become New Jersey's de facto state "hatching house," not only for Atlantic and Pacific salmon but for "salmon-trout" (sea-run brook trout) and landlocked salmon, two other species the fisheries commission introduced into state waters. The hatchery was also raising smallmouth bass and brook trout for private stockings, and watercress for sale in urban markets. Slack was a key player in a nationwide campaign led by Baird to introduce nonnative species to new waters. It was a vast ecological exercise with profound consequences - mainly positive - for American fisheries. To cite just one example, today's Delaware River supports a diverse mix of native and nonnative species: American shad, striped bass, shortnose sturgeon, and brook trout (all indigenous); and smallmouth and largemouth bass, rock bass, walleye, bluegill, muskellunge, channel catfish, European carp, and brown and rainbow trout (all introduced, mostly in the second half of the nineteenth century).

Between 1870 and 1875, Slack's operation raised more than 170,000 Atlantic salmon fry and released them into the Musconetcong and other Delaware tributaries; this was in addition to 154,000 released into the Raritan and two other New Jersey watersheds. During this same period, Troutdale also hatched 450,000 Pacific salmon fry from fertilized eggs shipped from California on the new transcontinental railroad. Most of these (265,000) were deposited in the Delaware, with the rest going to other eastern rivers.

Slack and others in the vanguard of the fish-culture movement viewed the introduction of salmon as eminently worth trying, and for a time it looked like their grand experiment might succeed. Mature salmon were first observed in 1875 and the numbers steadily increased through 1878. 1879 had a good run, but regrettably, the experiences of that year were not repeated. In 1880 just a few adults were recorded, and in 1881 a few were reported but not confirmed. The experiment was a failure.

In the spring of 1873, Baird named Slack a deputy U.S. fish commissioner, an appointment expanding his responsibilities beyond the borders of New Jersey. His immediate assignment was assisting shad-hatching operations in North Carolina and Virginia and escorting a shipment of

The "American Chopper," used by Slack to cut his beef heart.

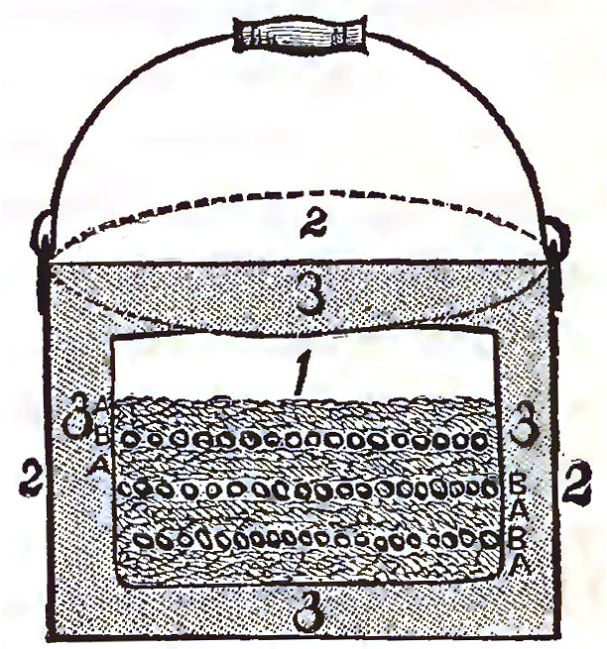
15,000 shad fry to western Pennsylvania for deposit into the Monongahela River, a tributary of the Ohio. The Monongahela fry were hatched at a seasonal station on the Delaware River at Lower Black Eddy, a stretch of slack water near Point Pleasant, Pennsylvania, about 30 miles from Troutdale. In honor of his boss, Slack named the station Camp Baird.

The next year Slack and his shad team set up camp on June 25. They had a good run of fish and by June 29 had hatched 100,000 fry. Slack dashed off a note to colleagues at the *Academy of Natural Sciences* urging anyone curious about "the modus operandi of impregnating and hatching spawn" to join them. Whether anyone did isn't known. What we do know is that Slack departed camp on July 2, leaving an assistant in charge, and went home to Troutdale. Probably he was sick, for on July 3, according to a subsequent account, he took to bed, "prostrated . . . by a violent attack of Pleurisy," an inflammation of the lining of the lungs often associated with pneumonia. Presumably by telegraph, he stayed in touch with Camp Baird until it ceased operations on July 13, having hatched 530,000 fry. By then Slack was gravely ill. He lingered another six weeks and died on 24 August 1874, a month shy of his fortieth birthday.

In his time, John H. Slack was a prominent figure in what can rightfully be called the heroic age of American fish culture. We can marvel at his efforts, however wrongheaded, to establish salmon in rivers where nature never intended them. He might have achieved the stature of his contemporaries Livingston Stone, Seth Green and Fred Mather if he hadn't died young and bet on the wrong fish. In 1875, a year after Slack's untimely death, Stone shipped the first eggs of California rainbow trout to Green's hatchery in Caledonia, New York, with more following in 1878. A few years later, Mather began raising brown trout imported from Germany and Scotland at the New York State hatchery in Cold Spring Harbor. By the early twentieth century, rainbows and browns were thriving in much of the eastern united States. Had he lived, Slack would doubtless have been involved in the introduction of both species, and we would recognize him today as a central player in the history of American fisheries. Instead, he is mainly a footnote, a man who pursued a quixotic quest that was bound to fail.

The following is taken from Slack's 1872 book:

A beef's heart or kidney is taken, and with a sharp knife cut in pieces about an inch square. If heart is used, all skin, arteries, valves, and other fibrous portions which cannot "be readily cut are rejected. The pieces are then moistened with water and chopped to a pulp. This was formerly done with a hatchet and Knife - a work of no small labor. We now accomplish it by means of the "American Chopper." A pound of heart can be cut by this in about seven minutes sufficiently fine for the smallest trout. Should any coagulated blood be found in the heart, it may be thrown into the chopper with it. Yet, still some minute fragments of fibrous tissue may remain, and to remove these, as well as to be



Slack's device for Eggs packed for egg transportation.
A = moss; B = spawn; 1= spawn box; 2 = tin kettle; 3 = sawdust.

sure that all the meat is chopped sufficiently fine, the pulp is mixed with water and washed (not rubbed) through a fine wire sieve of twenty-eight threads to the inch. By this means all fragments over about one-fiftieth of an inch in diameter are retained and may be returned to the chopper for further comminution.

In Merritt's 2011 biography of Slack, he noted: **In the spring of 1868, a Harper's Weekly correspondent visiting Troutdale found everything in order.** The "correspondent" was, of course, William Shanks. The mystery is now solved. John Hamilton Slack, in 1838, was the first known American to use beef heart as a fish food.

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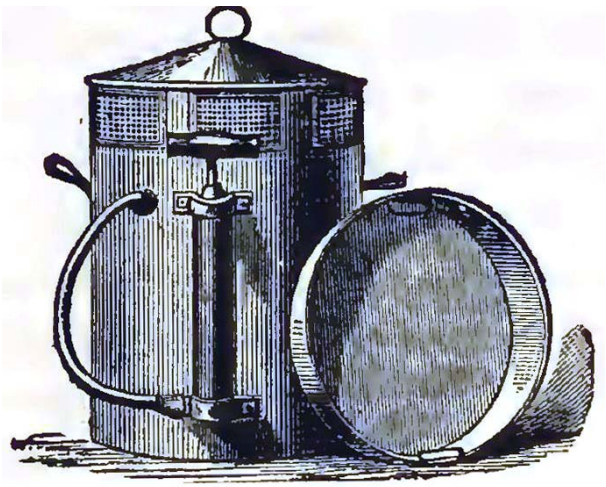

The Troutdale Transit Tank, invented by Slack. The can is constructed of heavy galvanized sheet iron ; to the outside is attached an air-pump, communicating by means of an india-rubber pipe with a tube leading to the bottom of the can, which terminates in a nose similar to that of a watering-pot pierced with minute holes. By simply working the handle, air is driven in, and being divided into fine bubbles by the nose, completely aerates the water, restoring the oxygen consumed in respiration by the fishes.

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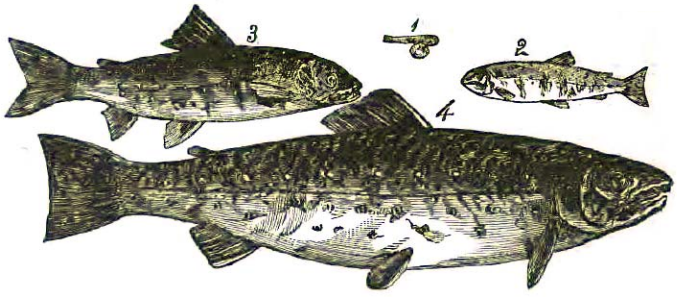


Trout at various ages:
1, just hatched; 2, six months;
3, one year; 4, two years.

PDF SECURITY FOR AQUARIUM HOBBY ORGANIZATIONS

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, August 11, 2017)

File security has been with us since the beginning of personal computers. The simplest kind was to move a tab on a floppy disk to prevent overwriting any of its files. Another was to set the file to read only, which protected them from accidental or unauthorized changes. Things haven't changed much since the natal days of the home computer, except that they have gotten more complicated and security more difficult.

WHAT IS A PDF FILE?

In 1991, Adobe Systems' co-founder John Warnock outlined a system called "Camelot" that evolved into what is now known as the Portable Document Format or PDF. While Adobe Systems made the PDF specification available free of charge in 1993, it was a proprietary format, controlled by Adobe, until it was officially released as an open standard on July 1, 2008. It was published by the International Organization for Standardization as ISO 32000-1:2008, at which time control of the specification passed to an ISO Committee of volunteer industry experts. In 2008, Adobe published a Public Patent License to ISO 32000-1 granting royalty-free rights for all patents owned by Adobe that were necessary to make, use, sell, and distribute PDF compliant implementations.

The PDF file format is used to present documents in a manner independent of application software, hardware and operating systems. Each PDF file contains a complete description of a fixed-layout document, including the text, fonts, graphics and other information needed to display it. In other words, it is a file that will look the same on the screen and in print regardless of what kind of computer or printer someone is using and regardless of what software package was originally used to create it. Problems that are caused by fonts that are not installed on the viewer system are unknown when using this format, the files are very small and their content can be stored compressed. Thus, it is a convenient, cheap and effective solution for distributing digital documents, hence its widespread use by aquarium hobby organizations.

PDF files can be created in a number of ways. On my computer I have four programs that I use to create them. One is Microsoft Word. In Word I enter my text and include figures and tables as required along the way. When finished, I print the file using a PDF printer driver (this is one of the printer options that comes up when you hit the PRINT button) and the resulting file has the PDF extension. Another program is Adobe Photoshop. I enter the text, figures and tables as I do in Word but in this case when finished I use the "Save as" command and save it as a PDF file. The other two are pdf creation/editing programs, Adobe Acrobat and Nuance Power PDF.

When you create a PDF file it cannot be easily edited or changed in any way (one reason is that it is compressed to save space). However, you can add to it and the additions can be easily edited or changed. Look at it this way. The elements of PDF file you just created - text, images and tables - are embedded on a single layer and combined as one entity. However, in a PDF editor you can add other layers, notably headers, footers and watermarks, and these can be edited and changed easily. Headers and footers are areas where you can insert the date, time, page numbers, and more to top and bottom margins

of each page in a document. Watermarks are a pattern of bits inserted into a digital document that typically identifies on each page the file's copyright information (author, rights, etc.). (The name comes from the faintly visible watermarks imprinted on stationery that identify the manufacturer of the stationery). The purpose of digital watermarks is to provide copyright protection for intellectual property that is in digital format.

The problem is that ANYTHING in a PDF file CAN be edited with a PDF editor. Large areas such as watermarks, headers and footers can be whiteouted digitally, and individual text can be deleted, changed or added to the file.

WHY DO AQUARIUM HOBBY ASSOCIATIONS NEED PDF SECURITY?

There are two - but not necessarily mutually exclusive - main reasons:
(1) The organization wants to restrict the use of the material to members only, and
(2) The organization wants to sell the material either as a way to recover the cost of producing it or as a means of income.

With regard to the latter, some of these materials involve a massive amount of the member volunteer work that supports these organizations. The pilfering of this revenue could not only be crippling in obtaining volunteers to do this kind of work in the future, but it could affect the financial future of the organization as well. In any event, for whatever reason the security of these widely used PDF files needs to be protected.

PDF BUILT-IN SECURITY

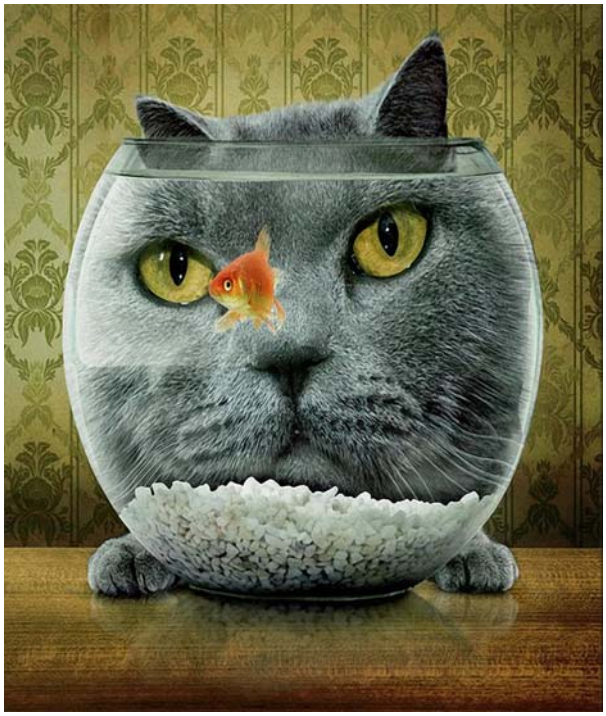
PDF documents offer two basic types of PASSWORD security:
(1) A USER PASSWORD (also referred to as an open password) is required to open the file for viewing.
(2) A PERMISSIONS PASSWORD (also referred to as an owner or master password) is required to change any security settings, such as prohibiting changing the document, printing, copying or extracting text. Note: If a restricted file is copied, the file will generally have "(SECURED)" added to the name of the file, e.g.,

Newsletters, 2010-2017, American Mudskipper Association.pdf (SECURED).

PDF password cracker tools fall into two major categories:
(1) Tools that recover the user password, and
(2) Tools that remove the permissions password in restricted files, allowing full access to the file.

In the first category, the Brute Force Attack is the most widely known password cracking method. This attack simply tries to use every possible character combination as a password. The number of possible combinations (and therefore required time) grows rapidly as the length of the password increases and this method quickly becomes useless. The table shows the time required for the Brute Force Attack depending on the password length and used character set. It is assumed that the attack is carried out on a single computer and the brute force speed is 500 000 passwords per second.

This kind of security, however, is not relevant for aquarium hobby organizations; it is used by the



PASSWORD LENGTH	CHARACTER SET			
	Lowercase letters	Lowercase Letters & Digits	Both Lowercase & Uppercase Letters	All Printable ASCII Characters
5	Instant	2 min.	12 min.	4 hours
7	4 hours	43 hours	23 days	4 years
9	4 months	6 years	178 years	44,530 years

owner of the file to protect it from being accessible to or stolen by others who have access to the computer that holds the file.

In the second category, the tools that remove the PDF permissions password allowing full access to the much easier. Here one is not looking for the correct password but only the place in the file where the permissions password is located. Since one doesn't even need to know the password to remove it, even a 20-character password with upper and lower case letters, numbers and all ASCII characters (e.g., #, $, &, etc.) is worthless in this regard.

WATERMARKING AND RESTRICTIONS

Since the purpose of digital watermarks is to provide copyright protection for intellectual property that is in digital format, some organizations have used them and they do provide some security. For one thing, it is difficult to sell or even give away a document when it is watermarked for a specific owner. Infringement of copyright is almost always specifically mentioned on the CDs that contain these documents, for example,

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Copyright © American Mudskipper Association 2017

If this is done, there is really no need to place any further restrictions on the CD, such as prohibiting copying, printing or extracting pages.

It has been traditionally assumed that including a user-name watermark such as in this example in a PDF file secures the file. Now there are two types of people in this world: (1) those who would never copy an organization's material and give or sell it to another, and (2) those who would. Anyone in the former group would not try to break security, so any discussion about security would be of academic interest to them at the most. Anyone in the latter group would persist until they found a way to break this kind of security. Once broken, the watermark could then be removed manually. THUS, ADDING A USER-NAME WATERMARK TO A FILE IN THIS WAY IS HARDLY ANY SECURITY AT ALL.

PDF CREATOR/EDITORS

The three best of these programs from a 2015 re-

view of ten of them (in order of decreasing rank, i.e., 9.95, 9.4 and 9.00) were: Adobe Acrobat ($300), Nuance Power PDF Advanced ($98) and Foxit Phantom PDF Standard ($78). (These prices will, of course, vary.) Although Acrobat is the standard, you don't have to pay the high Adobe Acrobat price. The Nuance Power PDF Standard, which has all the features that an aquarium hobby organization would need, can be found for as little as $65 on Amazon.com. Indeed, this is the PDF creation program I use, having replaced my old Adobe Acrobat Version 9. In this white paper I will refer to it simply as "Power PDF."

Note that not all PDF editors fully support and respect settings made by other editors such as watermarks, headers, footers and restrictions that are made after the basic pdf is created. Therefore it is best when using an editor to use it only on pdf files that do not contain post PDF creation settings made by any other program.

A SOLUTION

There is a solution that has been available for some time and it is difficult to break, especially for long files. PDF programs since the time after Acrobat version 9 have had the ability to flatten and merge elements within pdf files. PDF files are generally constructed as layers, with the main layer containing the text and images of the document and secondary layers such as headers and footers and watermarks.

To "flatten" a PDF file means that a selected secondary layer in the file will become seamlessly imbedded throughout the document. In Power PDF, watermarks can be protected by embedding them in the file by doing the following:

1. After constructing the watermark go to the "Advanced Processing Menu" and select "Layers" (see Figure 6).
2. A little wrench icon with a down arrow appears; right click on the arrow and select "Flatten Layers." Wait until Power PDF finishes doing this on all pages of the file.
3. The watermark can now only be removed page by page in a PDF editor, a daunting task for large files.

Incidentally, the process is extremely fast; on my computer a 1,000 page PDF file took Power PDF 20 seconds to install the watermark and 18 seconds to flatten and embed it in the file.

HEADERS AND FOOTERS

The header is a section of the document that appears in the top margin, while the footer is a section of the document that appears in the bottom margin. Headers and footers generally contain additional information such as page numbers, dates, an author's name or footnotes, which can help keep longer documents organized and make them easier to read. However, they can also be used to display the same type of security information that the watermark is intended to do and thus a footer is helpful in showing an additional security warning such as, "COPYING OF THIS FILE OR ANY PART OF IT FOR DISTRIBUTION IS A CRIME!"

There is, however, a catch; they cannot be embedded like watermarks and thus they can easily be removed manually. However, one can prepare a watermark that contains, for example,

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Copyright © American Mudskipper Association 2017

at the top, and the following at the bottom

COPYING OF THIS FILE OR ANY PART OF IT FOR DISTRIBUTION IS A CRIME!

We've met!

POWER PDF AND WATERMARKS

Power PDF allows only one watermark per file but there is no limit on the number of lines in the watermark. A left click on "Watermarks" in the Home Menu brings up a thumbnail view of all the watermark lines on the left side of the screen. A red plus sign at the top of the thumbnails enables you to add a watermark line, name it and set type properties and position of the line. When this is done, Power PDF creates a new thumbnail with that name. Note that a double left click on a thumbnail enters the line into the file, and a right click brings up a list of options, the most important being "Apply" and "Edit."

It is important to note that when a watermark line is edited, the old line must first be removed, otherwise the edited line will be written right over the old one. It might be supposed that the options "Remove Watermark from Document" or "Delete" will do the job but the first will remove ALL the watermark lines from every page of the document and the second will remove the line AND its thumbnail. The line must be removed therefore by other means to be shown shortly.

A FLOWSHEET FOR SENDING THE FILES TO MANY RECIPIENTS

First, create a copy of the file to be secured and add the water mark with name of the first recipient. In this example I have used a single-page pdf file dealing with the origin of plastic bags in the hobby. Figure 1 shows the file and the various Menu headings of Power PDF.

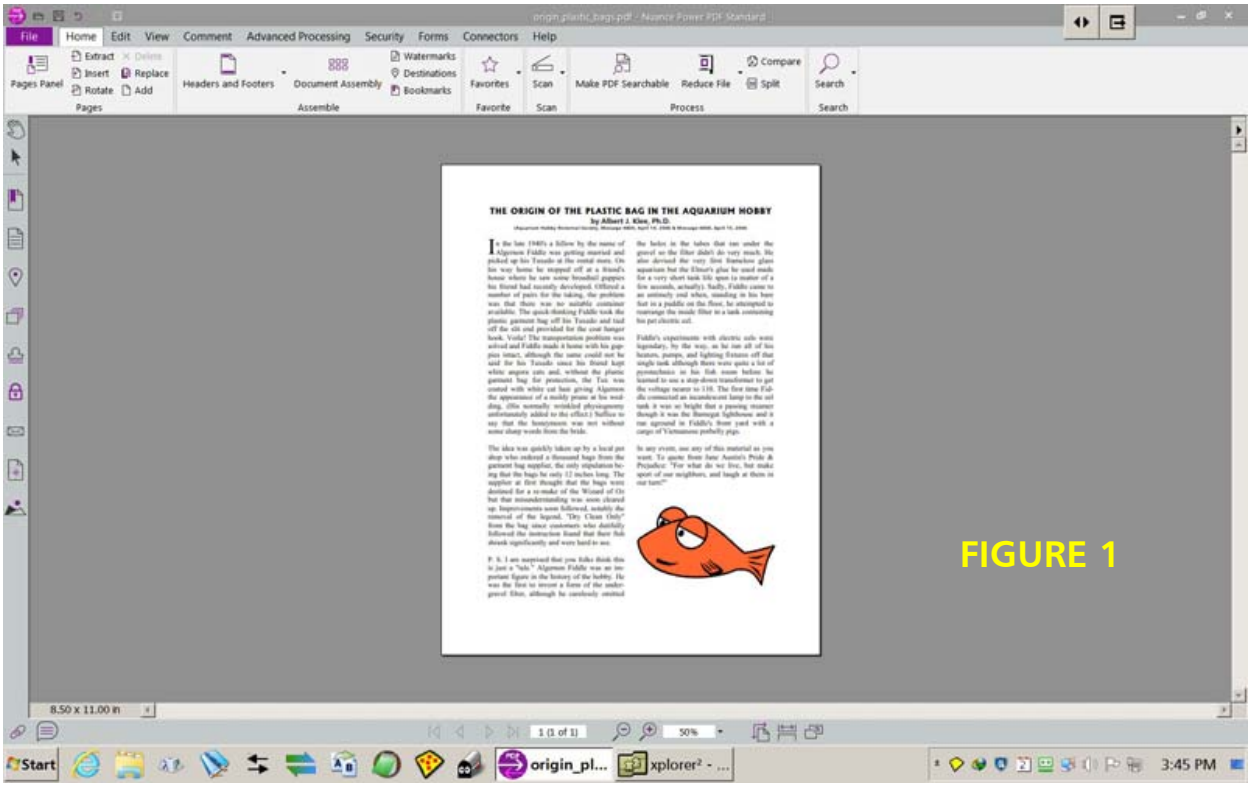
1.In HOME, click on WATERMARKS. A section to the left opens up with a red plus sign and a wrench image at the top (Figure 2).

2. Click on the red plus sign. A "Create Watermark" dialog box opens up and you are ready to create the first watermark and its thumbnail. (Figure 3).
3. In the Title box type LINE1.
4. In the Properties Text box type in the first line of the watermark,

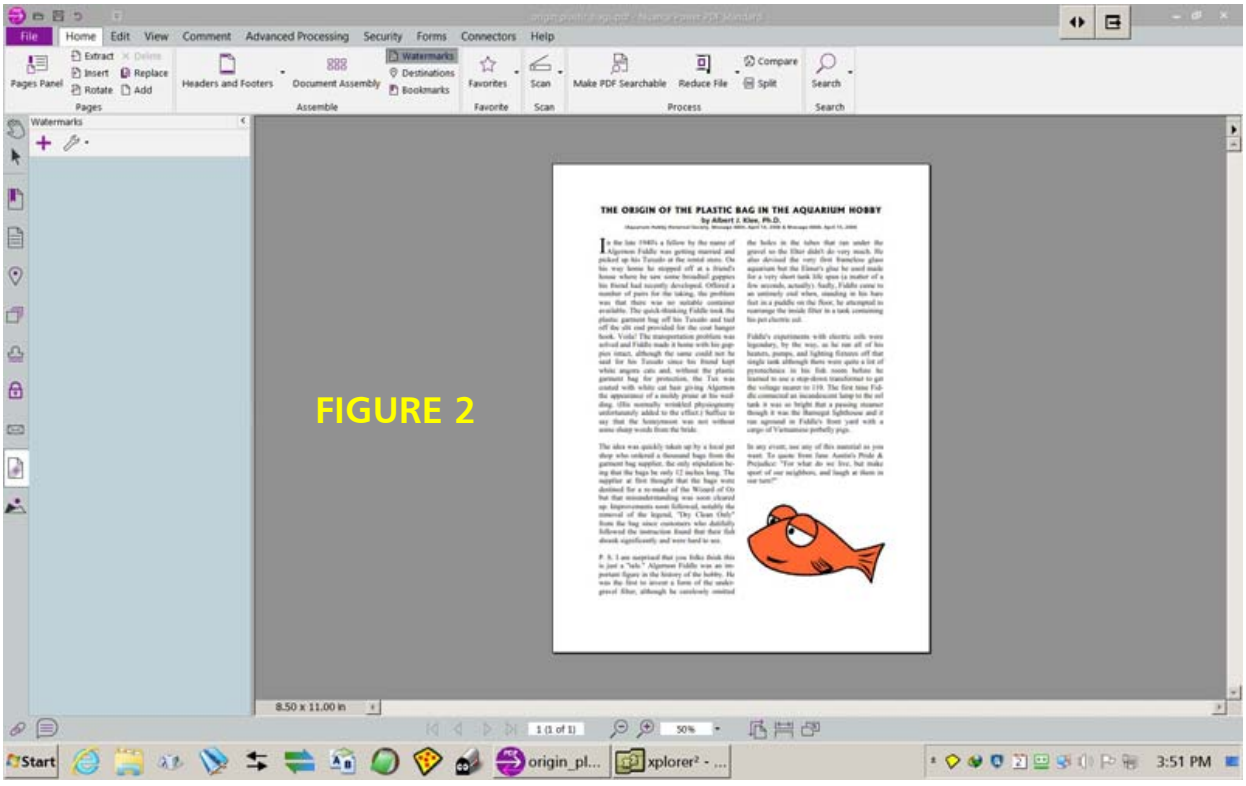
Issued to Paul Fishfinger 7/31/2017.

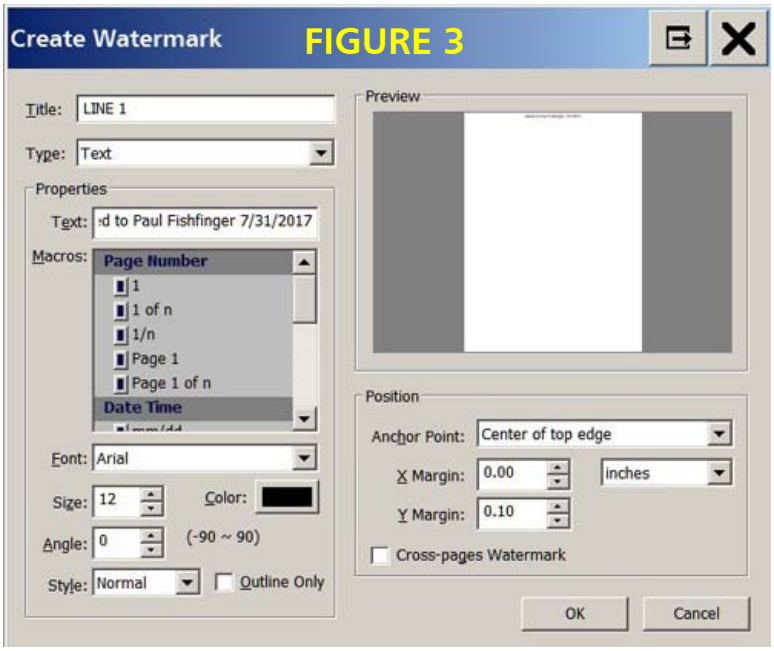
Use the Font, Size, Color and Style boxes to set the type.
5. In the Anchor Point box select "Center of top edge."
Use the Y-Margin box to place the line vertically (0.10 in this case). You can use the scroll wheel, the arrow in the box or just type it in.
6. Click OK.

7. Repeat this for the **Copyright © American Mudskipper Association 2017** line and the **COPYING OF THIS FILE OR ANY PART OF IT FOR DISTRIBUTION IS A CRIME!** line, titling them Line 2 and Line 3, respectively. For Line 3 set the Anchor Point box to select "Center of bottom edge" so one doesn't have to scroll down almost a full page. (Note: In this file I used Y-Margins, in inches, of 0.10, 0.25 and 0.07, respectively for Lines 1, 2 and 3.)



8. Right click on the Thumbnail for Line 1 and left click on “Apply.” An “Apply Watermark” box will appear. Make sure all pages are selected and left click OK. Wait until the application of the watermark is finished. The file is now watermarked with Line 1.





9. Repeat for Line 2 and Line 3. You now have a 3-line watermarked file (Figure 4). Save this file under the name MASTER.PDF and copy it (in two or more locations) in case anything goes wrong.

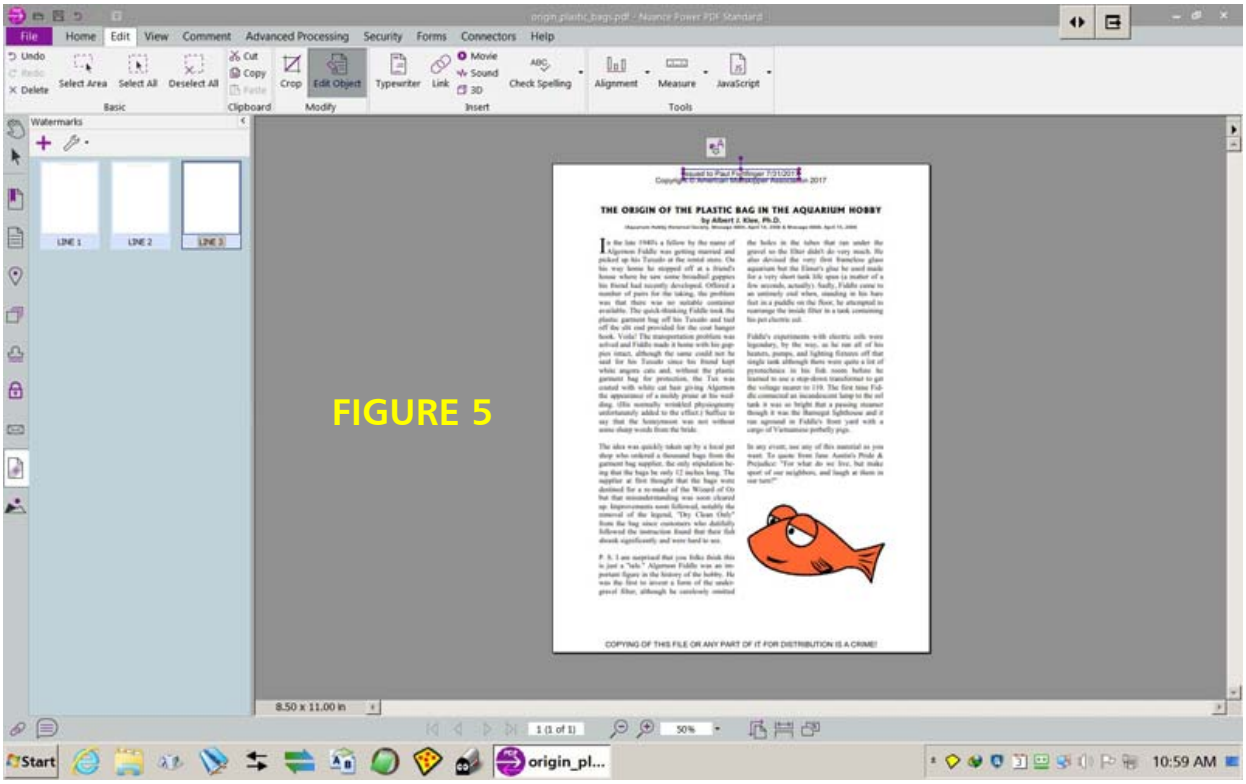
The flowsheet procedure now is as follows:

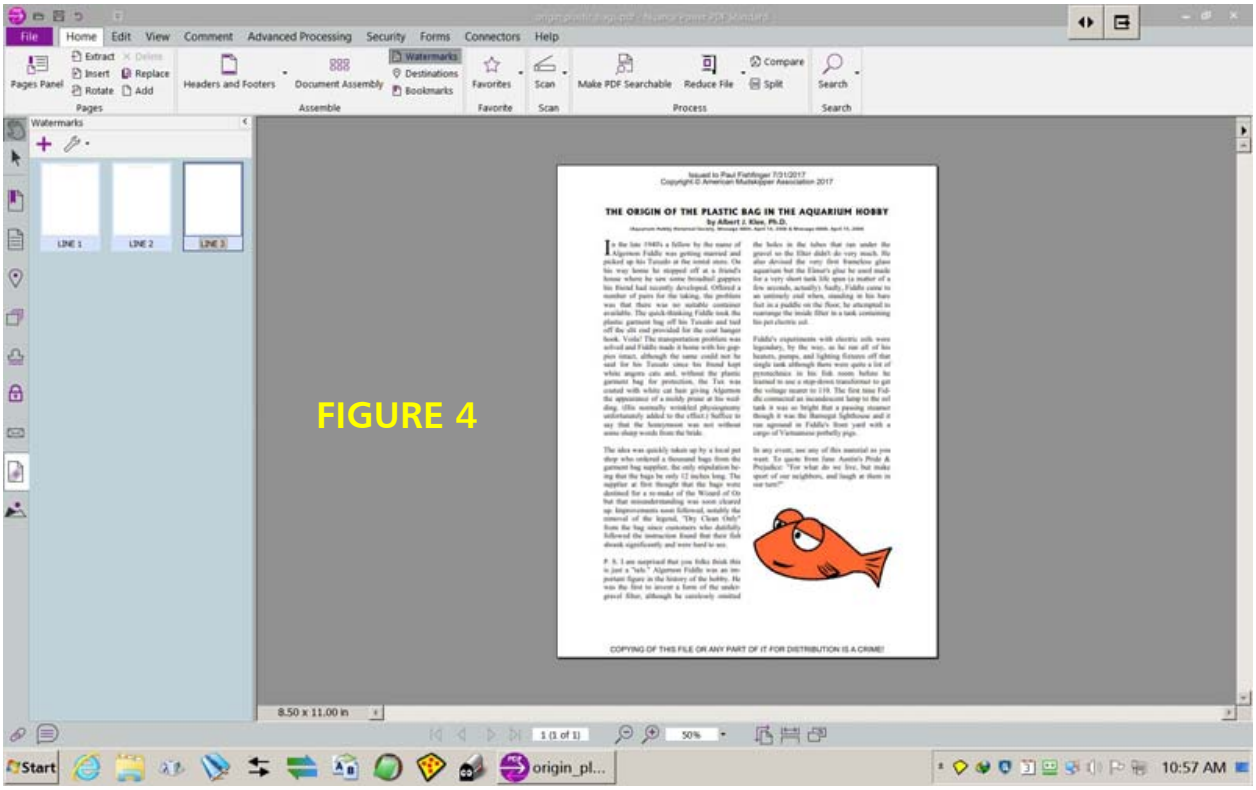
1. Copy the Master.pdf file to a different folder and rename it to describe what it contains, e.g., **Newsletters, 2010-2017, American Mudskipper Association.pdf**.

2. Under the Edit Menu select Edit Object and the cursor changes to an arrow. Place it over LINE 1 in the watermark and left click. A box now surrounds Line 1 (Figure 5). When you see the crossed arrows, right click and select Cut. The first line in the watermark is now deleted, leaving the other lines unchanged.

3. Under the Home Menu select Watermarks and right click on the first line thumbnail and select "Edit." Change the name to the new recipient and click OK. Right click on the thumbnail and select "Apply." Wait until the application of the watermark is finished.

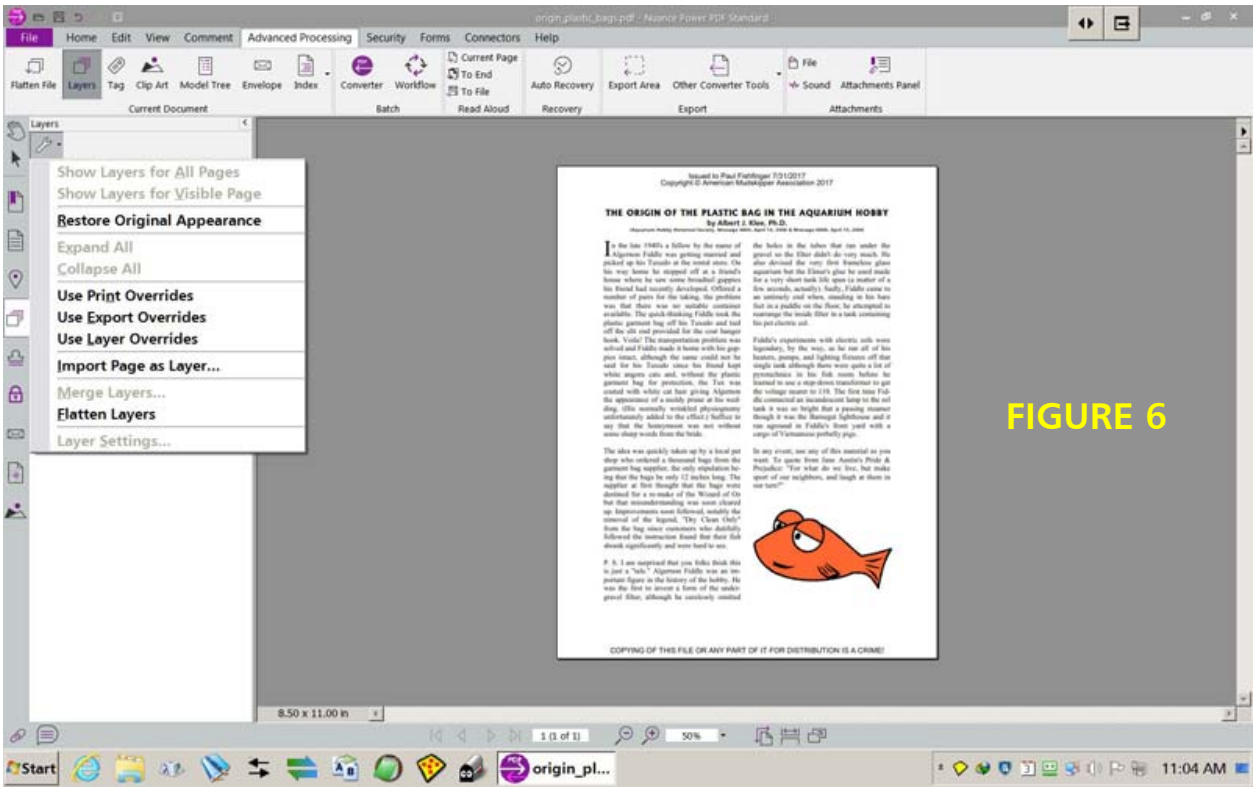
4. Under the ADVANCED PROCESSING Menu select Layers. A box opens up at the left with a wrench at the top left corner. Left click on the wrench and then left click on "Flatten Layers" (Figure 6).





5. Save this file and either send it to the recipient or burn it to a CD and send it. Now go back to Step 1 and stop when all recipient files have been written.

Although this flowsheet may look complicated, it is actually very quick and simple once one has tried it. It is usually not necessary to refer to it again after doing it three or four times.



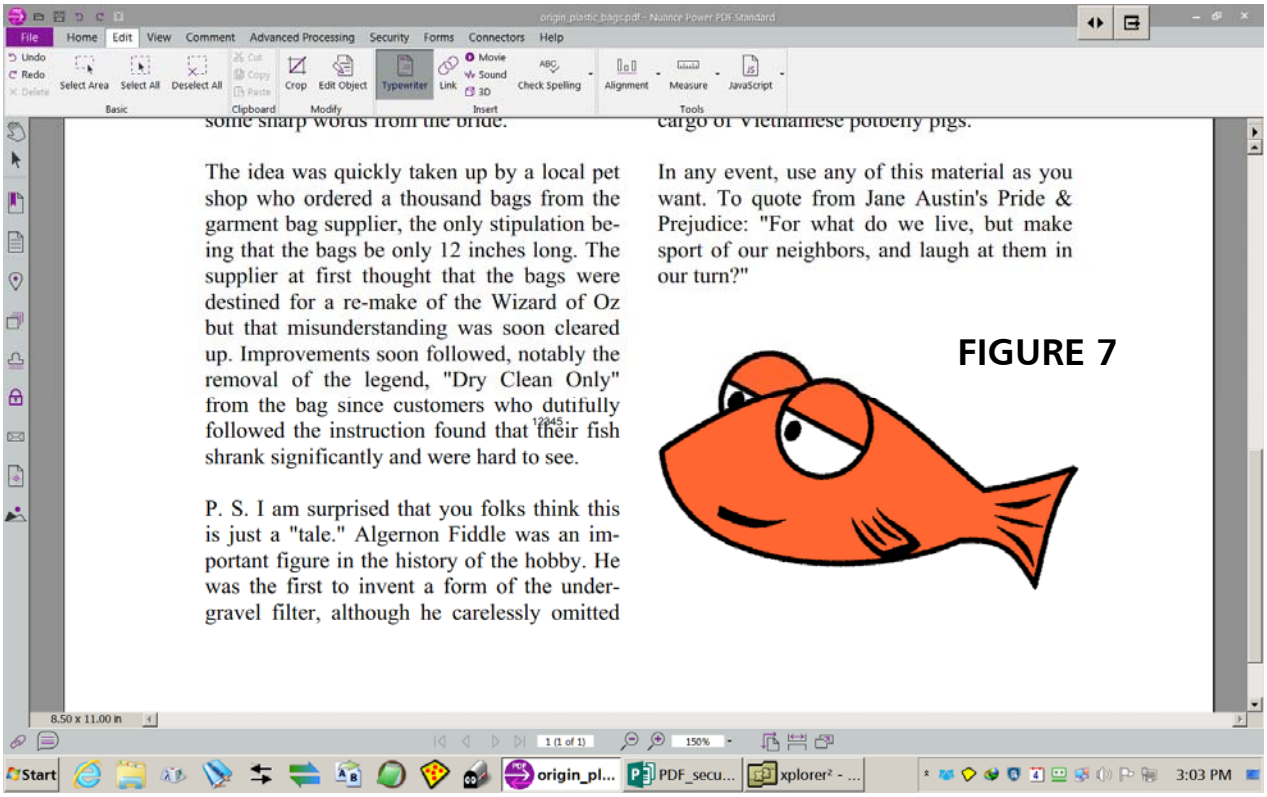


FIGURE 7

EMBEDDING THE USER NAME

Embedding the user name in such a way that it is not easily detectable is another security measure, especially suited to large files. This is done as follows:

1. In Power PDF select a page in the document.

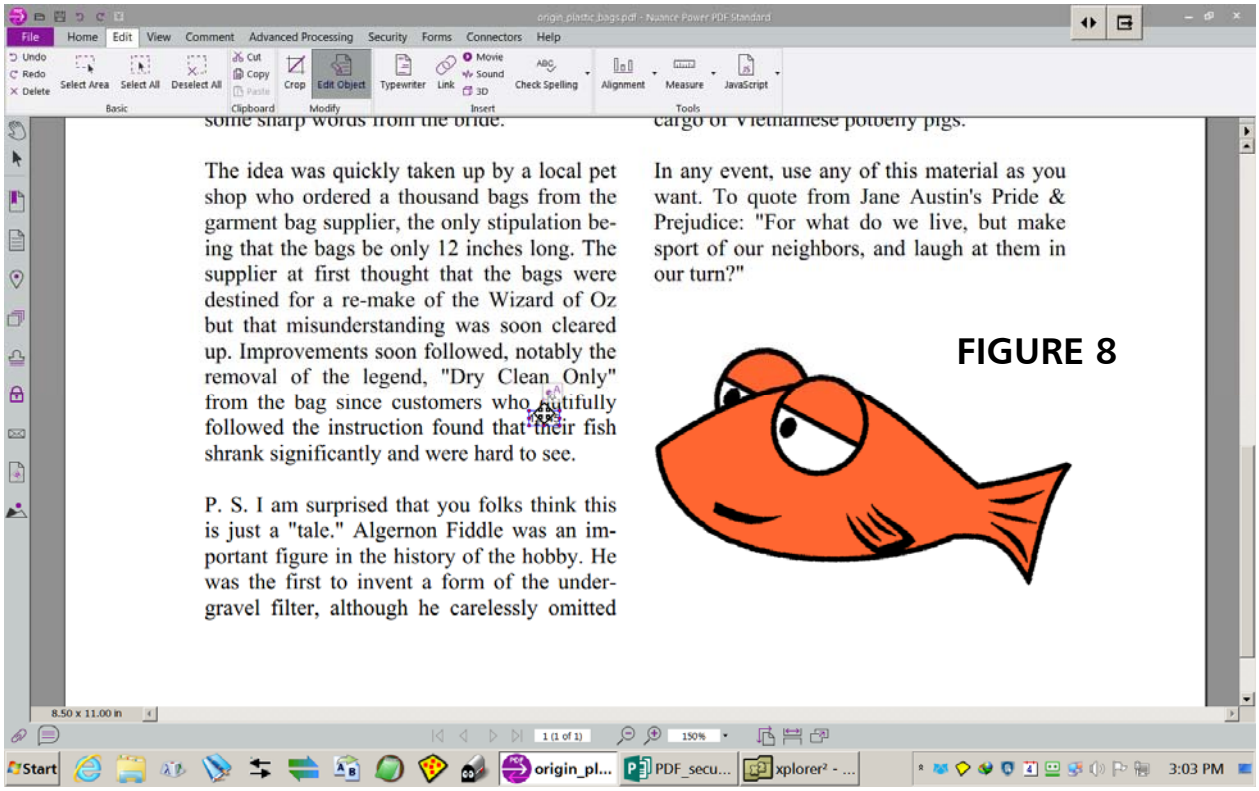
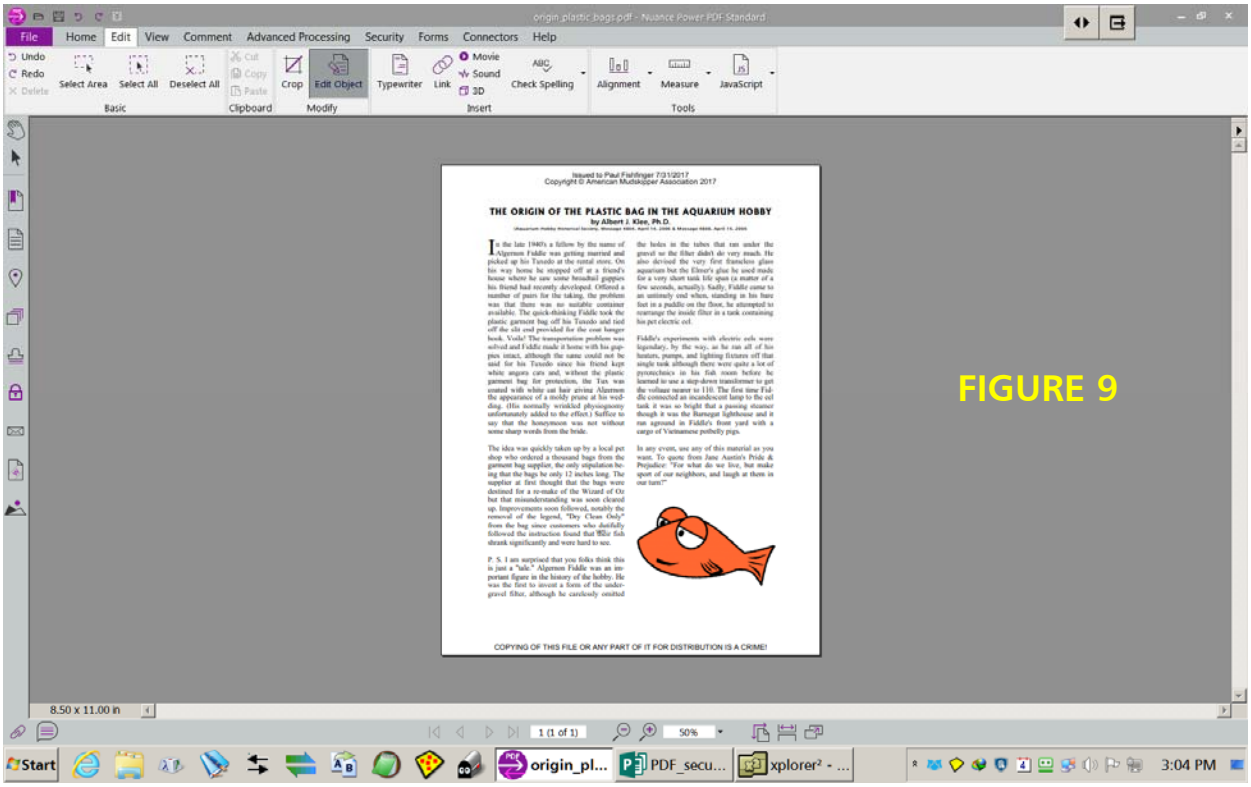


FIGURE 8



2. Under the Edit Menu select "Typewriter."

3. Move the cursor anywhere and left click.

4. Enter the code used to ID the user (I have used "12345."). In Figure 7 the fish's nose is pointing to it.

5. Under the Edit Menu select "Edit object." Move the cursor on the text just created left click and a box now appears around the text. Right click within the box and select "Properties" and then the "Text" tab. Select Arial at a 6 point type size and close the Properties box.

6. Place the curser within the box (it turns to a cross - Figure 8) and move the text it anywhere on the page you like. You can also use the Control plus arrow keys (small movements) and Shift plus arrow keys (very small movements) to move the box. If the arrow keys are used it is not necessary for the cursor to be in the box.

7. Under the Advanced Processing Menu, click on Flatten File, check "Select All" and click on "OK." Figure 9 shows that it is difficult to spot the code, especially if it is buried in an image in the file.

The code is now in the file and the organization can retrieve the user's name even if the watermark is removed. The organization must keep a record of the page the code number is on, although for simplicity this can be the same for all recipients. It also should keep quiet about it. However, an interesting ploy is simply to announce in the watermark that the name is embedded in the file without actually doing it. The thief will waste his time trying to find it! It is an additional signal that the file may be traceable to its original owner, another deterrent to illegal distribution of the file.

HIGH SECURITY IS EXPENSIVE

Unfortunately, having a watermark that is difficult to remove is no guarantee that the file will not be given away or sold. There is always a market for "hot goods" sold by a thief and commercial companies go to great - and expensive - lengths to minimize this.

There are three main approaches that can be taken to provide a high security for documents:

1. User-independent authorization systems: These are systems where files are downloaded and are authorized for offline usage by either: device

identification, which requires prior registration of the device; or by entry of an authorization code that is checked on a central system (does not require prior registration).

2. User and/or device-dependent systems: These are systems where each person downloading a document must be pre-registered on a centrally managed service, and then each publication they are permitted to view is centrally enabled for them.

3. Online-based systems: Approaches 1 and 2 assume the files are to be downloaded and read offline - no host connectivity is required after the initial stage of downloading and enabling. In many ways a simpler alternative is a hosted service, where the files are kept centrally (i.e., in the "cloud") and displayed via a browser.

Note that all of these systems require a "central system," a "centrally managed service" or a "hosted service," all of which are expensive and which must be maintained 7 days a week, 24 hours a day.

An example of the most common system employed commercially today is activation. These activation schemes work by creating a unique value or ID for each user, based on the user's hardware configuration and the product serial number, though this is implemented differently by different vendors. Microsoft, for example, sends a single combined value, while Macrovision, the maker of the popular Digital Rights Management (DRM) product SafeCast, sends two separate values: the serial number and a number representing the hardware. The user information is transmitted via the Internet (or telephone) to a vendor's activation server, which receives the value, records it in a database and sends back a unique activation code that unlocks the user's product.

Depending on the vendor's implementation, unique hard drive or Registry identifiers are stored on users' machines. There is no way around this, since the key to the process relies on checking user licenses locally each time the application runs. Macrovision's SafeCast stores the values in several areas to make cloning more difficult and to protect legitimate users from accidentally wiping out their license files. (One area is an unused portion of a PC's boot track 0. While this sounds clandestine, an ID stored in that location is less likely to be deleted inadvertently than a file or Registry entry would be.) Clearly no aquarium hobby organization could afford to implement any of these systems.

CONCLUSION

Placing other restrictions on the file, such as changing the document or printing, copying or extracting text is a waste of time since they can be removed without any special knowledge needed by an unprincipled user and are irritating to a legitimate user. In short, the best solution for creating recipient files is, starting with an unsecured PDF file, adding a user-name watermark, flattening all layers, saving the file under a different name and sending it or burning it to the recipient's CD. Change the user-name in the first watermark line and repeat for as many new recipients you have. I also recommend embedding the user name (in code) and not advertising that this is being done.

JOSEPHINE WHITE (1916-1973)

Our First African American Aquarist of Note

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, September 2, 2017.

Josephine White was born Josephine Harris in Abbeville, South Carolina on March 15, 1916, her father being a farmer with a large family. Josephine had five brothers and three sisters and of the nine children, Josephine was the youngest. Not much is known about her early age but at the age of 18 she married Charley White, who lived in the small town of Due West, about 12 miles away from Abbeville. She had four daughters in quick succession, all one year apart (in the 1940 census they were: Betty, age 5, Nellie Mae, age 4, Dolly, age 3 and Jessie age 2). Unfortunately, Charley died shortly after Jessie was born and Josephine was a widow with four children to support. Coming from such a large family, it is supposed that they provided some additional support.

TOP: The location of Abbeville County in South Carolina. BOTTOM: The locations of Abbeville and Due West in Abbeville County, South Carolina.

The year 1940 was still in the Great Depression era and she listed her occupation as laundress and her prior year income, in today's currency, about $1200. The depression was interrupted by World War II and since men were scarce, women were in jobs in factories supporting the war effort. It is possible that Josephine moved from South Carolina - perhaps with one or more of her brothers - to take a job in one of these factories or else to do laundry or other household tasks for those in those jobs. In any event, she obtained a Social Security number during this time while living in Illinois.

In 1951she met Victor White (no relation) and were married shortly afterwards. Victor was born in September 1903 in Hutchinson, Kansas, about 36 miles from Newton and was about 13 years her senior. In 1953 she had a son, Walter, and at that time Josephine, her husband, son and four daughters were living together in Newton. I met Victor and found that he was a pleasant and friendly fellow. Walter, by the way, over time developed a keen interest in his mother's hobby.

Oxen pulling a wagon heaped with cotton bales into early Abbeville, South Carolina.

Josephine was now a "housewife" and for the first time had the time and money for a hobby. How she became interested in tropical fishes is not known but it is clear that it started sometime in the early 1950's. Her interest in the aquarium was broad, as attested to the fact that she was a Charter Member of the American Killifish Association in December 1961. In addition to being an accomplished breeder of such fishes as angels, rams, a variety of tetras (including the black phantom and the emperor), barbs, discus, bettas, killifishes and African frogs, Josephine White had that rare ability to communicate to her fellow aquarists the knowledge her years of experience in the hobby has accumulated. Some time back, the Duluth Aquarium Society collected a number of Josephine's articles and produced a booklet of her work. Other aquarium societies have followed this idea of publishing a collected work of a single author, but Josephine was the first author to be so honored. Her last article, titled "Aquariums for Show and Pleasure," appeared in the June-July 1972 issue of *Northwest Aquaria*, a publication of the Greater Seattle Aquarium Society (after her death, it was reprinted in the July-August 1974 edition. See Addendum).

Josephine often traveled over 125 miles just to attend an aquarium society meeting. She was frequently asked to judge fish shows, and she traveled all over this country on such duties. She was Vice-President of the International Betta Congress, and was on its Board of Directors. She also created the marble and piebald betta varieties. Josephine was a religious person and played an active part in her local church. In one exchange involving the question of whether a fish can or not, she remarked, "Well, I was right again. I told you all things are possible by the grace of God."

EPILOGUE

Josephine White died in November 1973, a few months shy of her 58th birthday (her husband died ten years later, at the age of 80). She was born poor, black, with little formal education and forced to raise her four children alone after her first husband (also poor, black and with little education) died. She worked at menial jobs until she remarried, but had a warm-hearted personality and a positive outlook on life. That she was highly intelligent I can attest to personally, and her many accomplishments support this observation as well.

I often wonder what Josephine would have become if she had the opportunity to go to college. Over the years I have known many people who have been educated at expensive universities with no apparent effect whatsoever. Josephine White would not have been one of them. Someone a long time ago asked me who I thought was the most interesting person I had come across in the aquarium hobby. It was supposed that I would answer that it was William T. Innes, but the question was who was the most interesting, not who had the greatest effect. My answer then was Ida May Mellen. That still holds, but if I had to choose a second place, it definitely would be Josephine White.

TOP LEFT: Reno County Kansas with Hutchinson shown by the white dot.
TOP RIGHT: Harvey County Kansas with Newton shown by the white dot. (The black dot is Wichita.)
BOTTOM. Newton in the 1950's.

ADDENDUM: AQUARIUMS FOR SHOW AND PLEASURE

By Mrs. Josephine White

(From the June-July issue of *Northwest Aquaria*)

Now is the time to start planning your aquariums for the oncoming show. A well planned aquarium can and will be a pleasure to all who see it at home or in a show. Smaller aquariums present some problems one does not have in larger aquariums; but for those who have only smaller aquariums or want to show them this should in no way be a stumbling block. Regardless of the size of the aquarium it must be very clean inside and out, so start with a clean, empty aquarium, making sure the back glass is quite dry.

START WITH A GOOD BACKGROUND

First, let us consider the backing for the aquarium. This I believe is very important. The fish shops have several different kinds and brands of crystal paint and sprays and both come in a wide choice of colors to suit everyone's preference. Since these paints have very toxic fumes, application of them should be done outdoors or in another room as far away from the fish as is possible, so the fumes will not be picked up by the pump and pumped back into other aquariums. Painting should be done in the early morning or cool of the evening or in a cooler room, then let dry where direct sun does not shine on it. This gives best results. Follow the directions on the container of paint carefully, starting at the top of the aquarium and working to the bottom. The brush paints can be poured from the bottle across the top of the glass with the aquarium tilted at an angle, and working this from side to side until the paint reaches the bottom by this motion. This gives the effect of hills and valleys and is most attractive. Choose your color carefully, as 1ight or bright colors do not compliment all fish. Since this may be done several weeks ahead of time for the show, and you may not be certain just what fish will be shown in it, it may be wise to choose a color that will show all fish to the best advantage for your background.

OTHER BACKGROUND SUGGESTIONS

Some people do not like to paint the backs of their aquariums. In this case, there are several choices both in material and color. Florist’s paper that is used to wrap flower pots works very well. Recently a contact paper especially for aquariums was introduced in the shops. Colored foil, such as is used in gift wrappings, also makes nice backings and may be taped to the back of the aquarium for easy removal when desired. Aluminum foil should seldom be used. Light reflects onto the back washing all color from the fish and gives a glaring effect.

PLANTS CAN SERVE AS BACKGROUND

For those who do not want a backing of any kind on their aquariums there is another method: Planting very thickly across the back with *Vallisneria, Myriophyllum, Ambulia, Anacharis* or *Cabomba,* taking care all plants are tall enough to reach the top at least and if longer look very nice laying on top of the water when seen from the top. Planting thickly prevents seeing through the aquarium. The plants require a lot of light and some will do poorly if used in fresh water. It is best to use well-aged water, or better still, clean, clear, filtered aquarium water.

FILTER SYSTEM IS IMPORTANT FACTOR

I like to set up aquariums at least two weeks before a show... this takes planning but pays off best in the end. Remember dirty gravel causes cloudy water. Always wash gravel well and sterilize. This should be done to filters, rocks and driftwood. The bit of green color that may cling to some rocks and wood gives a very pleasing effect. Filters should be carefully chosen to be sure they are large enough for the aquari-

um used so the water will clear in the shortest length of time, and remain clear. Sub-sand filters or outside filters are best for use in shows, since they take little room in the aquarium and are more easily hidden. But if you do not have either of these, a corner box filter may be used. Regardless of the type of filter used, the filter box and/or stems should be hidden as much as possible with tall plants, rocks, driftwood or a combination of these, attractively arranged.

GIVE SOME THOUGHT TO YOUR GRAVEL

Gravel can be piled up high and held in place with rocks and stones, giving a shelf effect that is most attractive. Remember to keep all rocks, stones and plants in proportion to the size aquarium used. Best results in any and all set-ups require more gravel than is normally used, and this should be piled high at the rear of the aquarium and slope to the front, and may be quite shallow in the center, near the front. This too, helps bring the fish to a more central area, making them easier to be seen. Gravel should be chosen with care; all fish do not show well over just any kind or color of gravel. Gravel that is more natural on color works best in most cases and should be medium size.

SET UP IN ADVANCE IF POSSIBLE

I have found that an aquarium set up well in advance looks more natural. Things seem to settle in place, plant roots work into the gravel, preventing unsightly roots from showing and this gives time for any changes you may feel will improve the overall picture. Every time the aquarium is seen for the first few days you may decide to make a few changes. Be sure all roots are buried as deep as possible; then pull the plant up (gently so as not to bruise the leaves) until the crown of the plant rests just at the top of the gravel. In larger aquariums some of the plants may be planted in small glass dishes or plastic dishes or flower pots and buried in the sand. Never lay rocks and stones on top of the gravel; these should be buried at least an inch (if at all possible) in the gravel so they will not give the effect of being just dropped in as an afterthought. A portion of driftwood should be buried for the same reason. All rocks, stones and driftwood should be chosen to give a pleasant color contrast. Plants used may be contrasting shades of green but not too startling and should be pruned to remove all defects in the leaves. This may make for a smaller plant, but two or more plants may be held together by lead weights at the crown base to make a better shaped plant. When we are dealing with smaller aquariums, any driftwood used must be small.

POSITION PLANTS CAREFULLY

Plant the taller plants for the background as close to the rear of the aquarium as possible and around the filter or filter tubes (to hide them) and around the two back corners first. One corner may be planted thicker than the other. Remember no two settings in nature are exactly the same. A stone or rock may be placed in this corner so it will extend out into the unplanted area and very low plants arranged near the end of this to give the effect of new plants just starting to grow there. Small Cryptocorynes, Dwarf Vallisneria or small clumps of moss may be used for this. The opposite side should be planted with a larger plant, commonly called a center plant. This plant should not be placed in the center of the aquarium, but somewhat off-center. A few small rocks may be used at the base of the plant if desired, but do not make the aquarium appear rock-happy. Sword plants, Spatterdock, Temple Plant and Cryptocorynes or Radicans work very well for this. Remember the planting should be placed so there is an open area in the center of the aquarium so the fish will tend to swim in this area where they are more easily seen. Caves can be arranged for the fish that like this type of set-up. Construct them so the fish will feel secure and hidden, yet are not hidden from the viewer. Fish must feel secure to show best. Cover the gravel and plants with newspaper or paper- towels and fill the aquarium about three-fourths full; then remove the paper. This prevents the sand or plants from washing out of place.

TAKE GOOD CARE OF THE FISH

The fish you plan to use in this set-up should be chosen carefully according to size, color and sex, being certain they are as near perfect as possible, and placed in separate aquariums. If this cannot be arranged, place them with fish that will not nip or pick on them, or in any way cause damage or death.

FEED THEM WELL AND OFTEN

For healthy fish, feed the best food possible at least two times a day. Remember too many fish make a busy aquarium that is hard to view and the fish can and will get scrappy if they must fight for food, thus spelling trouble.

DON'T TEAR DOWN

At set-up time, siphon out the water from the set-up aquarium (into clean containers) down to the top of the gravel. Do not move the plants or rocks. Just cover with clean paper and the aquarium is ready to move to the show. Net the desired fish into a container with enough water from the aquarium they were in to completely fill the aquarium to be set up. This will lessen the shock of putting fish into different water. Keep the number of fish used on the conservative side.

Artificial plants are best used with plant-eating fish and usually not in combination with live plants. Artificial flowers should never be used in any case. Divers, hutches and ceramics should be used only in novelty set-ups. Burping clams, shells and things of this type should never be used in "natural" set-ups.

Below are a few suggestions for fish that can be used in two to five gallon aquariums. These are mature fish or very nearly mature, as all show fish should be, to show their best.

FISH	No. for 2 Gal.	for 5 Gal.
Killifish:		
Lyretails, Gardeneri, Rachovi & small Killies)	pair	1 pair
Blue Gularis (larger)		2 pairs
Guppies	1 pair	2-3 pairs
Platies, Moons or Variatus	1 pair	2-3 pairs
Tetras, Danios (Neons, Cardinals, White Clouds, Zebras, Spotted & Leopard Danios & any small species)	2 pairs	3-4 pairs
Swordtails		1 pair
Ramirezi	1 pair	2 pairs
Badis badis	1 pair	2 pairs
Other dwarf cichlids		1 pair or trio
Barbs	1 pair	2 pair or 6 fish (males and females)

LARGE TANKS REQUIRE MORE OF EVERYTHING

Larger aquariums will, of course, need more plants, sand or gravel, rocks, longer and larger pieces of driftwood, where this is used. Larger aquariums, from ten gallons up, allow much more room for more attractive planting and ideas, as well as larger fish. Care should be taken not to have the rocks too large or too numerous, or a rock-heavy appearance is given.

SAME PRINCIPLES APPLY

Bank the gravel from the back to the front. I like to use nearly twice as much gravel for a show set-up than is normally used. This allows for deeper planting of the plant roots and the rocks can be buried easier. Select the best filter possible for the size of the aquarium. The larger the filter the faster it will clean the water after the aquarium has been set up. If an inside filter is used this may be partly hidden in the deeper gravel, giving good results. Arrange the gravel and background plants to hide the filter or any filter tubes as much as you possibly can and as attractively. Using larger aquariums will also permit you to use the larger varieties of plants. Since most shows last only a few days and the fish used in these aquariums are frightened and upset in most cases from being moved, care should be taken that the corners are filled so they will not hide in them. Vallisneria makes a nice background plant in any aquarium and there are several choices in this: a giant, corkscrew and regular...as well as *Sagittaria, Cabomba, Myriophyllum* and *Anacharis* which can be used but they are not rooted plants and should be weighted down and buried deep so they do not float up.

USE ROCKS AND PLANTS TOGETHER

Shale and rock ledges can be built against the rear glass, across part or all of the back, or in one corner if desired, filling in any spaces with gravel for stability and to keep the fish from hiding or being trapped there. One of the most attractive setups I have seen was a shale ledge in one corner over and around the filter. The filter tube came just above the highest ledge of shale; this gave the effect of water trickling down from a mountain stream. Mudskippers were shown in this set-up and the water level was naturally lower than in most cases, so the fish could get out of the water on a ledge when they wanted to. The gravel sloped to the opposite corner that had a beautiful rock with low plants at its base. Needless to say, this set-up took a great deal of planning and time. The aquarium was of fifteen gallon size and very attractive. Where a center plant is used this could be larger and there are several good varieties to choose from: Sword plants, Lace plants, Radicans, Cryptocorynes (some of these have large, broad leaves, Spatterdock, Temple plants and Water Wisteria al 1 make nice center plants. None should be planted to the very center of the aquarium but rather back and off-center so none of the leaves will touch the front glass. These plants are all different in shades of color and texture and will add interest to any aquarium. Small plants of most of these and especially Cryptocorynes are very attractive planted around the base of a rock.

LEAVE ROOM TO SWIM

Whatever the choice of plants and planting, leave an open swimming space in the front of the aquarium for the fish so they can be seen in the open. Larger aquariums need larger plants, but too many plants tend to hide the fish, and detract from the total effect.

NATURAL PLANTS ARE BEST

If plant-eating fish are to be used in the aquarium, it is permissible to use artificial plants. An aquarium can be made attractive with the use of larger rocks and driftwood, which are found in the natural habitat of the fish.

TOO MANY FISH

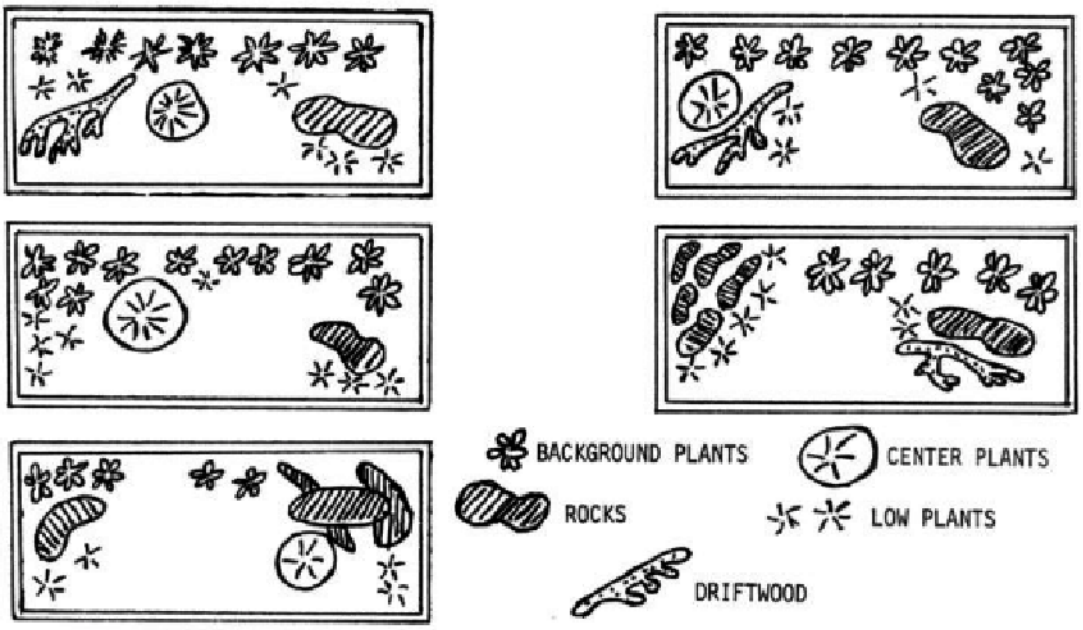
Large fish may be displayed to a better advantage in large aquariums. It is better to display one good pair of fish than a group where one may be old, lazy, injured, sick or deformed, or have torn fins from overcrowding, all of which can take valuable points from a good pair of fish.

SELECT TANK TO FIT FISH

The size and the number of fish to be shown in each aquarium should be one of the most important points in the selection of the size of aquarium used. Naturally larger bodied fish such as Piranhas, Oscars, Discus, Severums and Chocolate Cichlids, to name a few, should be shown in aquariums of at least 25-gallon size.

DON'T PUT SINGLES IN COMMUNITIES

In community set-ups, all fish should be compatible, and two or three of a kind should be shown. Large and small fish do not go well in a community aquarium (such as mature Angels and Neons). If only one of a kind is available...even though it be a perfect specimen...it is best not included.
I hope that the following "top-view" drawings will help give ideas on possible aquarium set-ups.



Josephine White was an avid breeder of Discus in the 1960's.

THE CULTURAL ASPECTS OF THE WARINGTON/GOSSE AQUARIUM ERA, 1850s-1860s

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, November 30, 2017)

In Stephen Jay Gould's book, *Leonardo's Mountain of Clams and the Diet of Worms*, and more specifically in his essay within titled "Seeing eye to eye, through a glass clearly," he remarked that although the owner of any respectable Roman villa could look down upon the animals in his fishpond - and similarly the simple bowl had also allowed the contemplation of a fish or two in the more direct, edge-on, eye-to-eye orientation (through glass, or some other transparent medium that did not always come easily or cheaply) - these precursors were not aquariums in the technical sense for they lacked the defining feature: a stable community of aquatic organisms that can be viewed, not from above through the opacity of flowing waters with surface ripples, but eye-to-eye and from the side through transparent glass and clear water.

According to Gould, a fishbowl presented a temporary display, not a stable community. The water quickly goes foul and must be changed frequently. The concept of an aquarium, on the other hand, relied upon the principle of sustained balance among chemical and ecological components - with plants supplying oxygen to animals and plants removing the carbon dioxide generated by the fish, fish eating the growing plants, and snails (or other detritus feeders) scavenging the wastes and devouring any algal film that might grow on the glass walls.

Since the word "aquarium" owes its usage in the aquarium hobby to Linnaeus and the gardeners and the horticulturists that came after him and can be applied to any artificial body of water that contains fish, I disagreed with Gould (and therefore devised my "Four Stages of the Aquarium Hobby") but not with his conclusion that "**… we only learned the "natural" way to see marine life when the invention of the aquarium permitted us to see through a glass clearly, and to examine a brave new world face to face."** In Figure 1, for example, Johann Scheuchzer's marine fishes are portrayed from the top-down vantage point of a shore-bound observer. This was a common portrayal in the 1700s. In Figure 2, in the first edition of Louis Figuier's - the Carl Sagan or David Attenborough of his day - *The Earth before the Flood* (1863), the top image depicted Devonian sea creatures cast up on the beach. In the bottom image from the fourth edi-

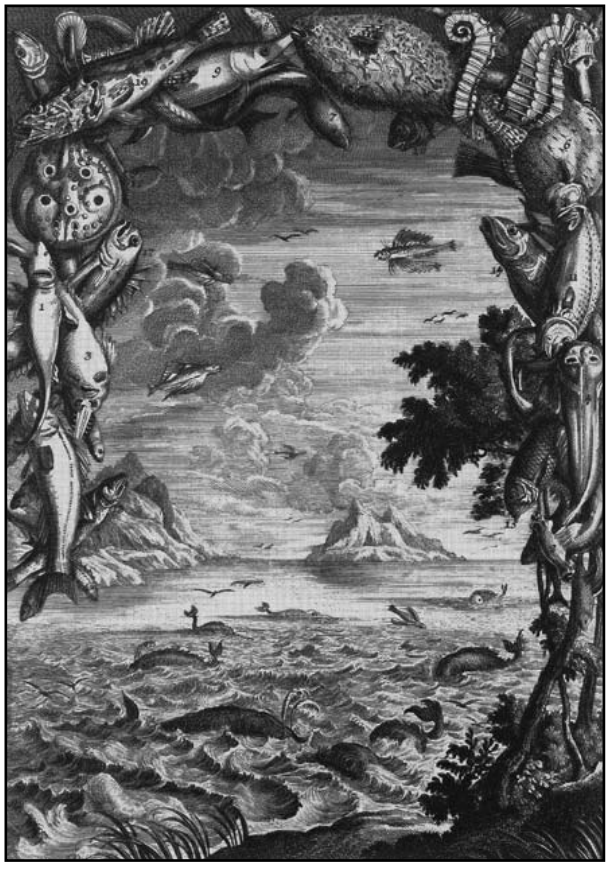


Figure 1: Scheuchzer's marine fishes as seen on the surface of the ocean and as a framing garland are portrayed from the top-down vantage point of a shore-bound observer. This was a common portrayal in the 1700s.

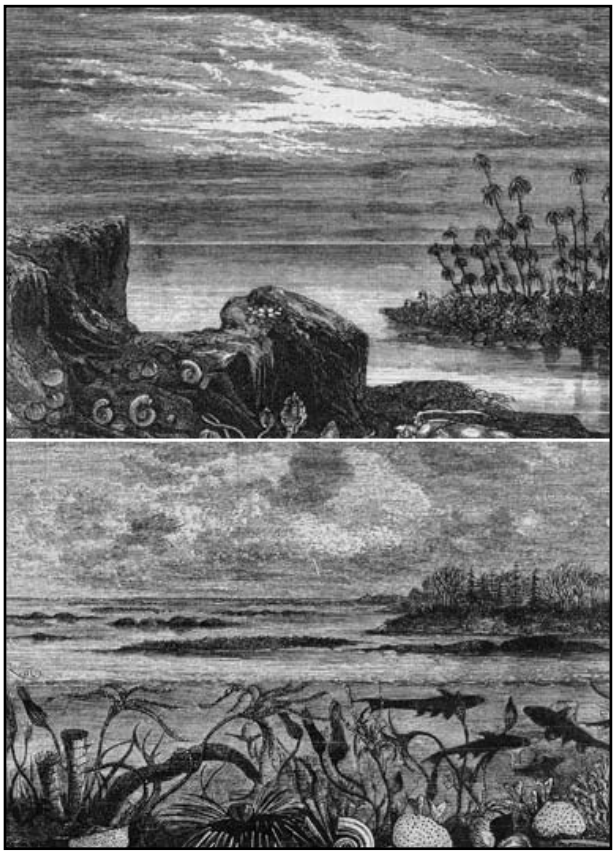


Figure 2, Top: In the first edition of Louis Figuier's "The Earth Before the Flood" (1863), this image depicted Devonian sea creatures cast up on the beach. Figure 2, Bottom: In the fourth edition (1865), a post-aquarium perspective or straight-on view is evident.

tion (1865), a post-aquarium perspective or eye-to-eye view was evident.

Until the middle of the eighteenth century, naturalists had been mainly interested in the physiological description of fish and this could easily be carried out from the study of a corpse. However, the study of the behavior of aquatic beings requires one to be able to observe them living in their natural environment, the water. At the turn of the eighteenth and nineteenth centuries many naturalists were therefore looking for a specific technical device capable of keeping marine organisms of all kinds alive for an extended period of time, the aim being to reconstitute as closely as possible the natural environment of fish. In the past, several modes of conservation and observation of aquatic flora and fauna had been implemented with varying degrees of success, such as the fish pond and the simple jar. Thus was born the "balanced aquarium," the proof of principle demonstrated by the chemist Robert Warington and the naturalist Philip H. Gosse in the early 1850s in England. The intention of the promoters of the aquarium originally was not to confine this invention to the scientific world alone, but to disseminate it widely to the population as a whole so that it could study life underwater, and also to observe and admire it. This resulted in two types of construction: the private aquarium, owned by private individuals, and large public aquariums.

It is interesting to ask what, in the cultural behavior of this period, determined this "moment" of the aquarium, its rapid rise and then its rapid decline (it lasted at about as long as the hoop skirt). To what extent had the aquarium become, in the hands of young women of good society, an ornamental object, a fashionable requirement and then a delegation to the commonplace? How did the aquarium, on a larger scale, enter the early stages of a pictorial culture based on the renewal of visual aids. How was this invention ambiguous because it represented, on the one hand, an undeniable mark of the progress of science and of the superiority of man over nature, but on the other hand, a world dominated by progress and nascent capitalism as well as a moral guide bringing the viewer closer to nature?

THE FIRST AQUARISTS: WOMEN AND THEIR DAUGHTERS

In his 1856 book, "Rustic Adornments for Homes of Taste," Shirley Hibberd extolled the invention of devices - rustic adornments - that allowed home-dwellers to cultivate nature within domestic walls. Hibberd's book contained successive chapters on all forms of indoor natural displays, from fern cases to aviaries and floral arrangements, but he devoted his opening chapter to the great craze that defined his decade of the 1850s - the establishment of aquariums in homes seeking approbation for being with the times. **"I commence,"**

Hibberd writes, "**with the Aquarium, which, for its novelty, its scientific attractions, and its charming elegance, deservedly takes the first place among the Adornments of the House**."

Although the initial intention of the inventors of the aquarium and naturalists in general was to introduce this new apparatus of study to a very large part of the population as part of a wider project of scientific popularization and dissemination of natural history to amateurs, in spite of these democratic intentions the main actors of the fashion that surrounded the aquariums were largely from the wealthy classes. For them, the aquarium was a new and expensive curiosity, the most beautiful object in a parlor. The aquarium took on the status of all the fashionable rarities which, since the eighteenth century, had invaded the collections of the wealthy.

Yet what marks the originality of this new invention, and which explains more precisely its ascent at this precise time, is the role it played with the women of such classes. Parallel to the vast movement of interest of women for natural history, many of them, such as Jeanne Power de Villepreux or Anna Thynne, had directly participated in the scientific research which preceded the establishment of this kind of aquarium. Subsequently they were, more than men, passionate about the aquarium, and were the first to participate in the fashion movement that accompanied the newly-introduced device. In other words, speaking to the lady of the house, if you did not have one of these aquariums in your home, your dwelling was behind the times and out of fashion.

It should be mentioned that what happened in England during this time occurred in lockstep with what was happening in France. The French have two phrases, *outre-Manche* and *d'outre-Manche* meaning "across the channel (or in Britain)" and "from across the channel (or from Britain), respectively. *Outre-Manche* in France, for example, this was evidenced by the publication of numerous articles dedicated to the aquarium in newspapers intended for this type of public, particularly in the 1860s such as *Le Journal des Demoiselles* , *Le Magasin des Demoiselles* and *Le Magasin des familles*. In these articles, any girl of good family was advised to have an aquarium in their living room (Figure 3).

The place of women in the enthusiasm for these ornaments of a new kind can also be linked to their position in the domestic sphere. Women at the turn of the 1850s and 1860s tended to take better care of their homes. In some cases, special attention was paid to decorating in order to match or enhance the husband's position. Through its feminine interest, the aquarium gradually lost its purely scientific status, becoming an object that was above all, decorative. Articles from the periodicals cited above highlighted the ornamental aspect of the aquarium, populated by movements and animated by the always changing colors of the fish (Anon, 1860):

The aquarium is placed in front of a window: a ray of sunshine arrives, makes the water

Figure 3: Young women around an aquarium, *The Journal of the Demoiselles*, p. 257, August 1864.

sparkle, sparkle the scales of the sea bream, blossom the beautiful flower of the aquarium; a sparrow comes to drink, flies take a bath: life and what it brings with it of pure, gay, fresh and charming, bursts thus under this ray of sun, and ready to this corner of your room a charm that will never give to it the sumptuous furniture nor the most wonderful object of art.

Even a scientist such as Pierre Carbonnier, who specialized in aquaculture and had a Quai du Louvre (a wharf located along the Seine River) aquarium shop in Paris, explained the success of his aquariums to his wealthy clients (Carbonnier, 1864):

The aquarium has become almost a piece of furniture of luxury and amenity, and has found its place in apartments of the rich, even in their lounges, next to their elegant planters.

In the hands of the mistresses of the houses of the 1860s, the aquarium was not a laboratory apparatus, but a pure trinket of distinguished interiors. The aquarium was often perceived as a painting, a composition of forms and colors, always recreated by the movements of plants and aquatic animals in the tank. Descriptions of aquariums revealed this image, which tended to reinforce the ornamental character of the aquarium, representing it, through its "plastic beauties," as a "beautiful lantern,"(Rufz de Lavison , 1863), a source of splendor and beauty in a rich interior. Thus remarks the young girl of the *Diary of the Demoiselles* when she speaks of her fish (Anon, 1861):

Mine - I told you that everyone possessed at least one - is charmingly vivacious; its scales shine in the sun like gold; the fine fins, of which I admire the minute details, when they do me the honor of remaining at rest, seem to be hands of extreme delicacy, which bear it in every direction.

A NEW VISUAL SPECTACLE

In Philip Gosse's *The Aquarium* (1856), Plate I (Figure 4) is an image of a wrasse drawn by Gosse - he was a consummate draftsman - and hand-colored by him. The lithographic publishing house founded by Michael Hanhart (1788–1865) in London produced outstanding chromolithographs. Using a complex layering of tint stones, Hanhart produced elaborate works unique for their coloration and tonal values. The technique involved the use of multiple lithographic stones, one for each color, and was extremely expensive when done for the best quality results. Depending on the number of colors present, a chromolithograph could take even very skilled workers months to produce. Hanhart was the one Gosse chose for the Wrasse Plate and for the numerous other colored plates (pasted in the book) in the book that depicted life undersea. These plates stunned the readers of Gosse's books including artists of all sorts and their various schools.

There were, of course, paintings that included goldfish bowls before the Warington/Gosse 1850s -1860s aquarium Era. Figures 5 and 6 were painted in 1829 and 1833, respectively, and not surprisingly both are still lifes. The Giusti painting, however, in comparison almost appears modern. Figure 7 was painted in 1835 by Samuel F. B. Morse, who introduced the daguerreotype to America and also invented the telegraph and the code that bears his name. This, however, was a family portrait and the goldfish within is merely one in the set of background objects. Figure 8 was painted in 1856 by Jonathan Eastman John-

Figure 4: The first Plate in Gosse's 1856 "The Aquarium."

Figure 5: "Still Life, Game and Hanging Snipe with Goldfish in a Bowl (Dead Game)," painted in 1829 by Benjamin Blake (1757–1830). Blake worked for most of his life in London, producing small, gem-like larder and game pieces redolent of country life.

Figure 6: "Stilleben mit Aquarium Umstellt von Sommerblumen und Vogel sowie Schmetterling" (Still life with aquarium surrounded by summer flowers and bird and butterfly), painted by Salvatore Giusti (1773-1851) in 1833.

Figure 7:
Mrs. Richard Cary Morse and family. Richard was the brother of F. B. Morse (1791-1872) who made this painting in 1835.

son. It is a rather dreary image - the paint is peeling off the wall and the girl is clearly not happy- and as the title of the painting indicates, it is just one of the girl's pets. None of these figures have

Figure 8: "Girl and Pets," painted in 1856 by Jonathan Eastman Johnson (1824-1906), an American painter and co-founder of the Metropolitan Museum of Art, New York City.

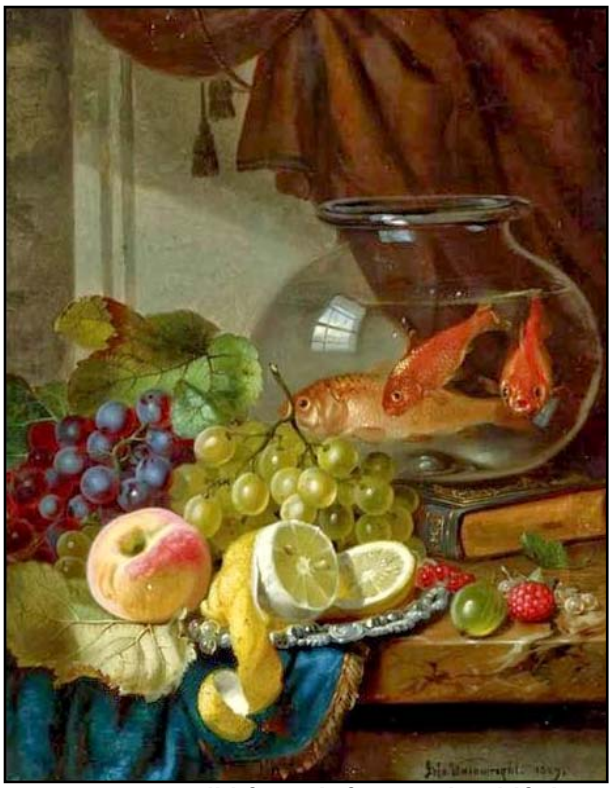


Figure 9: "Still life with fruit and goldfish in a bowl on a ledge, by John Wainwright (a popular British painter) in 1859.

Figure 10: "Fishbowl Fantasy" by Edward Ashton Goodes (1832-1910), painted in 1867. Little is known about this artist except that he lived in Philadelphia and exhibited at the Pennsylvania Academy of the Fine Arts between 1855 and 1868. He was known for his opulent still life, marine and landscape painting.

anything to do with the aquariums of the Warington/Gosse Era of this essay. Two that do, however, are shown in figures 9 and 10. Both are still lifes and like Gosse's Wrasse they are characterized by stunning color and excellent draftsmanship.

The picture in Figure 11 painted in 1864 by Sir John Everett Millais, was quite different from what had preceded. Here was a goldfish bowl but it was a major element, not just a bit of background. Just as important, it contained two human figures, young girls in this case. When a human is involved with an object in a painting - like the girl on the right who seems to be looking at the fish bowl - the viewer is involved as well. The viewer asks questions such as, is she interested in the color, the motion or the behavior of the fish, or does the fish bowl remind her of something quite different?

THE AQUARIUM HOBBY ICON EMERGES

Goldfish in art is a potentially fascinating subtheme. An icon is an emblem, symbol, sign or representation that stands for its object by virtue of a resemblance or analogy to it. A succinct aquarium hobby icon would contain one or two aquarists (three's a crowd and would detract from the fish bowl), one aquarium and one fish. All items must be significant elements of the image and the human must be looking directly at the aquarium (the painting by Perugini in Figure 12, for example, violates this requirement). Following an old photographer's adage, "less is more," the items should occupy most of the painting (photographers often do this by reaching for a longer focus lens so that the subject fills the frame; examples are shown in Figures 13 and 16).

Figure 11: "Leisure Hours," painted in 1864 by Sir John Everett Millais (1829-1896), an English printer and illustrator who was one of the founders of the Pre-Raphaelite Brotherhood. The group's intention was to reform art by rejecting what it considered the mechanistic approach adopted by artists who succeeded Raphael and Michelangelo.

Unfortunately, the Millais painting is not an aquarium hobby icon since it is not clear that the girl on the right is looking directly at the aquarium. Although it looks as if she might, there is too much ambiguity to state this with certainty. Figure 12, on the other hand, painted in 1868 by William Daniels, has all the elements that meet these requirements and is a textbook example of the aquarium hobby icon. The aquarium hobby icon, by the way, need not be drafted with the precision of a Gosse. Figure 13 shows painstaking draftsmanship whereas in Figure 14 the artist has relaxed the draftsmanship and the lines are just brush strokes but still fairly distinct. This brings us to Impressionism. This was a 19th-Century art movement that had its origins in the Warington/Gosse Era. It is characterized by relatively small, thin yet visible brush strokes, an emphasis on accurate depiction of light in its changing qualities, ordinary subject matter and unusual visual angles. It originated with a group of Paris-based artists whose independent exhibitions brought them to prominence during the 1870s and 1880s.

Figure 13: "The Goldfish," painted in 1892 by Thomas Benjamin Kennington (1856-1916). He was an English genre, social realist and portrait painter, and a founding member of the New English Art Club and the Imperial Arts League.

Figure 12: "The goldfish bowl," painted in 1868 by William Daniels (1813-1880). Daniels was a distinguished painter of the Rembrandt school and one of the greatest geniuses that ever reflected honor on Liverpool, the city where he was born.

Figure 14: "Lady with goldfish bowl," circa 1890, painted by Julian Russell Story (1857-1919), an American artist born in England.

Figure 15: "Goldfish Bowl," painted by Robert Gemmell Hutchison (1860-1936) circa end of the 1800s. He was a Scottish landscape artist, specializing in coastal scenes and belonged to the school of British Impressionism.

Figure 16: "The Goldfish," painted in 1892 by Thomas Benjamin Kennington (1856-1916). He was an English genre, social realist and portrait painter

Aquarium hobby icons that were painted by well-known Impressionists are shown in Figures 15, 16 and 17. The last painting shows Impressionism taken to an extreme (it is one of my favorites among the Impressionists). These paintings of the aquarium hobby icon continued well into the Twentieth Century when they were replaced by more modern art approaches of no real use as icons of the aquarium hobby. (One of the problems with all of the arts is that they are frequently populated by those who have absolutely nothing to say.)

THE RISE OF THE PUBLIC AQUARIUM

As was previously discussed, most marine scenes prior to the Warington/Gosse Era portrayed ordinary marine organisms as having been washed up on a shore in the foreground of a landscape seen from a human viewpoint. In effect, the aquatic

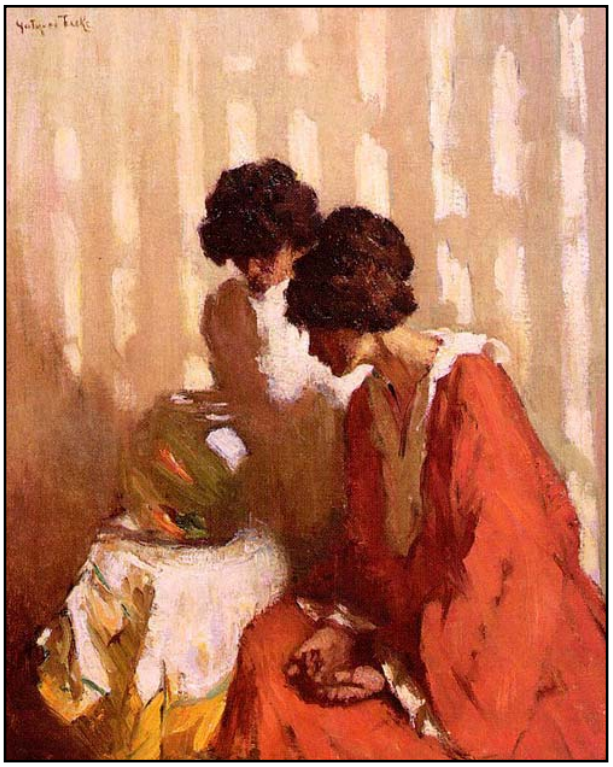


Figure 17: "The Goldfish," painted by Gertrude Fiske (1878-1961) in 1914. An American Impressionist Painter, although she traveled abroad, she preferred living and working in New England. She earned a reputation of a leading woman painter in Boston and won over eighteen prestigious awards. In 1930 she achieved full Academician status at the Boston Museum School.

world from which most fossils were derived was depicted only from the outside. This was difficult for the public and perhaps for most scientists also, to imagine a viewpoint that was not only pre-human but also subaqueous, until mid-century when the aquarium craze made the underwater world generally accessible for the first time in the form of the public aquarium. It was natural for scientists then to visualize the public aquarium as an institution constructed according to a scientific logic of the exhibition of species, as in an aquatic museum.

In 1841 Nathaniel Ward set up an aquarium for fish and plants in a large earthenware vessel. In this miniature lake, the water of which was never changed but kept in a constantly pure state by the action of the associated plants, the animals lived in a healthy condition for many years. This aquarium gave James Scott Bowerbank (both he and Ward were members of the Microscopical Society of London and knew each other) the idea of taking a large glass jar, in which he placed sticklebacks, minnows, snails and plants of *Valisneria,* and covering it with a piece of glass. It was this jar of Bowerbank's that attracted the attention of David Mitchell, then the Secretary of the Zoological Gardens of the Zoological Society of London and gave him the idea for the public aquarium that was opened in 1853 in the Zoological Gardens in Regent's Park. This was a modest undertaking, as shown by the building and its interior (Figure 18). Some of the tanks were built into the wall on the left side and many were merely situated on tables in the middle of the room. Both Robert Warington

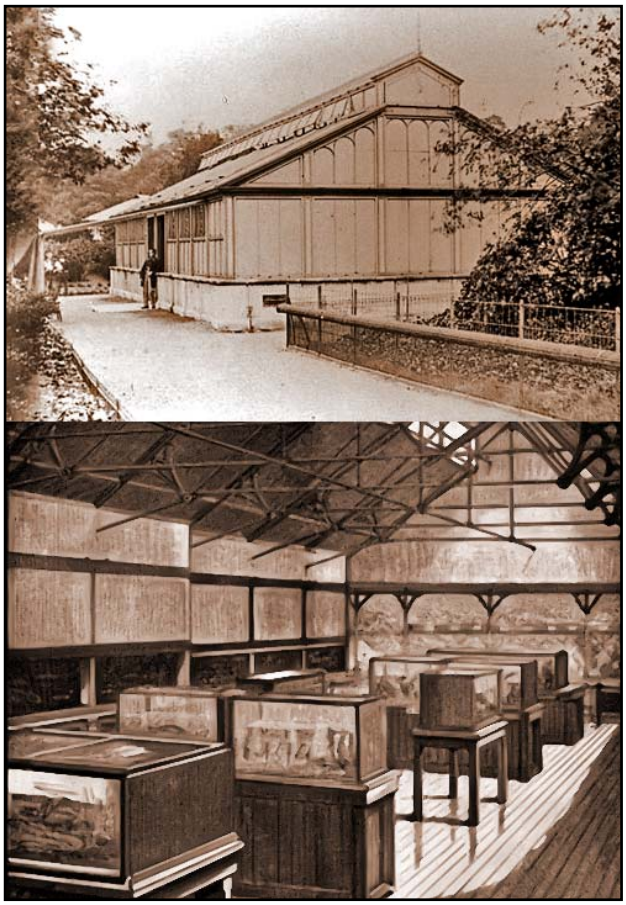


Figure 18: Top - Exterior of the Regent's Park Aquarium. Bottom - Interior.

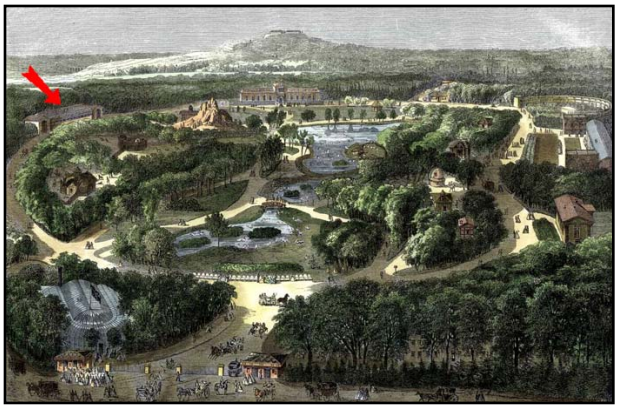


Figure 19: The Jardin d'Acclimatation. The red arrow points to the Aquarium.

(freshwater) and Philip Gosse (saltwater) helped design and implement the aquarium and both were scientists, chemistry and botany, respectively.

In France, the creation of the Jardin d'Acclimatation was the result of an accordance between an urban project and a scientific ambition. As part of the "remodeling" of Paris, the Emperor Napoleon III wanted to give Paris a landscaped park designed according to the model of English gardens. At the same time, the famous zoologist, Isidore Geoffroy Saint-Hilaire, was looking for a place to show a wide variety of animals because the other parks available were filling up. In 1854, he founded la Société Impériale Zoologique d'Acclimatation (the Imperial Zoological Acclimatization Society), which rapidly counted among its members three thousand eminent personalities of the sciences, arts and industry. The objective of the Society was to create a garden favoring the introduction, adaptation and domestication of animal species (Figure 19).

In 1858, the city of Paris granted the Company a 37-acre concession in the Bois de Boulogne. On the initiative of the Emperor and his wife, Eugenie de Montijo who actively supported the project, the concession area was increased by 12 acres. On Saturday, October 6, 1860, less than two years after the beginning of the work, Napoleon III, in the company of the Empress, inaugurated le Jardin Zoologique d'Acclimatation (the Zoological Garden of Acclimatization) in the presence of many prestigious guests including Jacques Offenbach, Prosper Mérimée, Hector Berlioz, Alexandre Dumas and Théophile Gautier. Three days later, the Garden, open to the public, began its long adventure.

Designed by the British engineer William Alford Lloyd, the Jardin d'Acclimatation's aquarium (fourteen glass and illuminated tanks housed in a 130 feet long and 33 feet wide building - see Figure 20 Top) was, according to Lloyd, "the largest, the most beautiful and the most complete of all those made so far. It is, after all, the most modern, since it has a system of re-oxygenation of water." Louis Figuier celebrated this "product of contem-

Figure 20: Top - The Jardin d'Acclimatation Aquarium building. Bottom - Interior of the Aquarium.

Figure 21: Exposition Universelle d'Art et d'Industrie de 1867.

porary science," which fulfilled the triple function of "natural museum, study cabinet and moral theater." He never tired of the ballet of fish (Figure 20 Bottom) and made the following statement: "Few shows are as varied, so picturesque; there are few who give material to as many reflections and which reveal to us better the inexhaustible fertility of the resources of nature."

A few years before the invention of the cinema, the aquarium represented a device of a new kind capable of producing varied images. It could be compared to a new kind of optical machine, such as the kaleidoscope or panorama, as a producer of images but also, depending upon the reactions of the spectators and the reconstructions of the journalists, as a source of illusion, even hallucination. Aquarium spectators were imaginatively projected to the bottom of the oceans. Théophile Gautier (1811-1872), a French poet, dramatist, novelist, journalist, and art and literary critic, recounted his impressions during his visit to the aquarium of the Jardin d'Acclimatation (Gautier, 1996):

After a few minutes, the illusion is complete. The feeling of proportion is lost. As for the fish, penetrated with light, they are of a fairy-like translucency. If they approach the invisible barrier that the glass opposes them, one would say that they are going to leave the frame outside their element.

If the goal of science was to instill a learning of aquatic science into visitors, then these two aquariums (Regent's Park and that of the Jardin d'Acclimatation) were on the right path. However, this was not to be. Their descendants gradually became the pretext for a debauchery of grandiose staging, suitable not to instruct but to impress the viewer. The evolution is clear when we compare the Aquarium of the Jardin d'Acclimatation, which was of reasonable size, contained selected species and in limited number, and the marine L'Aquarium de Paris that followed it.

In 1867, seven million people came to see France's answer to the challenge of the 1862 *London International Exhibition* (Figure 21). Eleven years after the first *Great Exhibition* of 1851, the British had proved to the world that it was no easy matter to repeat a resounding success. Napoleon III decided, seven years after the first French *Exposition Universelle*, that the French could and should again surpass the efforts of their ancient rival and sometime ally.

Figure 22: L'Aquarium de Paris.

L'Aquarium de Paris was arranged in the disused quarries near the prior Universal Exhibitions of Paris. The aquarium site, underground, was made up of old quarries that had served to shelter a part of the cavalry of the Emperor. The original aquarium was partly built in the open and partly built underground by imitating a cave with imitation concrete rocks. It was arranged in eighteen aquariums set between the pillars of the old galleries, on the circumference of two concentric ellipses whose gigantic and fairy-like setting harbored the most bizarre species (Figure 22). In the latter case, for example, a room was built underground so that the visitor found himself surrounded by tanks as if he or she were under water. This complex and costly arrangement was the most popular among the public because it responded to the aspirations for the grandiose which preoccupied Parisians at the time. The installation of a reservoir suspended above the visitors was not the only effect put in place for this purpose: long stalactites fell from the ceiling, resembling those that one could see in caves and all was plunged in darkness and silence (Figure 23). Several testimonies highlighted this supernatural staging, the following being an example from Ognier's "Souvenirs of the Universal Exhibition of 1867":

There is a moment when we cannot help feeling a certain tremor; in fact, instead of being between heaven and earth, we find ourselves between the earth and the water seen above and in which move fish of various species.

On the other side of the channel, things were not going well either. The Public Aquarium situation there, however, was very different from that in France. Thirteen commercial public aquarium ventures took place in Britain between 1871 and 1888 (see Table I - Note: The Regent's Park and Plymouth Aquariums were not commercial ventures). These were simply commercial speculations, money-making shows originated by joint-stock companies with a view to profit only. Scientific instruction or popular information were with their projectors only incidental considerations, and held no part, or only a very small part, in their inception.

William Alford Lloyd maintained that no aquarium pure and simple would pay its way, even in a very large town or city, unless its cost was limited (in current dollars) to about $348,000, and its annual expenses restricted to $58,000. He calculated that, allowing a sum of $75,000 as interest on the capital sum, the total receipts would require to be $17,400 per annum, or about $244 a day, which would represent forty two persons at $5.80 each This presented a rather dark aspect to enthusiasts and scientists of Natural History, for at the prevailing prices of building materials and the high rate of wages paid at the time, only a very indifferent aquarium could be erected for the sum named. At Rothesay, a small pleasure town on the river Clyde, it was found that the $580,000 subscribed for the erection of an aquarium was an insufficient sum, and the

Figure 22: The stalactites of L'Aquarium de Paris.

Figure 24: Royal Westminster Aquarium.

capital in consequence had to be been more than doubled.

To "pay," a really great Aquarium had to be something more than an aquarium; or, if not that in itself, it would be required to be a portion of some greater exhibition, as in the case of the Crystal Palace, where the Aquarium was but a small part of the larger building. The Aquarium attached to the Crystal Palace cost about $1,400,000, exclusive of the ground on which it was erected, and Lloyd felt sure that it never would have been remunerative but for its being an accessory of the greater building. The cost of erecting the Aquarium in the Jardin d'Acclimatation in Paris, although it contained only fourteen tanks of small size, was $483,000. The average number of visitors to the Parisian institution was about 450,000 annually, but it never paid any dividend.

Some of these new public establishments in Great Britain quickly failed: that in Manchester became a Catholic schoolhouse as early as 1877, whilst in 1880 the Aquarium at Tynemouth, having cost $9,562,900, was closed and sold at auction for just $3,125,800. Clearly, these were risky ventures, but some did prosper: Brighton's Aquarium, ideally situated on the promenade, was close to the Palace Pier and offered brass bands, organ recitals and a roller-skating rink. It certainly needed to be successful, having cost $15,398,000 to erect. The Royal Westminster Aquarium (Figure 24), an even more elaborate structure, had required $23,154,000 to build and was alarmingly costly to maintain, employing a 300 regular and a further 700 occasional staff.

The Era, September 12, 1885) noted a gradual lapse from the Royal Aquarium's original intent and knew precisely where to point the finger:

In all cases where a corporate body provides the capital, a dividend is expected, and to pay this it has been found necessary to abandon the lofty ideals propounded in the prospectus issued to the public when the Aquarium was in an embryonic stage.

Culture did not pay. In perpetual financial trouble, and with a dwindling public, the Westminster leviathan thus degenerated from a (prospective) temple of learning into a glorified freak-show, albeit a highly enterprising one (Sherson, 1925):

The fish, though few in number, were on view for some time; in fact, I think that one or two lingered on to the very end twenty-seven years later, in 1903 – but I have always wondered whether anyone went to look at them and if the water was ever changed!

[Note: William Alford Lloyd had been hired to design and build the aquarium, but later ceased his association with The Royal Westminster Aquarium:

There are few things more trying to that great virtue, patience, than a large public aquarium, especially in its preparation, before it is ready for the reception of animals. It is to this lack of patience on the part of the directors of the Royal Westminster Aquarium, and to their absolute refusal to allow me to have proper engineering assistance during its construction, and to general mismanagement, that its present confused state, and its unsatisfactory condition in every way, is due. On this account I re-

Figure 25: The dead whale at the Aquarium.

signed my post of adviser to the society, as I found it useless to advise when advice was recklessly disregarded.]

To continue Sherson's report:

The Royal Aquarium, in short, was intended to be a sort of Crystal Palace in London within easy reach of Charing Cross, a covered-in promenade for the wet weather, with the glass cases of live fish thrown in. In truth, the attractions of the place soon began to be very 'fishy' indeed. Ladies promenaded there up and down without the escort of any gentleman friend (till, maybe, they found one) and the appeal of the management to sensation lovers was very wide indeed. Bare-backed ladies dived from the roof or were shot out of a cannon, or sat in a cage covered with hair and calling themselves 'Missing Links'. Zulus, Gorillas, Fasting Humans, Boxing Humans and Boxing Kangaroos, succeeded one another in rapid changes, and failed in time to attract.

Another talking point, a beluga whale, was introduced to the Aquarium in 1877, but it quickly expired amidst accusations of maltreatment:

When once the animal was safely deposited in the tank its surroundings were fully as favourable as those of most other creatures when deprived of their natural liberty. The supposed marks of ill-usage on the dead body were the consequences of the eels in the tank having after its death nibbled the edges of its fins (*The Times*, October 3, 1877).

In 1880 Agnes Beckwith put the redundant whale tank to good use by treading water in it for 30 hours to equal the record set by Matthew Webb in 1875. Alongside the performing fleas (1878), bulls that climbed ladders and rolled on their backs (1883) and packs of wolves (1887), more familiar members of the animal kingdom also found celebrity; cat and dog shows, for example, were a popular attraction during the 1880s.

From time to time, the morals of the clientele who frequented the Aquarium were called into question. Drunks, thieves and prostitutes mingled with the sight-seers and their continued presence led to the London County Council refusing to recommend the renewal of the license in October 1889. After much debate in the Press, it was eventually conceded that the Aquarium was no better and no worse than many similar establishments and the license was renewed.

Thus the Royal Aquarium was not the prestigious exhibition space and educational forum initially envisaged. It was not the renowned concert venue originally hoped for, it was not the well-loved variety theatre hinted at in its ever-changing programs, it was not even an aquarium: it was in fact a circus fairground given unnatural permanence by its pretentious surroundings. Fairs and circuses are by their very nature transient novelties and in this re-

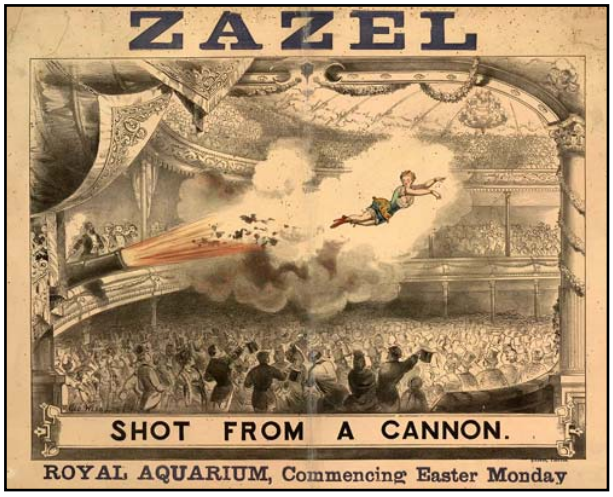


Figure 26: One of the attractions at The Aquarium.

TABLE I: PUBLIC AQUARIA IN THE UNITED KINGDOM, 1853-1888	
The Regent's Park Aquarium, London	1853
The Crystal Palace Aquarium, Sydenham, London,	1871
The Brighton Aquarium, Brighton	1873
The Manchester Aquarium, Manchester	1874
The Southport Aquarium, Southport	1874
Dr. Cocker's Menagerie at Blackpool	1875
The Rothesay Royal Aquarium, Rothesay	1875
The Royal Aquarium Summer and Winter Gardens, Westminster	1876
The Yarmouth Aquarium, Yarmouth	1876
The Scarborough Aquarium, Scarborough	1877
The Rhyl Aquarium, Rhyl	1878
The Tynemouth Winter Gardens and Aquarium, Tynemouth	1878
The Edinburgh Aquarium, Edinburgh	1878
The Aston Aquarium, Birmingham	1879
The Marine Biological Association of the United Kingdom Aquarium, Citadel Hill, Plymouth	1888

spect it is truly remarkable that the place managed to survive for twenty-seven years.

In Table I, only the Regent's Park Aquarium and the aquarium of The Marine Biological Association in Plymouth were non-commercial ventures. The Marine Biological Association of the United Kingdom was founded in 1884 at a meeting of the Royal Zoological Society "…for the purpose of establishing and maintaining Laboratories on the Coast of the United Kingdom, where accurate researches may be carried on leading to the improvement of Zoological and Botanical Science and to an increase of our knowledge as regards the food, life-conditions and habits of British Food-Fishes and Molluscs." This, it was hoped, would lead to a better understanding of the marine environment and the impact of fishing on this environment, which would in turn help to inform better policy-making and legislation which would help manage the fishing resources. The laboratory would have state-of-the-art facilities, including tank rooms and apparatus for the circulation of seawater. The MBA was to be governed by a Council that was headed by a President and the Director was responsible for the day-to-day running of the Association. Thomas H. Huxley was elected its first President and William Henry Flower was elected its first Director.

Plymouth was chosen as the site for its laboratory and aquarium because of its rich flora and fauna. They readily accepted the site under the Royal Citadel offered by the War Department as it was possible to maintain direct salt-water contact. Construction of the building, which was constructed of Devon limestone, commenced in 1887 and the world renowned headquarters of the Association was opened on Saturday June 30th 1888 by Professor (later Sir) William Henry Flower (1831-1899). Flower was director of the Natural History Museum and president of the Zoological Society of London from 1879 to 1899. In 1882 he was awarded the Royal Medal of the Royal Society. Flower was also a leading authority on the arrangement of museums. He insisted on the importance of distinguishing between collections intended for the use of specialists and those designed for the instruction of the general public, pointing out that it was as futile to present to the former a number of merely

Figure 27: The Marine Biological Association of the United Kingdom Aquarium, Plymouth.

Figure 28:
Sir William Henry Flower (1831-1899).

typical forms as to provide the latter with a long series of specimens differing only in the most minute details. His ideas, which were largely and successfully applied to the museums of which he had charge, gained wide approval, and their influence entitles him to be looked upon as a reformer who did much to improve the methods of museum arrangement and management.

The Laboratory of the MBA opened on Plymouth Hoe (referred to locally as the Hoe; this is a large south-facing open public space in the English coastal city of Plymouth) on June 30, 1888. A tank room on the ground floor became the first Plymouth Aquarium and was serviced by underground reservoirs that held up to 100,000 gallons of seawater, which was continually being cleansed and pumped back into the tanks.

Initially, access to the Aquarium was free, but as the rooms developed into a larger and more sophisticated aquarium throughout the twentieth century, the MBA introduced a small fee. In spite of this, it continued to attract hundreds of visitors daily. Through this, the Association met its charitable objective of sharing with the public the knowledge gained through its research activities: the aquarium provided a literal window into the local marine environment. However, it had taken almost a half-century after the start of the Warington/Gosse Era before these goals of the scientific community were realized.

THEOLOGY AND THE AQUARIUM

For many years a large body of British public opinion held to the absolutist view that the sole account of the early history of the earth that could possibly have any validity whatever was that to be found contained within the covers of the Bible. A wordy pamphlet-war long continued in this vein, and at the same time, just because it was their own special subject that had given rise to this terrible debate, those naturalists who found the claims of evolution difficult to reconcile with their religious beliefs experienced an agonizing conflict. Unlike others, they could not honestly deny the evidence or fail to comprehend its overwhelming suggestiveness. Their only refuge was to seek for some flaw in the accepted interpretations, whether doctrinal or scientific, and propound a comforting alternative or else to postpone all decision, hoping that the theory would be disproved or that some champion of the theologians would come forward with a palatable compromise.

Not all naturalists found the facts of evolution spiritually dismaying, and those who did reacted in different ways. There was no recognizable “line” on the matter in natural history circles. If anything, because of the closeness of naturalists to the controversy’s raw material, the spectrum of attitudes among them was even wider than in general. Most of those who grappled with the issues concentrated on the metaphysical or theological aspects; the naturalists, almost alone, could not avoid prolonged and fierce disputes over the scientific ones as well. We can, however, compare the writings of two gentlemen who wrote both about aquarium matters and religion - Philip Henry Gosse and the Reverend Charles Kingsley.

Figure_29: Philip Henry Gosse with his son, Edmund.

First, let's set the record straight as to the character of Philip Gosse. After his father's death, Edmund Gosse published anonymously a Victorian biography, *Father and Son* (Gosse, Edmund, 1907), a book that has never gone out of print in more than a hundred years. The reaction of readers to Philip Gosse's personality and character as represented in *Father and Son* has included phrases such as "scientific crackpot," "bible-soaked romantic," "a stern and repressive father," and a "pulpit-thumping Puritan throwback to the seventeenth century."

However, even a modern editor of *Father and Son* has rejected this portrait of Philip Henry Gosse on the grounds that his "writings reveal a genuinely sweet character." The biographer of both Gosses, Ann Thwaite (Thwaite, 1984), has established just how inaccurate Edmund's recollections of his childhood were, that Edmund indeed, as Henry James remarked, had "a genius for inaccuracy." Although Edmund went out of his way to declare that the story of *Father and Son* was "scrupulously true," Thwaite cites a dozen occasions on which either Edmund's memory betrayed him - he admitted it was "like a colander" - or else he changed things deliberately to make a better story. Thwaite argues that Edmund could only preserve his self-respect, in comparison to his father's superior abilities, by demolishing the latter's character.

In *The Aquarium*, Gosse argued that corallines were "**a City… of myriad individuals sharing a common life, and reflects that heavenly Jerusalem where happy spirits in resurrection bodies collectively form the Church of the living God, the Bride of Christ. The pleasure we take in the rock pools, which seem to be almost immune from the consequences of the fall… is a type of the pleasure we shall someday take in all of nature."**

As Edmund Gosse noted, his father had long complained that natural history had become "a science of dead things," a study not of living organisms in their natural environments but of dried, stuffed, preserved - and consequently deformed and distorted - specimens. To Gosse, clearly the existence of a living God, actively caring for his creation and leaving signs of its fate, could be better seen in living creatures, and the aquarium made that possible. To see creatures "in their proper haunts" was to see them "with their beauty of form and brilliance of color" - and to know how beneficent God had been in providing us with such pleasure even among the lowest creatures in the most unlikely places. In the months following his wife Emily's death, Gosse worked with remarkable diligence on a book that he viewed as the most important of his career. He believed that he had discovered a theory that might neatly resolve the seeming contradiction in the age of the earth as presupposed by Charles Lyell, with the Biblical account of Creation, which suggested that the world was 6,000 years old. Lyell (1797-1875) was a Scottish geologist who, following deistic traditions, favored an indefinitely long age for the earth, despite geological evidence suggesting an old but finite age. He was a close friend

of Charles Darwin, and contributed significantly to Darwin's thinking on the processes involved in evolution.

Gosse started to more formally organize his anti-evolutionary ideas shortly before the writing of *Omphalos*, his attempt to reconcile the Church and Science. His popular writing about marine organisms always had a touch of the theological about it, but in the summer of 1857 he published a series of collected essays from the magazine *Excelsior* under the name *Life in its Lower, Intermediate, and Higher Forms*. The title makes Gosse's belief in a created hierarchy clear, and of its contents his son would later write;

These essays were slight, and the religious element was quite unduly prominent, as if vague forebodings of the coming theory of evolution had determined the writer to insist with peculiar intensity on the need of rejecting all views inconsistent with the notion of a creative design. This book entirely failed to please the public, who had now for so many years been such faithful clients to him; with the scientific class it passed almost unnoticed.

In 1857, two years before the publication of Charles Darwin's *Origin of Species*, Gosse published *Omphalos: an Attempt to Untie the Geological Knot* and thereby created what has been called the Omphalos hypothesis. Gosse's book was an attempt to rescue Creation itself from the perceived threat of science denuded of Christian authority. Gosse fervently believed that God's word and works were in accord, but if there was any conflict between the two it was because naturalists had been looking at the world in the wrong way.

Gosse attempted to mend the increasing tear between a literal reading of Genesis and the facts of geology in a very peculiar way. If you found the skeleton of an extinct animal, Gosse proposed, you would naturally assume that the bones must have given form to an animal that lived at some distant period. But what if you were mistaken? What if, instead, the bones had been created already in place in the ground and had never been clothed in flesh and blood?

For Gosse, fossils were just components of the earth that implied history without actually possessing it. God, in other words, had created the world "already in progress." The first plants and animals were all adults, ready to reproduce "after their kind" and bearing the marks of age that they would be expected to bear. This rule applied to the first humans, too; Adam and Eve had been created with navels even though they had never actually been connected via an umbilical cord to a mother during gestation. Creation carried with it the illusion of time, and Gosse believed this could reconcile the "lost worlds" of geologists the scripture he loved so dearly. Naturally, he rejected any suggestion that life evolved.

Figure 30 shows a mammoth as restored in Gosse's *Omphalos*. In Gosse's view of history, however, such a scene never actually existed. According to him, the bones of the mammoth existed in the earth from the time of Creation and had never given form to a living animal. In what Stephen Jay Gould has called "glorious purple prose," Gosse argued that if one assumed creation *ex nihilo* ("out of nothing"), there would necessarily be traces of a previous existence that had never actually oc-

Figure 30: The Mammoth image from Gosse's *Omphalos*.

curred. *"Omphalos"* is Greek for "*navel*," and Gosse argued that the first man, Adam, did not require a navel because he was never born; nevertheless he must have had one, as do all complete human beings, just as God must have created trees with rings that they never grew. Thus, Gosse argued that the fossil record might also be evidence of life that had never actually existed but which may have been instantly formed by God at the moment of creation.

That Gosse published *Omphalos* two years before *On the Origin of Species* was no accident. As suggested by his son, by the mid-1850's Gosse had become very concerned about ideas that life had evolved. *Vestiges of the Natural History of Creation*, anonymously published in 1844, had popularized the *idea* of evolution even if it failed to convince naturalists of a mechanism by which it could be affected To Gosse, such theorizing was the equivalent of barring God from having anything to do with the world the Almighty had created.

Omphalos would fare even worse upon its release later that year. Even the later writings of his son, Edmund, are tinged with regret that Gosse could not restrain himself from speculating on the natural "philosophy" that Darwin and other naturalists were more adept at handling. (Interestingly, though, Gosse would later exchange numerous letters with Darwin about orchids in 1863. Neither evolution nor *Omphalos* entered the conversation.) Gosse, however, felt that he was more than qualified for the job. The people had to be told that God still lived in Creation, and Gosse fully believed that he could provide the ultimate answer that would put an end to what he saw as idle speculation over trilobites and rock formations. The overly florid and pompous nature of his prose underlined his confidence.

The general response was, as the *Westminster Review* put it, that Gosse's theory was "too monstrous for belief." Even his friend, the novelist Charles Kingsley, wrote that he had read "no other book which so staggered and puzzled" him, that he could not believe that God had "written on the rocks one enormous and superfluous lie for all mankind." Journalists later sniggered that God had apparently hidden fossils in the rocks to tempt geologists to infidelity. *Omphalos* sold poorly and was eventually rebound with a new title, *Creation*, "…in case the obscure one had had an effect on sales." The problem was not with the title, however, and in 1869 most of the edition was sold as waste paper. Gosse's reputation was ruined and the sales of his books declined.

Charles Kingsley (1819-1875, Figure 31) was a priest of the Church of England, a university professor, social reformer, historian and novelist. He was particularly associated with Christian socialism, the working men's college, and forming labor cooperatives that failed but led to the working reforms of the progressive era. Kingsley was born in Devon, the elder of two sons of a clergyman. He studied at King's College London and the University of Cambridge, graduating from the latter in

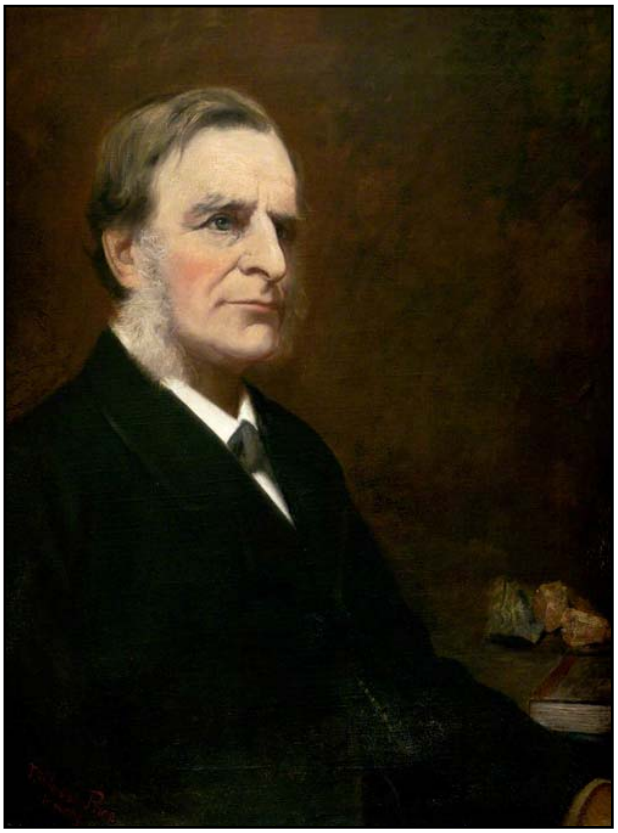


Figure 31: Charles Kingsley (1819-1875).

1842. Kingsley chose to pursue a ministry in the church and starting in 1844, he was rector of Eversley in Hampshire. In 1859 he was appointed chaplain to Queen Victoria, in 1860, he was appointed Regius Professor of Modern History at the University of Cambridge and in 1861 he became a private tutor to the Prince of Wales. In 1869 Kingsley resigned his Cambridge professorship and, from 1870 to 1873, was a canon of Chester Cathedral and in 1873 he was made a canon of Westminster Abbey.

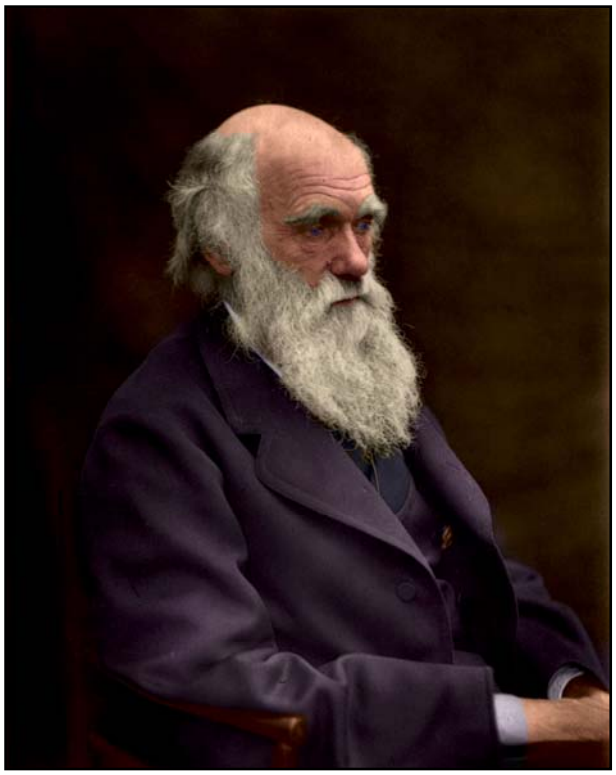


Figure 32: Charles Darwin (1809-1882). With the publication of *On The Origin Of Species*, the established Western view that creatures had been created independently by a God, and indeed the whole supernatural explanation of the universe, suddenly had competition. At first, denunciation by the likes of Bishop Wilberforce was complete. But religious views gradually adapted, through Philip Grosse's theory that fossils had been planted by God to give the earth a coherent history, to today's position where most theists have found accommodation with the idea of natural selection.

Kingsley took a keen interest in science and saw no problem in reconciling his religious faith with Darwin's theory of evolution by natural selection. Kingsley read a review copy of Darwin's *The Origin of Species* in 1859 before it had even been published and became a friend and correspondent of Darwin's in the 1860s. *On The Origin Of Species Kingsley* stated that it was "just as noble a conception of the Deity to believe that He created primal forms capable of self-development," and quotes from his letter were used in every edition of *On The Origin Of Species* until the last in 1872.

Kingsley would be one of the first clergymen to write in support of Darwin's *Origin of Species.* He was sympathetic to the idea of evolution and was one of the first to praise the book. He had been sent an advance review copy and in his response of November 18, 1859 (four days before the book went on sale) stated that he had "long since, from watching the crossing of domesticated animals and plants, learnt to disbelieve the dogma of the permanence of species." Darwin added an edited version of Kingsley's closing remarks to the next edition of his book, stating that:

A celebrated author and divine has written to me that "He as gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws."

Kingsley's love of natural history did not result in a written work until the mid-1950s when he spent the winter of 1853-54 at Torquay while his wife recovered from the ill-effects of living in their damp Rectory home at Eversley. Here Kingsley became enthralled by marine biology. He spent hours on the shore collecting specimens, kept a daily journal, and sent off sea beasts, shells and seaweeds to Philip Henry Gosse in London, with whom he had started to correspond. The fruit of these Devon sea-coast explorations was a series of

articles in the *North British Review for November 1854*, subsequently published as *Glaucus: or Wonders of the Sea Shore* (Kingsley, 1859). The name *Glaucus* refers to the fisherman in Ovid's *Metamorphoses* who turns into a half-man, half-fish creature and goes to live in the sea.

In the opening of *Glaucus* Kingsley asks the reader to picture their six week seaside holiday, which he paints as lackluster, idle and unfulfilling. He goes on to exhort the reader to try the wonders of rational recreation, to learn a little about the wonders of the shore and to marvel at God's handiwork. The exploration of the shore that he narrates to the reader begins with examples from the Devon coastline, namely the landscape of Torquay and Paignton. He loved the seaside and had, quite literally, no time for the idle pursuits of most other holidaymakers:

Follow us, then, reader, in imagination, out of the gay watering-place ... along the broad road beneath the sunny limestone cliff ... to the sea marge; for yonder lies, just left by the retiring tide, a mass of life such as you will seldom see again.

In *Glaucus*, Kingsley addressed the Victorian father on summer holiday, appealing to the notion that even leisure time should be spent in the pursuit of something profitable. Instead of reading another silly novel or engaging in "ineffectual attempts to catch a mackerel," why not "try to discover a few of the Wonders of the Shore" that are there "around you at every step, stranger than any opium-eater dreamed?" Natural history was not only a fascinating field of study, it had "become nowadays an honorable one," pursued by dukes and princes. "Nay," Kingsley declared, "the study is now more than honorable, it is (what to many readers will be a far higher recommendation) even fashionable." Natural history books were "finding their way more and more into drawing-rooms and schoolrooms" and knowledge of the subject was no longer "considered superfluous." Kingsley insisted that the study of natural history led to happiness, as an understanding of nature lifted the individual outside his petty world to a realm of higher meaning.

In Kingsley's opinion, fathers had a responsibility to teach natural history to their children. This "age offers no more wholesome training, both moral and intellectual, than that which is given by instilling into the young an early taste for outdoor physical science." The training provided by natural history was especially important for "middle class young men," the "frightful majority" of which were "growing up effeminate, empty of all knowledge but what tends directly to the making of a fortune."

Kingsley often quotes Gosse when it comes to finding and capturing marine specimens and keeping them in aquaria. He also remarks on Gosse's color plates in *The Aquarium*:

Those who have never seen one of them can never imagine (and neither Mr. Gosse's pencil nor our own clumsy words can ever describe them) the gorgeous colouring and the grace and delicacy of form which these subaqueous landscapes exhibit.

Advances in printing technology at this time made it possible economically to reproduce and disseminate such color images among the new and rapidly growing middle and working class populations. By the 1850s lithography was the cheapest and fastest way to achieve commercially viable color prints, but a close inspection of the plates in *Glaucus* re-

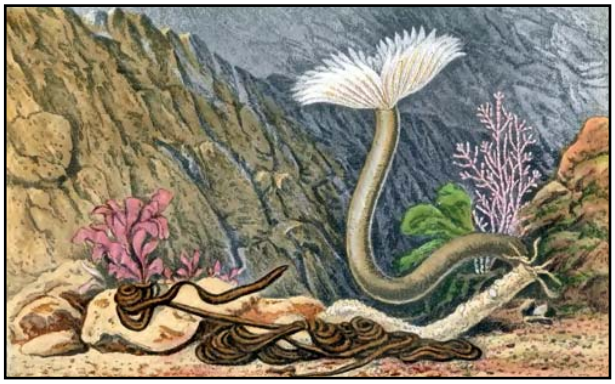


Figure 33: A plate from *Glaucus*.

veals etching, aquatint engraving and wood engraving, i.e., a combination of intaglio and relief printing. The best color prints were achieved by printing from multiple wood blocks engraved on the end grain of a hard wood like box. As this was a labor intensive process and a less versatile medium, George Baxter (1804-1867) developed a more commercially viable method of combining intaglio and relief processes that allowed for the artistic effects and versatility of finely inked lines and etched tones in metal to be had in combination with colors printed from wood.

Kingsley coined the term "Pteridomania" (Fern Madness) to describe the Victorian's fern obsession that started in the 1840s. He viewed this Victorian craze for collecting ferns as a wholesome activity to be encouraged, and expanded to include all aspects of natural history, thus serving both as a means of keeping families and friends engaged in industrious pursuits while on vacation, and united in awe of the wondrous works of God. He also satirized the mania as follows:

Perhaps you smile, in answer, at the notion of becoming a "Naturalist" and yet you cannot deny that there must be a fascination in the study of natural history, though what it is is as yet unknown to you. Your daughters, perhaps, have been seized with the prevailing "Pteridomania," and are collecting and buying ferns, with Ward's cases wherein to keep them (for which you have to pay), and wrangling over unpronounceable names of species (which seem to be different in each new Fern-book that they buy), till the Pteridomania seems to you somewhat of a bore; and yet you cannot deny that they find an enjoyment in it, and are more active, more cheerful, more self-forgetful over it, than they would have been over novels and gossip, crochet and Berlin-wool. At least you will confess that the abomination of "Fancy-work" - that standing cloak for dreamy idleness (not to mention the injury which it does to poor starving needlewomen) - has all but vanished from your drawing-room since the "Lady-ferns" and "Venus's hair " appeared; and that you could not help yourself looking now and then at the said "Venus's hair" and agreeing that nature's real beauties were somewhat superior to the ghastly woolen caricatures which they had superseded.

Kingsley didn't see science as in opposition to the holy word of God, but instead praised scientists who, rather than twist the facts to suit the Bible or the Bible to suit the facts, continued their research with faith that God could take better care than anyone else of His own everlasting truth:

But it is a question whether Natural History would have ever attained its present honours, had not Geology arisen, to connect every other branch of Natural History with problems as vast and awful as they are captivating to the imagination. Nay, the very opposition with which Geology met was of as great benefit to the sister sciences as to itself.

For, when questions belonging to the most sacred hereditary beliefs of Christendom were supposed to be effected by the verification of a fossil shell, or the proving that the Maestricht [a city in the southeast of the Netherlands**]** ***homo diluvii testis*** [an extinct species of giant salamander] **was, after all, a monstrous eft, it became necessary to work upon Conchology, Botany, and Comparative Anatomy, with a care and a reverence, a caution and a severe induction, which had been never before applied to them; and thus gradually, in the last half century, the whole choir of cosmical sci-**

Figure 34: Plate 2 from *Glaucus*.

ences have acquired a soundness, severity, and fullness, which render them, as mere intellectual exercises, as valuable to a manly mind as Mathematics and Metaphysics.

But how very lately have they attained that firm and honourable standing ground! It is a question whether, even twenty years ago, Geology, as it then stood, was worth troubling one's head about, so little had been really proved. And heavy and uphill was the work, even within the last fifteen years, of those who steadfastly set themselves to the task of proving and of asserting at all risks, that the Maker of the coal seam and the diluvial cave could not be a "Deus quidam deceptor" [God who is sometimes a Deceiver] **and that the facts which the rock and the silt revealed were sacred, not to be warped or trifled with for the sake of any cowardly and hasty notion that they contradicted His other messages.**

When a few more years are past, Buckland and Sedgwick, Murchison and Lyell, Delabêche and Phillips, Forbes and Jamieson, and the group of brave men who accompanied and followed them, will be looked back to as moral benefactors of their race; and almost as martyrs, also, when it is remembered how much misunderstanding, obloquy, and plausible folly they had to endure from well-meaning fanatics like Fairholme or Granville Penn, and the respectable mob at their heels who tried (as is the fashion in such cases) to make a hollow compromise between fact and the Bible, by twisting facts just enough to make them fit the fancied meaning of the Bible, and the Bible just enough to make it fit the fancied meaning of the facts.

But there were a few who would have no compromise, who laboured on with a noble recklessness, determined to speak the thing which they had seen, and neither more nor less, sure that God could take better care than they of His own everlasting truth; and now they have conquered; the facts which were twenty years ago denounced as contrary to Revelation, are at last accepted not merely as consonant with, but as corroborative thereof; and sound practical geologists - like Hugh Miller, in his "Footprints of the Creator," and Professor Sedgwick, in the invaluable notes to his " Discourse on the Studies of Cambridge" - are wielding in defense of Christianity the very science which was faithlessly and cowardly expected to subvert it.

As I have mentioned, Kingsley saw no problem in reconciling his religious faith with Darwin's theory of evolution by natural selection:

Let us speak freely a few words on this important matter. Geology has disproved the old popular belief that the universe was brought into being as it now exists, by a single fiat. We know that the work has been gradual; that the earth

> **"In tracts of fluent heat began,**
> **The seeming prey of cyclic storms,**
> **The home of seeming random forms,**
> **Till, at the last, arose the man."**

And we know, also, that these forms, seeming random as they are, have appeared according to a law which, as far as we can judge, has been only the whole one of progress, lower animals (though we cannot say, the lowest) appearing first, and man, the highest mammal, "the roof and crown of things," one of the latest in the series. We have no more right, let it be observed, to say that man, the high-

Figure 35: Plate 6 from *Glaucus*.

est, appeared last, than that the lowest appeared first. Both may have been the case; but there is utterly no proof of either, and as we know that species of animals lower than those which already existed appeared again and again during the various eras, so it is quite possible that they may be appearing now, and may appear hereafter, and that for every extinct Dodo or Moa, a new species may be created to keep up the equilibrium of the whole. This is but a surmise, but it may be wise, perhaps, just now, to confess boldly, even to insist on, its possibility, lest the advocates of the "Vestiges of Creation" theory should claim the notion as making for them, and fancy, from our unwillingness to allow it, that there would he aught in it, if proved, contrary to Christianity.

Kingsley commented on *Omphalos*, treating Gosse lightly in his criticism, something unusual for him:

It is with real pain that I have seen my friend Mr. Gosse, since this book was written, make a step in the direction of obscurantism, which I can only call desperate, by publishing a book called "Omphalos." In it he tries to vindicate what he thinks (though very few good Christians do so now) to be the teaching of Scripture about Creation, by the supposition that fossils are not the remains of plants and animals which have actually existed, but may have been created as they are and where they are, for the satisfaction of the Divine mind; and that therefore the whole science, not merely of paleontology, but (as he seems to forget) of geognosy [now superseded by the term geology] **also, is based on a mistake, and cannot truly exist, save as a play of the fancy.**

It seems to me that such a notion is more likely to make infidels, than to cure them. For what rational man, who knows even a little of geology, will not be tempted to say - If Scripture can only be vindicated by such an outrage to common sense and fact, then I will give up Scripture, and stand by common sense ? For my part, I have seen no book for some years past, which I should more carefully keep out of the hands of the young. I am sorry to have to say this of the-work of a friend, both because he is my friend, and because there are thoughts therein, about the creative workings of the Divine mind, which however misapplied, are full of deep truth and beauty, and are too much forgotten now-a-days. But, as Aristotle says where he differs from Plato, "Truth and Plato are both my friends; *but it is a sacred duty to prefer Truth*."

It is one of the greatest ironies that I have ever encountered in my research into the history of the aquarium hobby that these two great men - Gosse and Kingsley - came to their downfalls because of religion. In the January 1864 issue of *Macmillan's Magazine*, Kingsley published a review of an anti-Catholic History of England by J.S. Froude. In the review Kingsley gratuitously attacked John Henry Newman by writing,

Truth, for its own sake, had never been a virtue with the Roman clergy. Father Newman informs us that it need not, and on the whole ought not to be, that cunning is the weapon which Heaven has given to the saints wherewith to withstand the brute male force of the wicked world which marries and is given in marriage. Whether his notion is doctrinally correct or not, it is at least historically so.

Figure 36: Plate 10 from *Glaucus*.

To translate into modern parlance, Kingsley basically said: “All priests are liars and Newman is the worst.”

John Henry Newman (1801-1890) was an Anglican priest, poet and theologian and later a Catholic cardinal, who was an important and controversial figure in the religious history of England in the 19th century. Originally an evangelical Oxford University academic and priest in the Church of England, Newman then became drawn to the High-Church tradition of Anglicanism. He became known as a leader of, and an able polemicist for, the Oxford Movement, an influential and controversial grouping of Anglicans who wished to return to the Church of England many Catholic beliefs and liturgical rituals from before the English Reformation. In this the movement had some success. In 1845 Newman, joined by some but not all of his followers, officially left the Church of England and his teaching post at Oxford University and was received into the Catholic Church. He was quickly ordained as a priest and continued as an influential religious leader, based in Birmingham. Kingsley hated Newman, as many Anglicans did; they never forgave him for leading the Oxford Movement on the path to Rome. (Newman converted to Roman Catholicism in 1845, and was ordained a priest two years later.) Kingsley hated Roman Catholicism, too, for many reasons, and he associated it with Mediterranean effeminacy and indolence. Rome’s insistence on celibacy in its priests particularly infuriated him.

Newman regarded Kingsley’s reference to him in the review as a gross slander. He might have let it pass, but he had endured years of obloquy and the review touched a nerve; he was not willing to be called a liar. So he demanded an apology from Kingsley and got a half-hearted one. Disputants issued pamphlets, Newman’s being far more effective than Kingsley’s, but Newman remained unappeased. He was quick to take offence, but only when it was loudly given. Although Kingsley had been “furiously carried away by his feelings,” the quarrel could not end there, because Newman deemed the insult an equal reflection on Roman Catholicism, the church as an institution and the priesthood. A pamphlet was not enough. He decided that the slander called for a larger response.

Newman’s definitive response was his masterpiece, *Apologia pro Vita Sua* (A Defense of One’s Life, 1864), a book in seven parts, the first two and the seventh being answers to Kingsley, the remainder a history of his religious opinions from boyhood to 1845. The book was written as rapidly as possible in six weeks with Newman writing standing up sometimes as long as 22 hours straight in order to get his story before the public. He said “it was "the most arduous work I ever had in my life" in "one of the most terrible trials I ever had." The reviews of the book (and these included those by members of the Church of England) were universally favorable, and its sales were enormous. His reputation was restored and heightened and indeed, even his constant financial worries were over.

Kingsley had crossed swords with an opponent too strong for him and was no match for his adver-

Figure 37: John Henry Newman (1801-1890).

sary's subtle skill. Kingsley disgraced himself in scholarship and truth by calling Newman a liar and failing to bring up a single instance of his lying; his reputation never survived the blunder.

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Figure 38: The first women's fad in England. "Collecting Ferns" (Pteridomania or "Fern Madness"), from the *Illustrated London News*, 1871.

Figure 39: The second women's fad in England. An engraving entitled "Cartoon of the Season: No. 7. The Seaside Sirens," circa 1855.

AN "UNJUSTIFIED EMENDATION"

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, February 3, 2018)

This story starts with the download of a book from the Smithsonian Library that had been donated to the U. S. National Museum by Dr. George Sprague Myers on September 30, 1935. In 1914 the Vereinigten Zierfisch-Züchtereien (United Ornamental Fishbreeders), a commercial consortium of aquarists in Rahnsdorfer Mühle and previously in Conradshöhe, both districts of Berlin, published the 352 page book, *Exotischen Zierfische in Wort und Bild* (Exotic ornamental fishes in Words and Pictures). The organization described itself as being the "Main Headquarters for imports with the biggest selection, and rarest fish novelties and aquatic plants." The book - over 100 years old - apparently is quite rare, the only known copy being that held by the Smithsonian Institution's National Museum, Division of Fishes, although copies from this Institution are available from various sources here and in Germany since it is in the public domain and one may freely copy and distribute it as no entity (individual or corporate) has a copyright on the body of the work.

GEORGE SPRAGUE MYERS (1905-1985)

Myers was born in Jersey City, New Jersey. He developed an early interest in vertebrate zoology, accumulating aquariums in which he kept species of exotic and native fishes. His first article on aquarium fishes was published at the age of fifteen; this was in 1920 when he was a Junior in High School. Around this time Myers began frequenting the American Museum of Natural History in New York City, seeking advice on natural history questions. As a result, he became a volunteer assistant at the museum from 1922 to 1924. At the museum he came under the influence of its ichthyology and herpetology staff including G. K. Noble, Karl P. Schmidt, John T. Nichols, Eugene W. Grudger, John Tee-Van, Charles M. Breder and others.

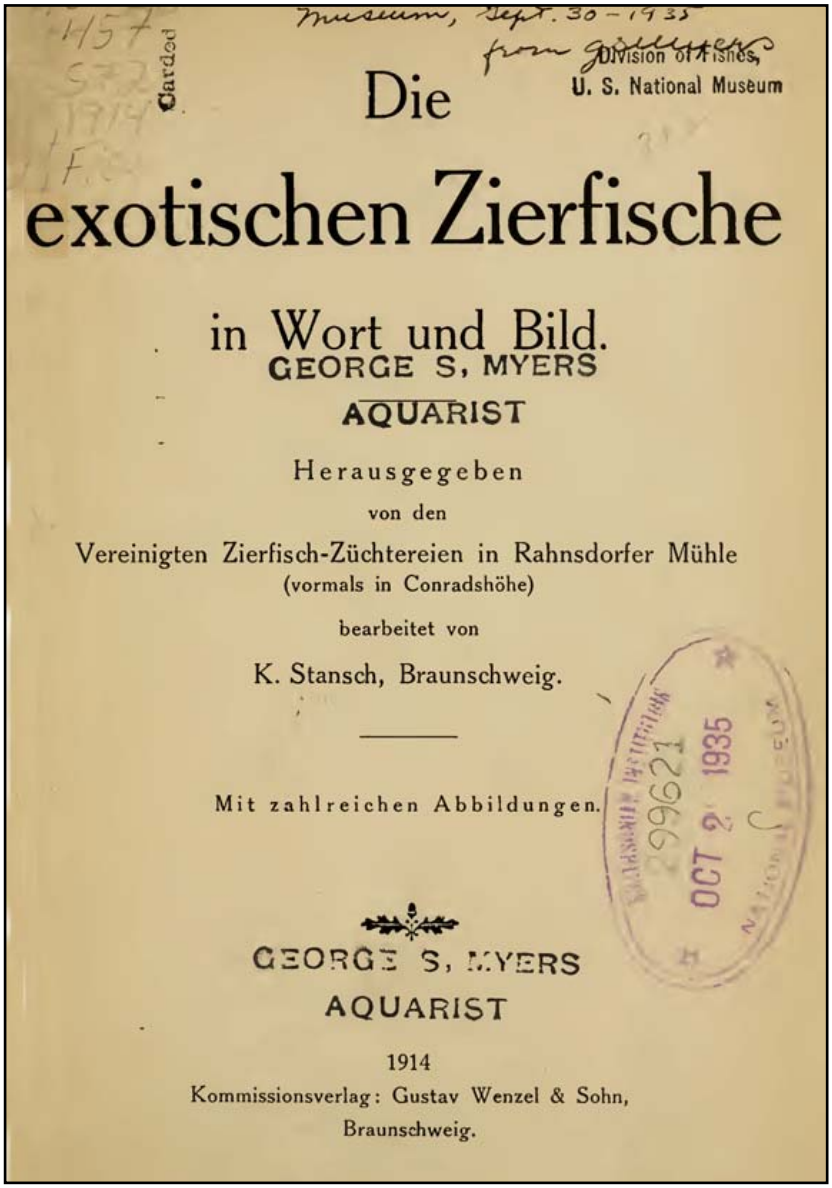

Figure 1: The inside cover page of George Myers' copy of *Exotischen Zierfische* showing two of his "George S. Myers Aquarist" stamps.

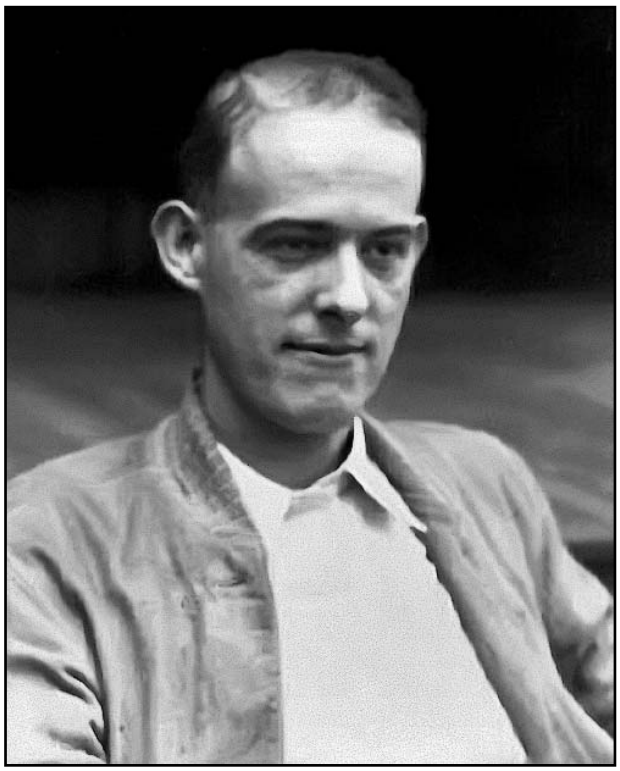

Figure 2:
GEORGE SPRAGUE MYERS (1905-1985)

In 1924, Myers was introduced to Carl H. Eigenmann, who invited him to attend Indiana University and offered him a part-time curatorial assistantship working in the fish collections. Under Eigenmann's guidance, Myers further developed his interest in the systematics of South American fresh-water fishes. He remained there until 1926, when Eigenmann fell ill and moved to California. In that year, Myers was contacted by David Starr Jordan about continuing his ichthyological studies at Stanford University. He accepted Jordan's offer and received an assistantship in the university's Natural History Museum. Myers' education was influenced by an outstanding group of systematic zoologists gathered together by Jordan. John O. Snyder, Edwin C. Starks, Harold Heath, G. F. Ferris and Albert W. C. T. Herre each played a role in shaping his career. Myers received the A.B. degree in 1930, the A.M. degree in 1931 and the Ph.D. degree in 1933. His dissertation was entitled, "The Classification of the African Cyprinodont Fishes, with a Discussion of the Geographical Distribution of the Cyprinodontidae of the World," an indication of his early interest in killifishes.

Myers began his professional career at the United States National Museum (USNM), where he was appointed Assistant Curator in charge of the Division of Fishes in 1933 and it was shortly afterwards that he turned his copy of *Exotischen Zierfische in Wort und Bild* over to the Smithsonian Library. He was an important advocate of modern ideas of fish evolution and was instrumental in developing the most widely accepted system of classifying the world fish fauna as primary freshwater, secondary freshwater, peripheral or marine. Much of his biogeographical research tended to give credence to the theory of continental drift based on evidence derived through observations of primary freshwater fishes.

Myers was a prolific writer and his bibliography included over six hundred titles on ichthyology, herpetology, biogeography, the history of systematic zoology and museum practices. He was also an accomplished editor. From 1932 to 1960, he served as associate editor of William T. Innes's *The Aquarium* and was scientific editor of all nineteen editions of Innes's *Exotic Aquarium Fishes*. He was also the founder and editor of the *Stanford Ichthyological Bulletin*, 1938-1967, and editor of *The Aquarium* Journal, 1952-1954. Older members of the American Killifish Association will remember that he was a good friend of this organization as it often called on him for help in identifying unknown killifishes and in providing assistance in killifish classification.

The book in question is definitely not a pristine copy, since page after page is stamped with the legend, "George S. Myers Aquarist," suggesting that he was in his early teenage years when he procured his copy. Furthermore - and what is of most interest to us here - he frequently corrected the scientific names of the entries throughout the book and occasionally even translated common names from German into English, but especially so in the section on egglaying cyprinodonts. In his copy of the book, his most frequent correction in the killifish section was his changing *Haplochilus* to *Aplocheilus* and in this essay I explore the reasoning behind it.

JOHN McCLELLAND (1805-1883)*

McClelland was a British medical doctor, born in Ireland, and had interests in geology and biology. He was a Member of the Royal College of Surgeons in London and entered the East India Company's Bengal Medical Service in 1830. From an early date, the East India Company's settlements and factories in the East were provided with medical officers. It was not until 1764 that The Indian Medical Service (IMS) was constituted. The service was, from the beginning, divided into three branches, the Bengal, Madras, and Bombay covenanted "Establishments." Its first duty was military as the Medical Department of the Indian Army for both European and native troops, and while its members might be lent to the Civil Department for civil employment, they were always liable to be recalled to military duty. In 1858, after the suppression of the Indian Rebellion or Mutiny of 1857, the Government of India was transferred from the Company to the Crown but the IMS was kept under much the same conditions as before.

One advantage of the IMS to its members was always the great scope available for different tastes, scientific and literary, as well as professional. Hence some of them distinguished themselves as Civil and Political Officers, Oriental Scholars and men of Science. In his history of the IMS, Dirom Crawford (1907) listed five areas in the last named. Under Natural History this included Francis Day, a pioneer ichthyologist who described more than three hundred fishes in his two volume work on *The Fishes of India* in 1878. Under Geology, McClelland was mentioned as one of the three most noted. (Crawford did not include a separate heading for ichthyology). This explains how McClelland was able to do research in addition to that of a military surgeon.

In 1835 McClelland, along with Nathaniel Wallich (a major figure in the history and development of Indian botany) and William Griffith (another well-known botanist), was sent on a mission (Tea Committee) to identify if tea could be grown in northeastern India. One field that McClelland felt might provide evidence for or against the success of tea cultivation was natural history. The more similar the terrain and the flora and fauna were to the tea-growing areas of China, the better the odds in favor. It was in this context that the expedition surveyed and collected birds and to some extent, mammals. Specimens were obtained and sent, with McClelland's report, to the Court of Directors of the East-India Company in 1837 along with drawings expressly made by local artists. McClelland had good evidence for close to 170 bird species, and this total shows just how remarkable McClelland's work was. In its day this was a very considerable sampling of the avifauna of what was then called Assam.

McClelland made preliminary identifications, which appear on the drawings, and provided written descriptions but he was aware of his limited experience as an ornithologist and requested that the Court of Directors have his collection examined by an expert and revised to take account of the most up-to-date information.

Thomas Horsfield (1773-1859) was an American physician and naturalist who worked extensively in Indonesia, describing numerous species of plants and animals from the region. At the time, he was a curator of the East India Company Museum in London, and the Court of Directors asked Horsfield to revise McClelland's material. To this end, he presented a paper to the *Zoological Society of London* (Horsfield, 1840) that appeared to

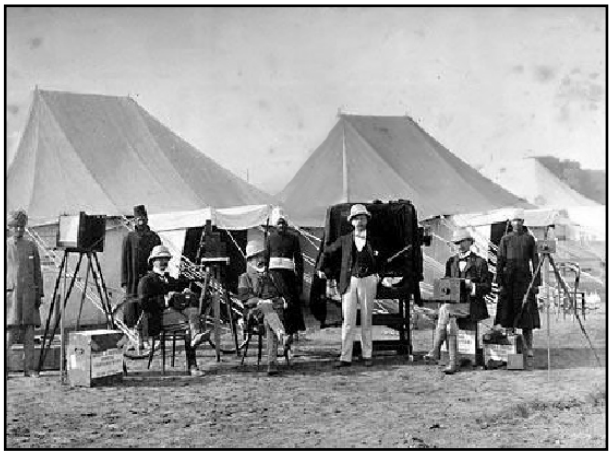

Figure 3:
Members of the Indian Medical Service, 1860.

***Because so little is known of McClelland, I have expanded this section on him to include the results of my researches into his life while he was in the Indian Medical Service.**

Figure 4: THOMAS HORSFIELD (1773-1859).

cover both McClelland's investigations and his own revisions of the mammals and birds. This paper contained the descriptions of 26 new birds, 22 of which figure in the McClelland drawings. Horsfield wrote:

"Mr. McClelland then expresses his desire that his Descriptive Catalogue, before publication, should be revised in England, in order to prevent the introduction of mere nominal species, and to conform the nomenclature to the latest discoveries in science" and continued "the only object has been to secure to Mr. McClelland the discoveries he has made."

There has been some confusion over the attribution of authorship in the names of taxa described in the Horsfield paper that do not have any attribution. In the paper there are cases where the new name is accompanied by a Latin diagnosis (written by Horsfield) *and* by an English vernacular description set within quotation marks and attributed to McClelland. Other cases either have no quoted text from McClelland or the text quoted does not include any description. What is needed therefore is a consistent method for crediting all the new names. Dickson (2003) recommends crediting to Horsfield those names, where no descriptive text by McClelland is included, and by crediting all others to McClelland as it combines consistency of logic with a minimum of change.

McClelland was appointed 1836 as the secretary of the "Coal Committee," the forerunner of the Geological Survey of India (GSI), formed to explore possibilities to exploit Indian coal. He was the first to propose hiring professional geologists for the task. He was also involved in surveys of forests and his reports led to the establishment of the Forest Department in India.

Although not a botanist he edited the posthumous botanical Works of Griffith and also wrote *The Geology of Kumaon, Calcutta*, 1835; *Reports of the Geological Survey of India for 1843 to 1846*, and *Medical Topography of Bengal and the Northwest Provinces, W.P.*, London, 1859; and

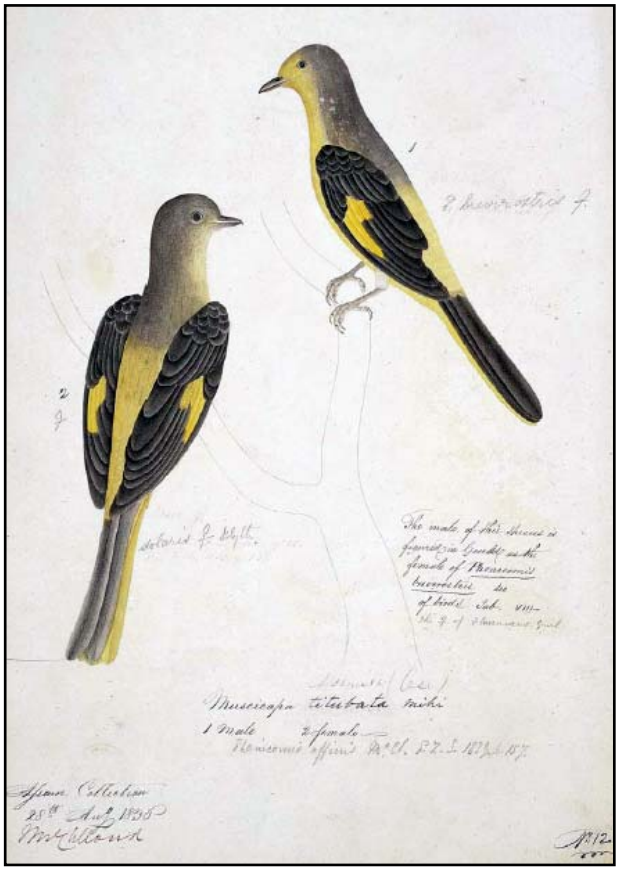

Figure 5: McClelland's paintings of two minivets named *Phoenicornis affinis* McClelland in Horsfield (1840).

Figure 6:
WILLIAM SHARP MACLEAY (1792-1865)

edited the *Calcutta Journal of Natural History* from 1841 to 1847. Scientific studies on Assam fishes were first made by McClelland who happened to visit the upper Assam being attached to a mission of Bengal Medical Service during 1835-36. He described 138 species covering various localities of India including Assam and published in 1839 a memoir on Indian Cyprinidae in the second part of the 19th volume of the Asiatic Researches. McClelland is commemorated in the name of the mountain bulbul, *Ixos mcclellandii* and a venomous snake, *Sinomicrus macclellandi*. In his work as an ichthyologist he described many species and several genera of fish, among them *Schistura*, a genus of fish in the family Nemacheilidae native to the streams and rivers of the southern and eastern Asia.

An ardent Quinarian, his devotion to its principles led to his difficulty in getting his monograph on Ganges fishes accepted by the Asiatic Society of Bengal. The British Civil Servant and entomologist William Sharp Macleay developed the Quinarian system of classification in his *Horæ Entomologicæ*, published in two parts in 1819 and 1821, and William John Swainson's work on ornithology gave wide publicity to the idea. For two decades, the Quinarian system was widely discussed in Britain and influenced such naturalists as Charles Darwin, Richard Owen and Thomas Huxley.

Macleay developed his system under the shaping influence of two pressures: (1) the insistence by followers of Linnaeus on developing artificial systems at the expense of the natural system and (2) the apparent tension between the continuity of organic nature and the failure of linear classification schemes (which continuity seemed to require). Against what he perceived as a dogmatic indolence on the part of the Linnaeans, Macleay developed a philosophy of science in which hypotheses that exceeded the available evidence should be proposed and subjected to severe tests. He also developed a novel comparative anatomical methodology, the method of variation, to aid in his search for the natural system. Using this method, he developed an intricate system that showed how organic nature could be continuous without being linear.

Macleay thought that nature was arranged in patterns of five. So there were 5 classes of animals in the natural world (Figure 7). Each class, such as birds, was comprised of 5 orders, and each of these orders contains 5 families, etc. What made

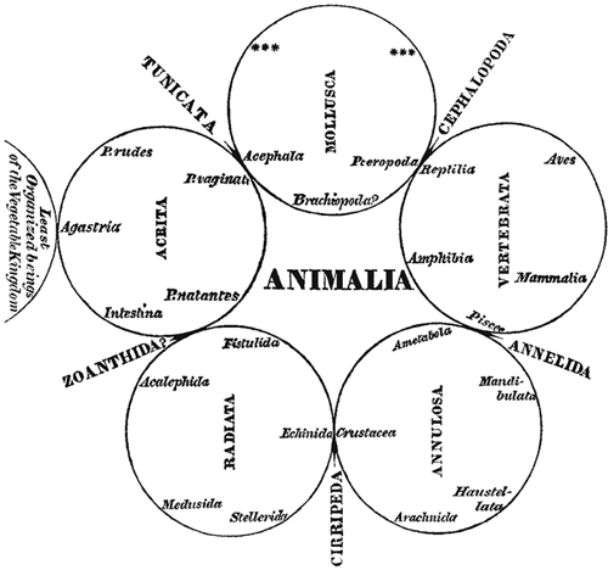

Figure 7: Part of the Quinarian system the classification of animals. The asterisks in the Mollusca represent missing groups that were expected to remain to be discovered.

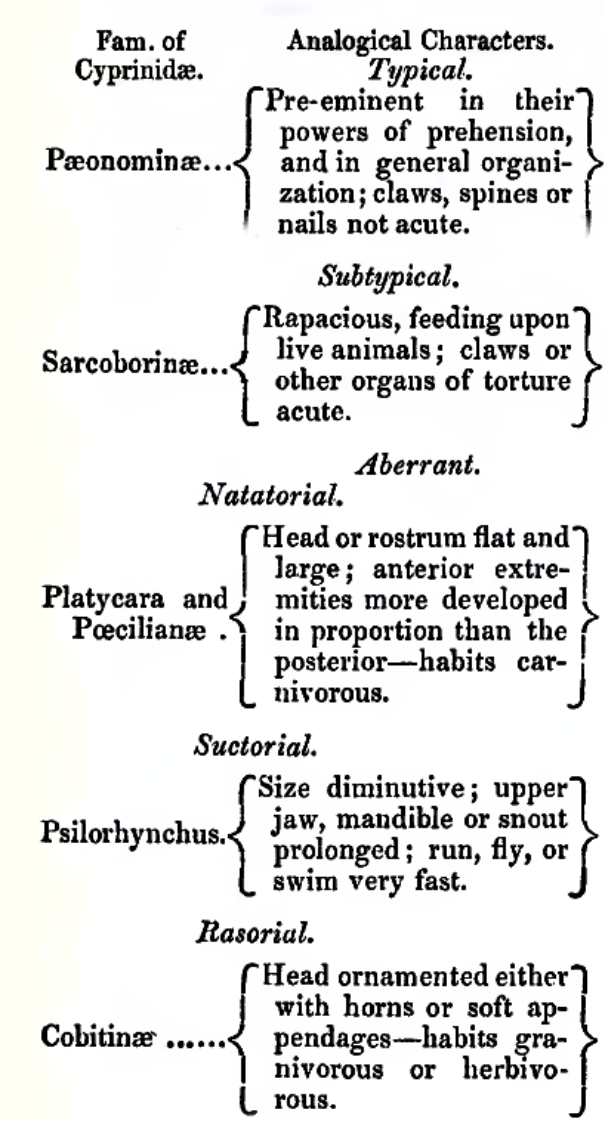

Figure 8: McClelland's Quinarian classification of the Cyprinidae into five subfamilies. Although circles were favored by Macleay, squares, triangles and straight lines were used as well to show the circularity.

the Quinarian system, as it was called, distinctive was its method of graphic display. Macleay would depict the five orders of birds as five circles, arranged in a larger circle with each smaller circle just touching. The five families would then be distributed around each of the five small circles. Where a family on one circle touched a family on another, there was judged to be an affinity. Families that were in corresponding spots in different orders were said to have be analogous.

Quinarianism was not widely popular outside the United Kingdom and it became unfashionable by the 1840s. The system had opponents even before the publication of Charles Darwin's *On the Origin of Species* (1859) that paved the way for evolutionary trees.

In his 1839 monograph on Indian *Cyprinidae,* the family at that time consisting, among others, of carps, barbs, loaches, aquarium livebearers and killifishes (McClelland, 1841), McClelland applied quinarian methods to the family and his classification is shown in Figure 8. McClelland appeared to be the only one at the time who unreservedly adopted quinarian views but fortunately, the Asiatic Society of Bengal did agree to publish his monograph.

In 1839 McClelland took the family *Pœcilianae* and, on the basis that although the members of the family were closely allied the numbers of their branchial rays differed, established the following six subgenera:

1. *Pœcilia*
2. *Lebias*
3. *Aplocheilus* (new)
4. *Fundulus*
5. *Molinesia* and
6. *Cyprinodon*

The misspellings are McClelland's and all six were considered genera by subsequent ichthyologists.

McClelland placed three members in his new subgenus: *Aplocheilus chrysostigmus*, *Aplocheilus melastigmus* (actually an *Oryzias*) and *Esox panchax*, the last named by Hamilton in 1822 and which McClelland considered therefore as *Aplocheilus panchax*. He named *Aplocheilus* on the basis of eleven characters but only four were correct and were not sufficient to characterize the subgenus; this was done by Valenciennes in 1846. McClelland did not specify a type species for his genus so this was done by the Dutch ichthyologist Pieter Bleeker in 1863 who named *Aplocheilus chrysostigmus* as the type species. This was actually directly opposite to what he had intended to do since *Aplocheilus chrysostigmus* is a synonym of *Aplocheilus panchax*.

Although I have chronicled McClelland's errors in his establishment of *Aplocheilus*, I should mention that one of Dey's conclusions in his 1984 "Ichthyological Developments in Assam During Nineteenth Century" was that although the occurrences of fishes in India dates back to three millennium BC (Hora, 1956) and that the first writer was Bloch in 1785, it would seem that the scientific attempt on the fishes of Assam that was initiated by Hamilton in 1814 and 1822 with 16 species was truly elucidated by McClelland in 1839.

In 1861, Northern India was visited by a devastating epidemic of cholera. In consequence of these terrible losses, the Government of India appointed a special Commission on August 31, 1861, commonly known as the "Cholera Commission." The Commissioners appointed were five in number: John Strachey, Esq., Civil Service, President; Dr. William Linton and John McClelland, Inspectors-General of Hospitals; Lt. Colonel J.C. Gawler, Officiating Deputy-Adjutant General, British Forces; and Major Patrick Stewart, Bengal Engineers.

They were instructed to investigate the circumstances under which the epidemic of cholera attacked the European troops in the North-Western Provinces and the Punjab; to place upon record all facts of interest that they could discover; to ascertain, so far as might be practicable, the causes which aggravated the virulence of the disease; to point out how those causes might have been prevented or avoided; and to endeavor to draw from the history of the past useful lessons for the future. It was no part of their duty, however, to inquire into the causes in which an epidemic of cholera has its origin, nor to investigate the pathology or treatment of the disease.

When the Indian Mutiny broke out in 1857, Florence Nightingale offered to leave for India immediately if there was anything she could do. Her services were not required but she became interested in the sanitary conditions of the army and the people there. She became familiar with many facets of Indian life and demanded that there should be improvements in health and sanitation there. From her work, a Sanitary Department was established in the Indian government.

Nightingale was anxious to receive the Cholera Commission report but it was delayed, prompting her to criticize it without seeing it. On November 10, 1863 she wrote: "As to the 'cholera commission' report, it is obvious they are ashamed to send it," and "We know its history. We know that there were evils which accumulated under McClelland, that it is a divided report - part of the commission refused to sign it - and that they are ashamed of the state of things and keep it close." On December 26, 1863 she wrote: "Allusion is made in Dr. McClelland's paper to the report of the Cholera Commission. This report never reached us here. All we have heard is that it is the report of a minority and that one of the ablest sanitary men in the British service, who was a member, refused to sign it (she is referring here to Dr. Linton). For some cause it has given offence."

Strachey, however, explained why the report was delayed and refutes their (Linton and Gawler) criticism of the report. Major Stewart was compelled to leave India on public duty before the completion of the Report but he was present with the Commission during the whole of the inquiry and that portion of the Report which concerned

Figure 9: JOHN STRACHEY (left) and his Brother Richard in 1876.

the special measures to be adopted for the prevention or mitigation of future attacks of Cholera was nearly finished before Major Stewart left the country. However, Strachey and McClelland were authorized to say that he concurred in the recommendations made by them therein to the Government.

The following was written by Strachey:

The duty of drawing up the Report of the Commission fell to me, although, as I need hardly say, the duty of writing upon such a subject was not one that I was likely to think agreeable. My task was not made easier by the fact that the Inspector General of Her Majesty's Hospitals in India was a Member of the Commission [i.e., Linton], and that he was little inclined to admit the shortcomings of his Department. Dr. Linton withdrew from the Commission at Agra, never took any part in its proceedings in that Circle, and never visited Morar, regarding which place the chief question is raised.

We hope that we may be pardoned for saying that serious criticism of this joint Minute of Dr. Linton and Lieutenant Colonel Gawler is hardly possible. It is not worthwhile to expose in detail its mistakes and misrepresentations and contradictions. If the reasons for the opinions given in the Report have not been sufficiently justified by the facts that have been already stated, nothing that could now be added could make the truth clearer. Regarding general conclusions of importance, Dr. Linton and Lieutenant Colonel Gawler hardly say a word, and there is nothing to show whether they adopt them or reject them. Very nearly the whole of their Minutes, except those portions which refer to irrelevant matters, is taken up with the defense of persons or departments whose misconduct or in competency has been exposed in the Report, and with attempts to show that nobody was to blame for anything that happened.

Linton's character was made clear by the following paragraph that appeared in his Report:

There is one point to which I wish to call attention. While the disease was at its height, a large number of men were daily required to attend on the sick and to rub their cramped limbs. This duty exposed to the utmost risk many men who would otherwise have incurred much less danger of infection; and the mortality was thus so much increased, though unavoidably, that I think it would on future occasions be advisable to entertain a number of Natives for such duties, rather than unnecessarily risk the loss of so many European lives.

On November 17, 1863, Nightingale had changed her mind about McClelland and the report:

Let me add that, when I said what was thought of the "cholera report" by the medical officials here (in my last) it was merely as such. The forty-eight hours' reading of it, which I have had since, show me that it con-

Figure 10:
FLORENCE NIGHTINGALE (1820-1910). Nightingale was at first very critical of McClelland and the Commission Report but later had a change of mind and praised them.

tains an amount of' valuable information and makes disclosures such as we have never had, nor made, in our report. But its recommendations are not equal to what we in this country should consider necessary from experience. However it is a great step in advance to have had such a report, although I can easily understand why it should offend army medical officials…

The apparent reason why Dr. Linton would not sign the Cholera Commission report and why it has created so much ill feeling in the Army Medical Department is that *one Indian medical officer, Dr. McClelland, and one civilian, Mr. Strachey, have not only exposed fearlessly the sanitary defects of the stations, for on this all parties may be agreed, but because they have criticized rather severely the measures and treatment adopted for the sick by the royal army medical officers.*

On September 14,1863 Major H. K. Burne, Officiating Secretary to the Government of India, Military Department, sent a letter to Strachey and the following is a quote from it:

The Report of the Commission appointed to inquire into the causes and history of the Cholera Epidemic of 1861 in Northern India, of which you were President, having been laid before Government with the subsequent correspondence on the same subject, I am directed to convey to the Commission, - especially to yourself and to Dr. McClelland, whose labors were prolonged considerably beyond the period over which those of the other Members extended, - the warm acknowledgments of the Government of India for the zeal and earnestness with which the inquiries were conducted, and the patience and care with which the varying results of the investigation have been compared and practical conclusions drawn for future guidance.

McClelland had been promoted to Officiating Principal Inspector General, Medical Department, in 1862 and was promoted to Principal Inspector General in 1863. After retiring from the Bengal Medical Service in 1867, he was knighted and became Sir John McClelland. By then he was married to a Scottish woman, Sophia Rosina, who was younger than him. They had a 5 year old son, John Gordon McClelland, who was born in Hampshire (the southern coast of England) in 1865. In 1871 he was living in Surrey (southeast England), and was listed in the census as a retired surgeon. McClelland died in St. Leonards (east Sussex on the south coast of England) in 1883 at the age of 82. Sophia married Henry Edward Swaine in Tunbridge Wells in 1884 and it is interesting to note that despite remarrying after his death in 1883, Sophia was buried in the same grave when she died, less than two years later.

McClelland made a number of observations during his lifetime that I find interesting, especially the first of the following two:

The number of species and groups are now so much multiplied in every department of natural history, that detached descriptions are daily diminishing in value; and besides, it is so easy to make a new genus if not required to show our reason for doing so, that we need not be surprised that it should now have become a regular trade, and that many acquire a temporary fame with the unthinking part of mankind by the practice.

Writers on natural history in the present day may he divided into three classes; first, those who recognise no rules but such as appear to be laws of nature, and taking nature as their guide, form their views according to the result of observations which are not confined to external characters, but embrace all that

Figure 11: ***Sinomicrus macclellandi.***

concerns natural objects [i.e., Quinarians]. The second class consists of naturalists who pursue the easier course of following authorities, but their works consist chiefly of technicalities derived from external characters indiscriminately applied to genera and species; their higher groups are consequently constructed according to rule rather than nature. The third class comprises describers of species, whose books are only remarkable for their size and expense. Nor can I altogether overlook upon this occasion another class of persons, who, though they are not naturalists, and scarcely even allow us to call them writers, yet exercise but too often an influence in societies detrimental to the objects of such institutions and the real advancement of science.

LOUIS AGASSIZ (1807-1873)

One of the great scientists of his day, and one of the "founding fathers" of the modern American scientific tradition, Louis Agassiz remains something of a historical enigma. A great systematist and paleontologist, a renowned teacher and tireless promoter of science in America, he was also a lifelong opponent of Darwin's theory of evolution. Yet even his most critical attacks on evolution have provided evolutionary biologists with insights.

Agassiz spent his early years in some of the most distinguished schools and colleges in Germany and he had the good fortune to be made early a student of the two great languages of ancient times. He became familiar, by reading them in their native Greek, with the high thought and reasoned truth and graceful style of Plato, and the accurate observations and descriptions of Aristotle. He also read the best Latin authors and wrote the language with great ease. Significantly, he was dogmatic in their usage.

Over the period from 1842 to 1847, Agassiz assembled his *Nomenclator Zoologicus* (1,564 pages and in Latin), which listed all of the names of the genera of animals. It was in two parts: I, the Supplemental List and II, the Universal Index. The first part contained 15,939 entries established previous to 1880 and the second part about 80,000 entries, also up to 1880 and which included all names in the first part. In the Universal part published in 1846, Agassiz listed the genus *Haplochilus* as a replacement for *Aplocheilus*. Each genus in the *Nomenclator* takes up only a single line, citing the name of the genus, the author of the name and the year named, and an indication in the group it belongs to such as Pisces, Aves, etc. (all this is heavily abbreviated).

What is astonishing is that these two names are, as far as their Greek roots go, identical. Aplo and haplo mean the same in Greek, i.e., simple or plain, and cheilus and chilus both mean lips. This is merely a matter of spelling and ichthyologists and other zoologists have been using the different versions for years without any demurral. Ichthyological examples include *Aplocentrus* (one of Rafinesque's "apparently a mythical" species of fish based on a purely imaginative drawing that Audubon prepared as a hoax) and *Haplochromis* (common aquarium cichlid), and *Balantiocheilus* (the Bala shark) and *Chondrochilus* (ray-finned fish in the family *Cyprinidae*). This, however, is merely a matter of how one prefers to spell these roots and Agassiz disagreed with the spelling of McClelland's *Aplocheilus*; it was not up to his own exacting standards.

Figure 12: LOUIS AGASSIZ (1807-1873)

The entries for *Aplocheilus* and *Haplochilus* in the *Nomenclator* are:

° Aplocheilus *M'Clel.* Pisc. 1839. (*Scr.* Haplochilus).
* Haplochilus — (*V. Aplocheilus MClel.*) Pisc.

Agassiz indicated that names in the entry with the superscript circle ° needed to improve in spelling and writing, and names in parenthesis in the entry with the asterisk * were faulty and must be abandoned. Although this was a poor reason for designating a new genus, many ichthyologists followed Agassiz's admonition and *Haplochilus* was widely used for quite a number of years but it was later criticized as being an "unjustified emendation" and thus nothing more than a synonym, hence the changes George Myers made in *Exotischen Zierfische.*

FRANCIS HAMILTON (1762-1829)

Since the *Aplocheilus/Haplochilus* fiasco started with Hamilton's *Esox panchax*, I'll say a little bit about some problems with his own name and discuss Hamilton's life in greater detail. Francis Hamilton was a Scottish physician born at Branziet, in Stirlingshire in 1762. He was the third son of Dr. Thomas Buchanan of Spital (the name derives from a shortened form of "hospital" dedicated to St. Bartholomew) - who afterwards succeeded as heir of entail to the estate of Leney in Perthshire - and Elizabeth Hamilton heiress of Bardowie near Glasgow. As a younger brother he was, of course, destined to a profession. He chose that of his father, and after the finishing the elementary parts of his classical education with considerable credit at the Grammar School of Glasgow, he commenced his medical studies at the University of Edinburgh.

Glasgow college has always enjoyed a high reputation for literature and ethics but, with the exception, perhaps, of the department of anatomy, its fame as a medical school has never equaled that of Edinburgh. During the latter part of the eighteenth century especially, the capital enjoyed a reputation for medical science scarcely inferior to that of any medical school in Europe. Its degrees were eagerly desired by students from all parts of Great Britain and from many parts of the continent, and its diploma was available in almost every part of the world as a powerful letter of recommendation. Hamilton was anxious to secure for himself the advantage of pursuing his professional studies under the eminent professors, who, at that time, more than sustained the high reputation which Edinburgh college had already acquired. Here he remained till he received his degree in 1783.

He soon after was appointed assistant-surgeon on board a man-of-war, a situation from which he was afterwards obliged to retire on account of ill health. He then spent some years at home in the country, his health being so bad as to disqualify him for all active exertion until 1794 when he received an appointment as surgeon in the East India Company's Bengal service. In the course of his medical studies, Hamilton had paid particular attention to botany and its cognate branches of natural science, and during his visit to the Birman Empire, he had an opportunity of making some valuable collections of the plants of Pegu, Ava and the Andaman Islands, which together with several interesting drawings, he transmitted to the

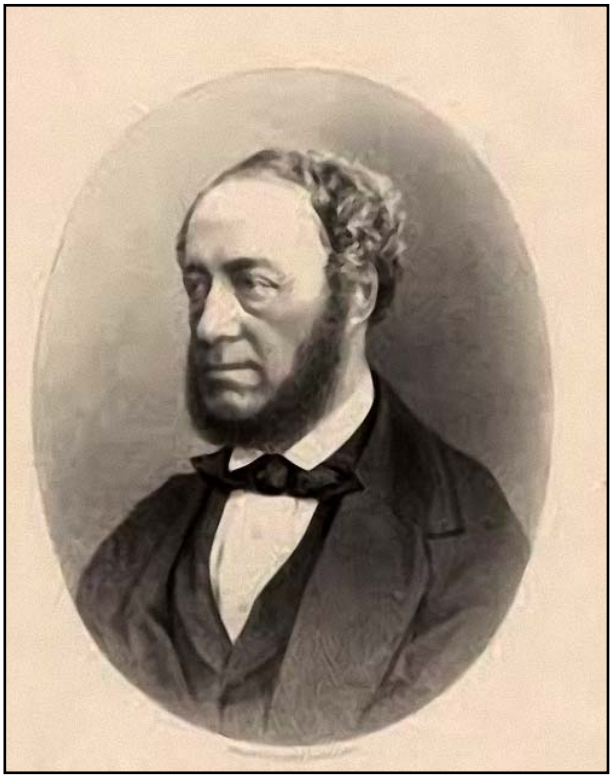

Figure 13: FRANCIS HAMILTON (1762-1829)

Court of Directors (the Minutes of the Court of Directors formed the central record of the deliberations and resolutions of the East India Company), by whom they were presented to Sir Joseph Banks. On his return from Ava, he was stationed at Luckipoor near the mouth of the Burrampooter, one of the major rivers of Asia, a trans-boundary river which flows through China, India and Bangladesh, where he remained two years, principally occupied in describing the fishes found in the neighborhood.

In 1798, he was employed by the board of trade at Calcutta on the recommendation of the Superintendent of the botanical garden, to visit the district of Chatigang (in Bangladesh) and its neighborhood, which formed the chief part of the ancient kingdom of Tripura. These extensive and well-watered districts of India beyond the Ganges afforded him a wide and rich field for pursuing his favorite study. The numerous specimens which he collected in this interesting country were also transmitted to Sir Joseph Banks, and added to his collection. Part of the following year, Hamilton spent in describing the fishes of the Ganges, of which he afterwards published an account.

Although killifish fanciers cannot really blame Hamilton for the *Aplocheilus/Haplochilus* fiasco, snakehead lovers have been annoyed by his error in *Ophicephalus*, a snakehead genus erected by Bloch in 1793. In the same publication that listed his *Esox panchax* ("An account of the fishes found in the river Ganges and its branches, 1822), Hamilton described seven species of snakehead under the generic name of "*Ophiocephalus*," a spelling error caused by the letter o that he had inserted in Block's *Ophicephalus*.

In 1800, he was employed by Marquis Wellesley, then Governor-general of India, to examine the state of the country that the company's forces had lately conquered from the Tipu Sultan (ruler of the Kingdom of Mysore) together with the province of Malabar. On his return to England in 1807, he published under the patronage of the Court of Directors the results of his inquiries in the Carnatic and Mysore districts. This work, "Travels in the Mysore" and extending to three large quarto volumes, were illustrated with maps and drawings and contained much valuable information concerning the agriculture, laws, customs, religious sects and history of India generally and particularly of the interior dependencies of Madras.

In evaluating his work the Edinburgh reviewers observed (*Edinburgh Review*, vol. xiii. Oct, 1808; 18 pages!), "Those who will take the trouble to peruse Dr. Buchanan's book will certainly obtain a far more accurate and correct notion of the actual condition and appearance of India and of its existing arts, usages and manners than could be derived from all the other books relating to it in existence...everything the author has seen is described perspicuously, unaffectedly and beyond all question, with the strictest veracity."

Soon after Hamilton had finished his survey of the Mysore country, he changed the scene of his labors from the south to the northeast of Hindustan, being appointed in 1802 to accompany the embassy to Nepal. In the course of this journey and his subsequent residence in Nepal, he made large additions to his former collections of rare plants. It was during this period also that he collected the greater part of the materials for his "History of Nepal," which he published in 1818 some years after he had retired from the Company's service. On his return from Nepal he was appointed surgeon to the Governor-general, and he employed such leisure time as he had for the study of natural history in superintending the menagerie founded by the Marquis Wellesley and in describing the animals which it contained. Undoubtedly India owed much to

Figure 14: ***Tetractenos hamiltoni.***

Hamilton and it would have been happier, both for her native population and her merchant princes, had her government been always entrusted to men of such practical capacity and unblemished integrity.

In 1805, Hamilton accompanied his patron (Wellesley) to England and in the following year was again sent to India by the Court of Directors for the purpose of making a statistical survey of the territory under the Bengal Presidency of Fort William, which includes Bengal Proper and several of the adjoining districts. With this laborious undertaking he was occupied for upwards of seven years, after which he returned to Calcutta and, in 1814, became Superintendent of the Botanical Garden. But he was now exhausted with long, continued exertion. His services had been liberally rewarded by the East India Company and an independent and honorably acquired fortune relieved him from the necessity of encountering any longer the hardships incident to his former mode of life, viz., among tribes half-civilized and often somewhat less than half-friendly, and exposed to the malignant influence of the Indian climate He naturally wished to enjoy the close of a busy life, free from the responsibility and uneasiness of public service, in some peaceful retirement in his native land.

While he was preparing for his voyage home, he was deprived, by the Marquis of Hastings, of all the botanical drawings which had been made under his inspection, during his last stay in India, and which he intended to have deposited with his other collections in the library of the India house. This circumstance he greatly regretted, as he feared that the drawings would thus be totally lost to the public. "To me," says Dr. Buchanan, in a paper which was published among the *Transactions of the Royal Society of Edinburgh*, "to me, as an individual, they were of no value, as I preserve no collection, and as 1 have no occasion to convert them into money."

In deciding that Hamilton's papers should be retained in India, it may be presumed that the object was that they should there be rendered more useful to the country than they could be in England. As McClelland remarked, "It could scarcely have occurred to the Marquis of Hastings that these works would be consigned to oblivion, and the author in consequence superseded by his successors."

However, although they seem to have been withheld from Hamilton himself, drawings from his original collection of unpublished figures of fishes somehow found their way to the Royal Botanic Gardens, Kew (Hamilton was professedly a botanist) and then into Hardwicke's *Illustrations of Indian Zoology* (1830-35) without any acknowledgement to point out from where they were derived. Major-General Thomas Hardwicke (1756-1835) was an English soldier and naturalist who was in India from 1777 to 1823. He collected numerous specimens of natural history and had them painted by Indian artists and from which many new species were described. Several of these species are named after him.

On returning to England he collaborated with the zoologist John Edward Gray to publish *Illustrations of Indian Zoology*. Hardwicke, however, did not credit the original artists in any of his plates. McClelland suspected that many of the fishes in *Illustrations of Indian Zoology* were originally done by Hamilton and copied by Hardwicke's engraver. He went to the Kew Gardens and found this was so. For example, in Plate 86 of *Illustrations of Indian Zoology* (Figure 17), the upper figure is *Cyprinus angra*, Ham., a pirated figure disguised under bad coloring and named "*Cyprinus Hamilto-*

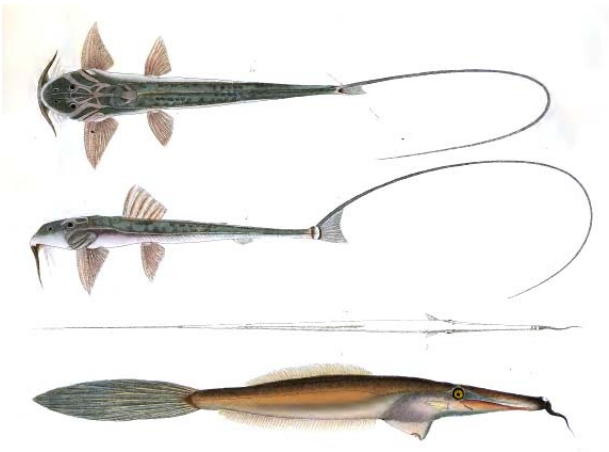

Figure 15: Two of Hamilton's drawings, *Hypostomus sisor* (top) and *Sisor Rabdophorus* (bottom).

Figure 16: Major-General *Thomas Hardwicke* (1756-1835)

nii, Gray" and the lower figure is *Cyprinus goha*, Ham., its coloring much exaggerated. There are two figures of each species, so that this plate had been taken wholesale from Hamilton. As McClelland noted (McClelland, 1841):

Although Buchanan was professedly a botanist his researches appear to have extended to all branches of natural history except entomology. His volumes on Gangetic Fishes, published at his own expense, under the disadvantage of being deprived of the greater part of his figures, are the only part of his zoological labours that are known, yet his inquiries in other branches of zoology were equally extensive, and equally entitled to publicity. It now appears that two quarto volumes of MSS., written with his usual erudition, have been retained in the library of the Botanic Garden since 1815; while every periodical that has since appeared deprived him of some portion of those claims to priority which his papers ought to have secured to him had they been placed in proper hands, or deposited in an institution where their existence could have been known or appreciated.

Such an injury to the advancement of information resulted from an oversight in an ordinary public office, the circumstance would excite less surprise but that the works of a naturalist should be so treated in a public institution expressly intended for the promotion of science, is so unaccountable to me, that I cannot presume to express an opinion on the subject. But as the case stands, perhaps the best remedy that can now be applied, injustice to Buchanan as well as to others who are still engaged in scientific pursuits, would be to give a complete edition of his labours, botanical and zoological, to the public; at the same time it is right to say, that no atonement can now make amends for the injury that has been inflicted on Buchanan as a naturalist, or for the time that has been lost in allowing others to go over unnecessarily the ground which he investigated, instead of beginning where he left off.

On his arrival in England in 1815, he presented to the Court of Directors his collection of plants and

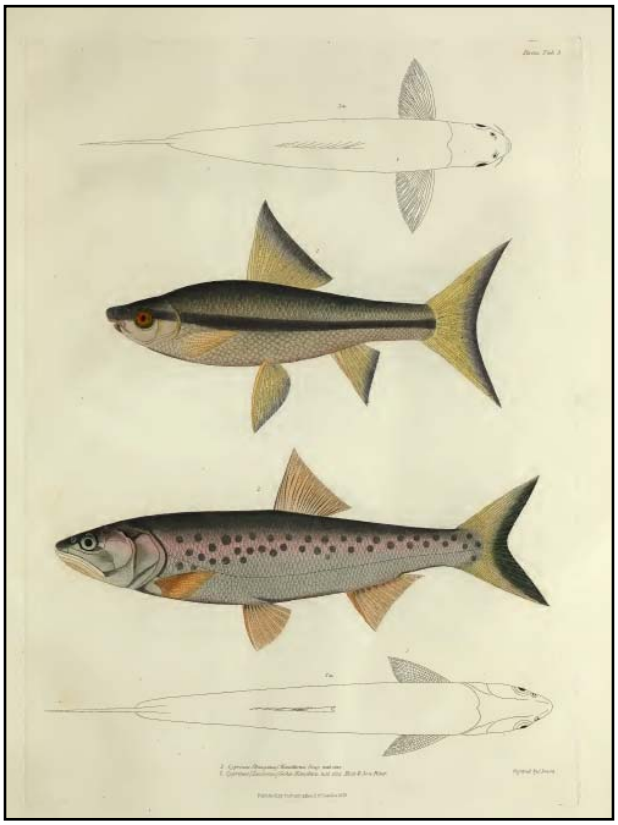

Figure 17: Plate 86 of Hardwicke's *Illustrations of Indian Zoology.*

minerals, some papers on the geography of Ava, several genealogical tables, nine hundred Indian coins, gold and silver, a collection of Indian drugs, his notes on Natural History, a few drawings and about twenty curious Hindu MSS. He then proceeded to Scotland, where he hoped to enjoy the fruits of his toil in quiet. On his arrival, he found his elder brother, Colonel Hamilton, involved in financial difficulties, from which he could only be partially relieved by the sale of such parts of the family estates as had not been entailed. Buchanan, who was himself next heir and Colonel Hamilton having no children, agreed to pay his brother's debts, which amounted altogether to upwards of £15,000. His brother soon after died abroad where he had gone in the hope of recovering his health, and Buchanan, succeeding him in his estates, adopted his mother's family name of Hamilton referring to himself as "Francis Hamilton, formerly Buchanan" or simply "Francis Hamilton." However, he is variously referred to by others as "Buchanan-Hamilton," "Francis Hamilton Buchanan" or "Francis Buchanan Hamilton."

He was now fixed at his residence at Leney and in his retirement still found pleasure in following the studies and scientific pursuits which had engrossed the busier part of his life. His garden occupied much of his attention and he introduced into his grounds many curious plants, shrubs, and flowers. Hamilton contributed largely to the scientific journals of the day, particularly the *Edinburgh Philosophical Journal, the Edinburgh Journal of Science, the transactions of the Linnaean Society of London, the Memoirs of the Hibernian Natural History Society, and the Transactions of the Royal Society of Edinburgh*. Also in the *Transactions of the Royal Asiatic Society* are several papers taken from his statistical survey of the provinces under the Bengal Presidency of Fort William, deposited in the Library of the East India Company. In 1819, he published his History of the Kingdom of Nepal, already mentioned, and in the same year a *Genealogy of the Hindoo Gods*, which he had drawn up some years before with the assistance of an intelligent Brahman. In 1822 appeared his *Account of the Fishes of the Ganges*, with plates. Hamilton died in 1829, in the 67th year of his age.

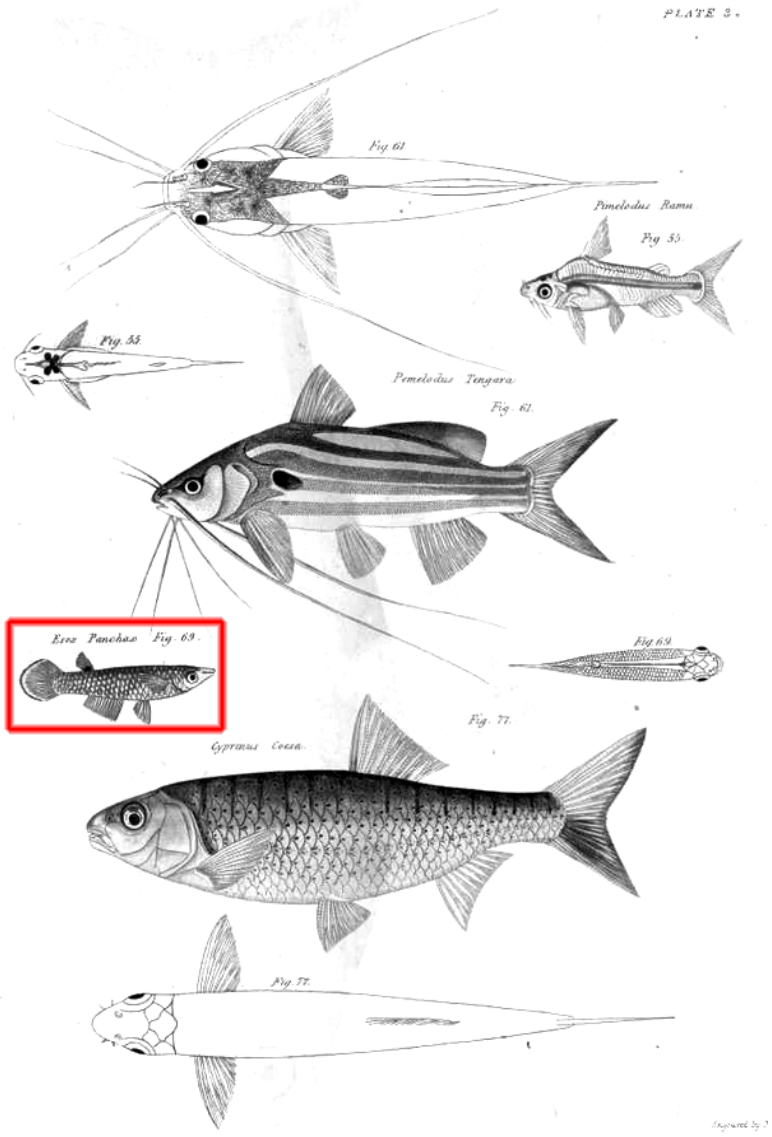

FIGURE 18: Plate 2 from Hamilton's "Account of Fishes Found in the River Ganges" (1822) showing his *Esox panchax* in the red rectangle.

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Figure 19:
The Mountain Bulbul,
Ixos mcclellandii.

WHAT'S IN A NAME?
THAT WHICH WE CALL A KILLIFISH...

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, February 17, 2018)

Felipe Alonso is an Argentine biologist , specializing in ichthyology and dedicated to the study of the behavior and evolution of Neotropical (a zoogeographical region comprising Central and South America) fish, and is an Argentine educator and naturalist and one of the founders of the *Killi Club Argentino*. Both are associated with the *Institute of Bio and Geosciences of the National Council of Scientific and Technical Research*, National University of Salta (a city in the northwest part of Argentina).

In a paper appearing in *BIBKCA* in 2018, a publication of the *Killi Club Argentino*, titled "The viviparous killifish and the history of the application of the word killifish (Cyprinodontiformes)," these two authors urge aquarists to apply the common term "killifish" to the livebearing as well as egglaying members of the Cyprinodontiformes (Cyprinodontiformes is an Order currently containing ten families of fishes primarily living in freshwater ecosystems. It includes what aquarists customarily call "killifishes" and "livebearers).

THE TECHNICAL BACKGROUND

Cyprinodontiforms are a diverse group of approximately 900 pantropical and temperate fishes, mostly found in freshwater. Whereas the vast majority of fishes lay eggs (oviparous), this group is unusual in that four groups of cyprinodont fishes give birth to living young (viviparous). Traditionally, it had been classified in five families: the worldwide, oviparous Cyprinodontidae, and four New World viviparous families: the Poeciliidae, Anablepidae, Jenynsiidae, and Goodeidae (see Figure 1). Fishes of the diverse Cyprinodontidae, in turn, have been divided into as many as eight subfamilies. This classification scheme implied that the viviparity would have appeared only once in the evolution of this group of fish, in a single ancestor common to all these families of viviparous fish and that the oviparous fish formed a separate group corresponding to the Cyprinodontidae family.

In 1981 Parenti examined the cyprinodontiform fishes with the following objectives (I have omitted the sixth objective since it is not relevant to this discussion):

(1) determine if the cyprinodontiform fishes as a whole form a monophyletic group (i.e., a group descended from a common evolutionary ancestor or ancestral group);
(2) determine if each of the five families is monophyletic;

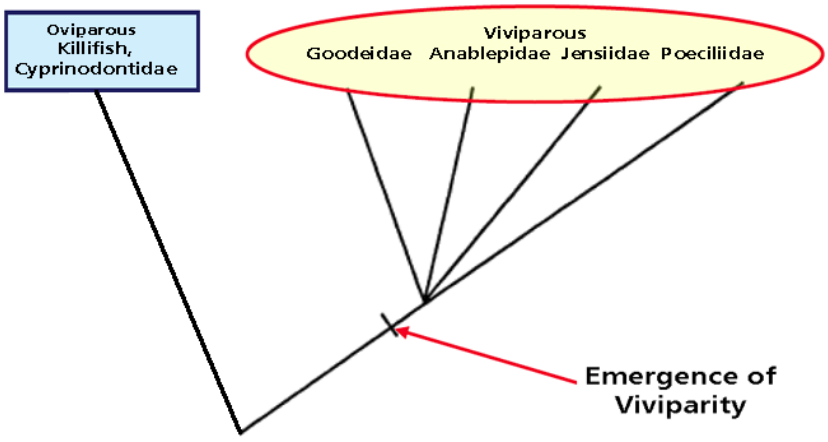


Figure 1: The traditional classification of the Cyprinodonts.

Figure 2: Dr. Lynne Parenti

(3)define the major subgroups of Cyprinodontiforms, concentrating on the genera of the Cyprinodontidae;
(4) determine the interrelationships of the subgroups;
(5) present a comprehensive classification of the Cyprinodontiforms that reflects the interrelationships.

The fishes in Parenti's study comprised the order Cyprinodontiformes Berg and were divided into two suborders, the Aplocheiloidei (which previously comprised, in part, the Cyprinodontidae), and the Cyprinodontoidei (comprising all other cyprinodontiforms as well as the four viviparous families). Parenti obtained the following general results by using the methods of morphological phylogenetic systematics (i.e., the formal name for the field within biology that reconstructs evolutionary history and studies the patterns of relationships among organisms):

(1) the Cyprinodontiforms are considered to be monophyletic by their sharing derived characters of the caudal skeleton, upper jaw, gill arches, position of the first pleural rib, pectoral girdle, and aspects of breeding and development;
(2) the family Cyprinodontidae is nonmonophyletic as it contains some of the most primitive and derived cyprinodontiforms;
(3) each of the four viviparous families is mono-

Cyprinodontiformes
- Aplocheiloidei
  - Aplocheilidae
    - *Nothobranchius melanospilus*
  - Rivulidae
    - *Cynolebias whitei*
    - *Rivulus harti*
- Cyprinodontoidei
  - Profundulidae
    - *Profundulus guatamalensis*
  - Fundulidae
    - *Fundulus heteroclitus*
- Poecilioidea
  - Anablepidae
    - *Anableps anableps*
    - *Jenynsia lineata*
  - Poeciliidae
  - Poeciliinae
    - *Cnesterodon decmmaculatus*
    - *Poecilia caucana*
    - *Tomeurus gracilis*
    - *Xiphophorus maculatus, X. signum*
  - Fluviphylacinae
    - *Fluviphylax pygmaeus*
  - Aplocheilichthyinae
    - *Aplocheilichthys kassenjiensis, A. spilauchen*
- Cyprinodontoidea
  - Goodeidae
    - *Crenichthys baileyi*
    - *Xenotoca eiseni*
    - *Zoogonecticus quitzeoensis*
  - Cyprinodontidae
  - Cubanichthyinae
    - *Cubanichthys pengellyi*
  - Cyprinodontinae
  - Orestini:
    - *Aphanius chantrei, A. dispar, A. fasciatus, A. mento*
    - *Kosswigichthys asquamatus*
    - *Orestias agassii, O. ispi, O. luteus*
  - Cyprinodontini:
    - *Cualac tesselatus*
    - *Cyprinodon variegatus*
    - *Floridichthys carpio*
    - *Garmanella pulchra*
    - *Jordanella floridae*
    - *Megupsilon aporus*

Figure 3:
Classification of Killifish Taxa by Parenti.

phyletic; however, their previous definitions in terms of uniquely derived characters have been altered;
(4) the development of an annual habit, exhibited by members of the aplocheiloid killifishes and possibly some cyprinodontoids, includes derived reproductive traits exhibited to some degree by all killifishes; therefore, the annual habit does not define a monophyletic group of killifishes;
(5) similarly, viviparity is not hypothesized to be a uniquely derived character, but has apparently arisen at least three times within the group.

Parenti's classification of killifish taxa is shown in Figure 3 and her phylogenetic hypothesis is shown in Figure 4. The latter shows that viviparity would have arisen 3 times independently in the order Cyprinodontiformes, and what were previously two distinctly different groups, that of the former family Cyprinodontidae (the oviparous killifishes) and that of the viviparous Cyprinodontiformes were intermixed. What was believed to be a group of species closely related to each other (the oviparous "Cyprinodontids"), actually turned out to include species that were much more related to viviparous species than to any other group of oviparous killifish. For example, oviparous killifish of the subfamily Fluviphylacinae, such as members of the genus *Fluviphylax*, are more related to a Guppy or a Molly (*Poecilia* species), or a swordtail or a platy (*Xiphophorus* species).

For the next ten years Parenti's work stood alone. About this time the collection of molecular (DNA) data became feasible due to newly-invented and much improved laboratory protocols. Suddenly Parenti's phylogeny became a prime ground for comparison with the newly generated molecular data. Two lineages sharing a common ancestor from which no other lineage has sprung is called a "sister group" (see Figure 5 next page for examples). The sister taxon relationship of the Andean *Orestias* and the Mediterranean dwelling genus *Lebias* [*Aphanius*] was quickly tested with molecular data (Parker and Komfield, 1995), and Parenti's hypothesis was supported. The hypothesis that *Empetrichthys* and *Crenichthys* were more closely related to the Goodeidae than to the genus *Cyprinodon* was also tested with molecular data (Meyer and Lydeard, 1993; Grant and Riddle, 1995), and the molecular data also supported these results.

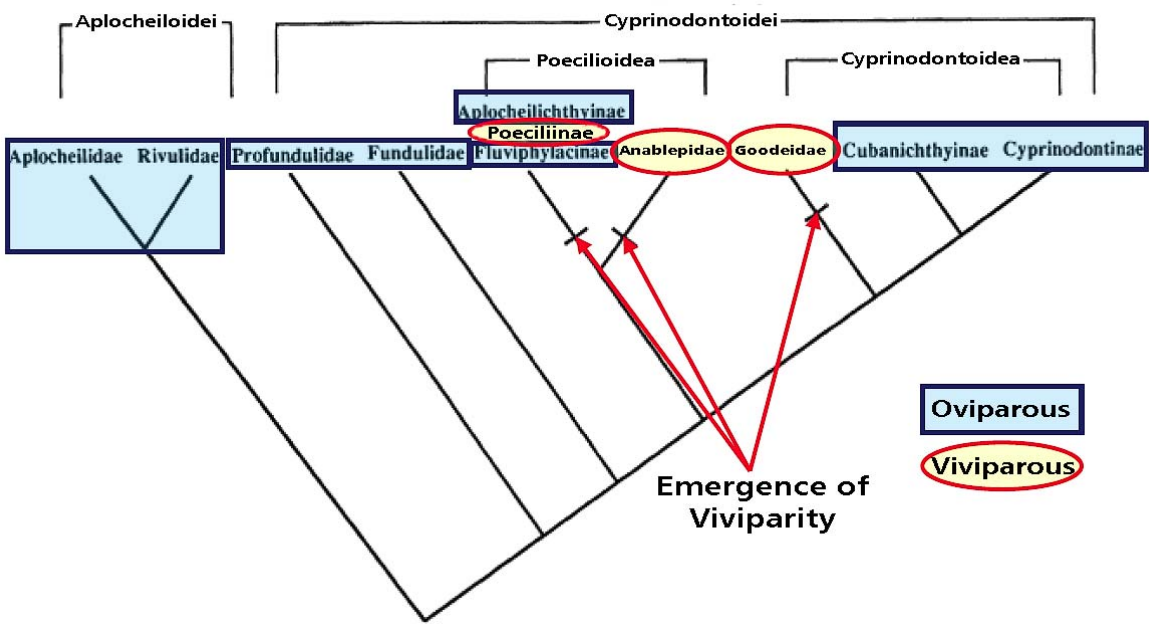


Figure 4: Parenti's phylogenetic hypothesis of the Cyprinodontiformes.

This is not to say that all the relationships that Parenti proposed were supported. In the molecular study by Meyer and Lydeard of numerous members of the order Cyprinodontiformes, several of Parenti's relationships were rejected. This study for example found that the genus *Profundulus* was closely related to the Goodeidae plus *Empetrichthys* and *Crenichthys*, rather than being one of the basal 'primitive' groups within the Cyprinodontiformes. Among other things, this study showed that synonymizing the genera *Jordanella* and *Garmanella* was erroneous and that *Jordanella floridae* was actually not at all related to *Garmanella pulchra*. It did indicate, however, that viviparity probably evolved independently three times in cyprinodontiform fishes: in the subfamilies Goodeinae, Anablepinae and Poeciliinae (*sensu* Parenti 1981). Advanced forms of viviparity, in which the mother provides additional nourishment to the embryos through placenta-like structures (ovoviparity), apparently evolved at least three times from egg-laying ancestors: in the subfamilies Goodeinae, Anablepinae, and more than once in the Poeciliinae. Obviously there is only one true phylogeny that reflect the evolutionary history of the group. We are getting there, but we are not there yet.

Alonzo and Calviño's point from all of this is that since many oviparous killifishes are much more closely related biologically with viviparous species than with other killifish, the definition of killifish as "oviparous Cyprinodontiformes" is considered by some ichthyologists to be an artificial or unnatural group that does not represent a biological entity. **All this is true but it is hardly relevant to aquarium organizations, most of whose members couldn't care less about evolutionary theories.**

ALONZO AND CALVIÑO's ARGUMENTS

The following are their five reasons for making this name change and appended to them are my comments below each.

1) The original definition (i.e., egglaying cyprinodonts) is arbitrary and lacks a pragmatic or logical basis.

As the one responsible for the wide-spread usage of the term in this sense, I can categorically state that this is not true and I expand upon this in the following section.

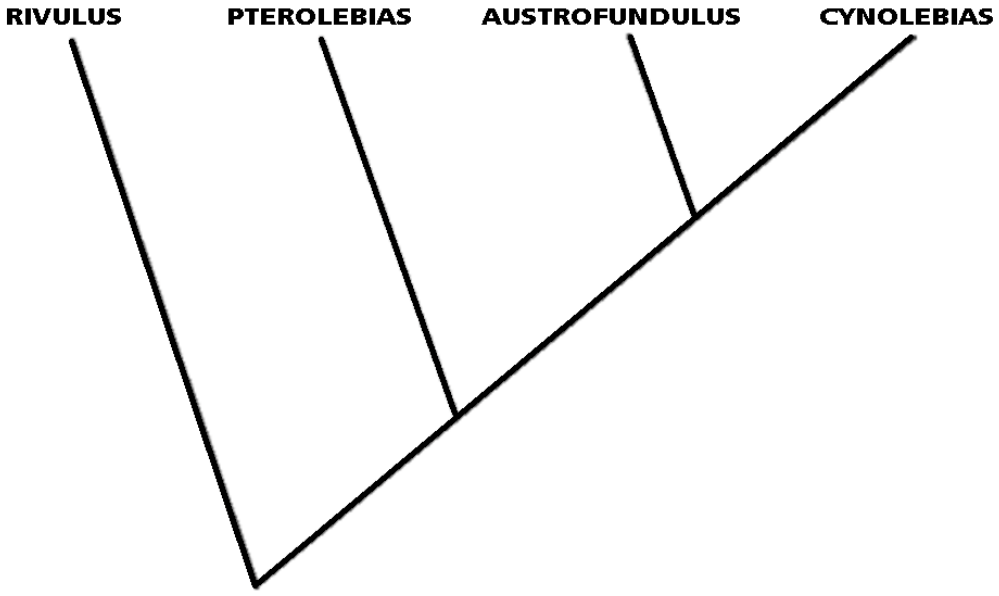


Figure 5: Taking the "austro-cyno" group as a unit, its sister group is *Pterolebias* since *Pterolebias, Austrofundulus* and *Cynolebias* all had a common ancestor. Taking the "ptero-austro-cyno" group as a unit, *Rivulus* is the sister group since all had a common ancestor.

2) When considering viviparous and oviparous Cyprinodontiformes as separate things, it leads to errors and confusions when describing or studying the biology of these organisms.

Noting that killifish is not a scientific term but an aquarium one, I can attest that the American Killifish Association has never had any problem in describing the fishes of interest to them or in studying their biology.

3) In order to carry out serious projects that aim to study and preserve killifishes, it is essential to study ALL the Cyprinodontiformes as a whole and not an arbitrary cut of some yes and no others.

It is not essential at all. The AKA has serious projects that aim to study and preserve killifishes and, analogously, the American Livebearer Association has serious projects that aim to study and preserve livebearers. They do not need to be studied en masse.

4) There are no good reasons not to include the viviparous Cyprinodontiformes in a new definition of Killifish, rather than an attachment to the old definition, a mere opposition to change or simply custom. While we understand that there is a question of traditionalism, we can also see that the definition of the term killifish has been changing and arbitrary throughout its history.

On the contrary, this is not a "mere opposition to change or simply custom." Change for change's sake is dangerous to any organization but especially in hobby organizations like ours, where constant change can trigger confusion, resistance and unnecessary learning curves, all of which can lead to disastrous results for their memberships. Changes should only be made if organizational objectives are not being met (not whether ichthyological objectives are met) or if there is a better way to do it. Alonzo and Calviño seem to think that those like myself who think this is a ludicrous idea do so because we are old fogies refusing to keep up with the times. This is rather presumptuous of them.

5) According to the knowledge that we currently have about the evolution of these fish the need is imperative for a new adjustment to the definition of killifish.

As is clearly shown in their publications, aquarium organizations have little or no interest in the evolution of their fishes. Taxonomic ichthyologists have two main tasks: classification and supplying the latest "correct" scientific name (although some of my friends disagree and would describe their main tasks as reclassification and renaming). In any case aquarists are interested only in the naming task.

THE HISTORY OF COMMON NAMES

Surprising as it may seem, professional ichthyologists do not always relish the use of long, difficult-to-pronounce scientific names. When the great American ichthyologist David Starr Jordan wanted a common name to apply to all members of the family Cyprinodontidae on the North American continent, he decided to use "killifish" as his term. In Jordan and Gilbert's "Synopsis of the fishes of North America" (Jordan, 1882), the term "killifishes" was used as the common name for the

Figure 6: David Starr Jordan (1851-1931).

Cyprinodontidae. At the time, the egglaying and livebearing cyprinodonts were not separated so the family included both groups and this explains why so many livebearers were also called killifishes. What Alonzo and Calviño are suggesting, therefore, is really not new.

In Jordan and Evermann's "The Fishes of North and Middle America Part I" (Jordan, 1896), they placed all of the Cyprinodonts in the family Poeciliidae, since Theodore Gill (the eminent ichthyologist and professor of zoology at George Washington University who was associated with the Smithsonian Institution for over fifty years) argued that although it was generally believed that Agassiz was the first to detach the cyprinodonts from the cyprinids, Agassiz never did define the new family (Gill, 1895). Now it was the turn of the family Poeciliidae to carry the common name of "killifishes."

At the time Gill published his 1895 paper on the taxonomy of the cyprinodonts, Samuel Garman had just published his Memoir, "The Cyprinodonts" (Garman, 1895), and Gill was forced to add an addendum to his paper. Garman split his Cyprinodonts into eight subfamilies, pretty much agreeing with Gills own "Families and Subfamilies of Fishes" (Gill, 1893) except that Gill listed his subfamilies under Poecilliidae instead of Cyprinodontidae. Gill used no common names in his 1893 paper and neither did Garman except he started his paper with: **The Cyprinodonts," "Top minnows," or "Toothed Carps," as they are variously called, form a well-defined group.**

In Jordan's "A Classification of Fishes Including Families and Genera as Far as Known" (Jordan, 1923), the cyprinodonts were now placed in the order Cyprinodontes (*Microprini*). Jordan commented that:

Hitherto the viviparous and Oviparous Cyprinodonts have been placed in a single family, but the differences within the group are ex-

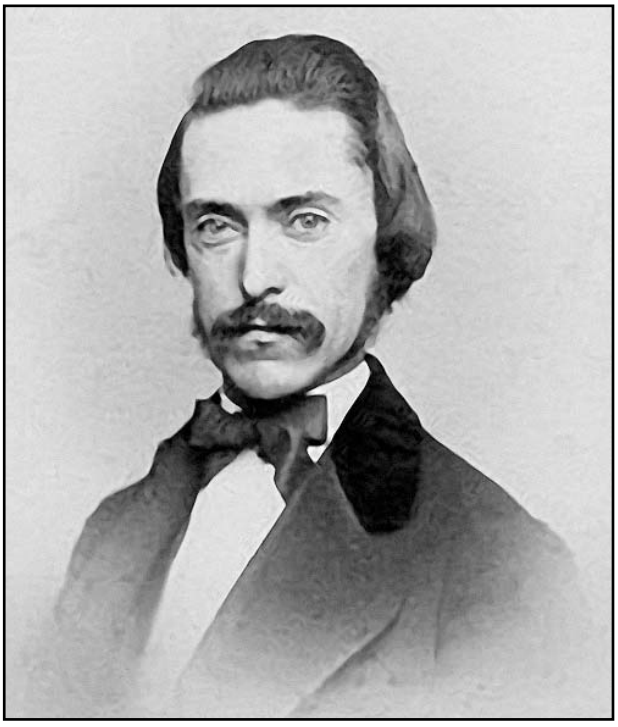


Figure 7: Theodore Nicholas Gill (1837-1914).

tensive and if the species were not all of small size they would certainly be assigned to two or more family groups.

Among the ten families he lists in this order are Cyprinodontidae, with "killifishes" as their common name, and Poecilidae, with "Top Minnows" as their common name.

In an article that appeared in the *Tropical Fish Magazine* in March 1955, the pioneer specialist in the classification of cyprinodonts, Dr. George S. Myers, proposed that aquarists use killifish for the egglaying cyprinodonts and a new term, gambusino, for the livebearers. Gambusino is from the Mosquitofish, *Gambusia affinis*; it is a Cuban term meaning "nothing," as the Mosquitofish is quite small. Gambusino, however, never caught on and was soon forgotten.

Other names had been used by aquarists in the past but they tended either to be awkward like "egglaying toothcarps - or misleading like "mudfish" and "topminnow" or both. However, the most prominent of these was the term "Panchax," used mostly by aquarists. Here we must go back some years to the time when ichthyologists recognized Panchax as a valid generic name, such as *Panchax lineatus, Panchax chaperi* and others. But as times change, so does ichthyological opinion and knowledge, and "Panchax" was adjudged to be a synonym of other names and thus was dropped from the rolls of scientific nomenclature. It is important to remember that even in its heyday, it never did apply to the whole family or even a subfamily, and so it was hardly a fitting term for aquarists to use. I wrote a lot about killifishes in those days and it was anathema to me to have refer, for example, to a group of *Aphyosemion* species under the rubric of another scientific name no longer used.

Thus I started to follow Myers' advice using killifish in my own writings and this was followed by some of my friends who also were interested in the group. The word was a short, easy to pronounce term for any egglaying member of the family Cyprinodontidae and had logical roots and the support of reputable scientists. Thus it was the name we used when Bob Criger and I founded the *American Killifish Association*. It was a great surprise to me when aquarium organizations all over the world decided to use the term as well. However I can well understand it: "Eierlegende Zahnkarpfen," for example, is quite a mouthful! Thus the argument that the original definition of killifish as used by aquarists was arbitrary and lacked a pragmatic or logical basis is clearly not true.

WHAT IS SAUCE FOR THE GOOSE IS SAUCE FOR THE GANDER

As far as Alonzo and Calviño's urging that we add the livebearers to the definition of killifish, common names are arbitrary labels but they are important and have specific meanings to organizations that carry them. Furthermore, Alonzo and Calviño are somewhat hypocritical when suggest-

Figure 8: George Sprague Myers (1905-1985).

ing that we aquarists adjust to this significant name change when zoologists themselves are just as reluctant to change their own names.

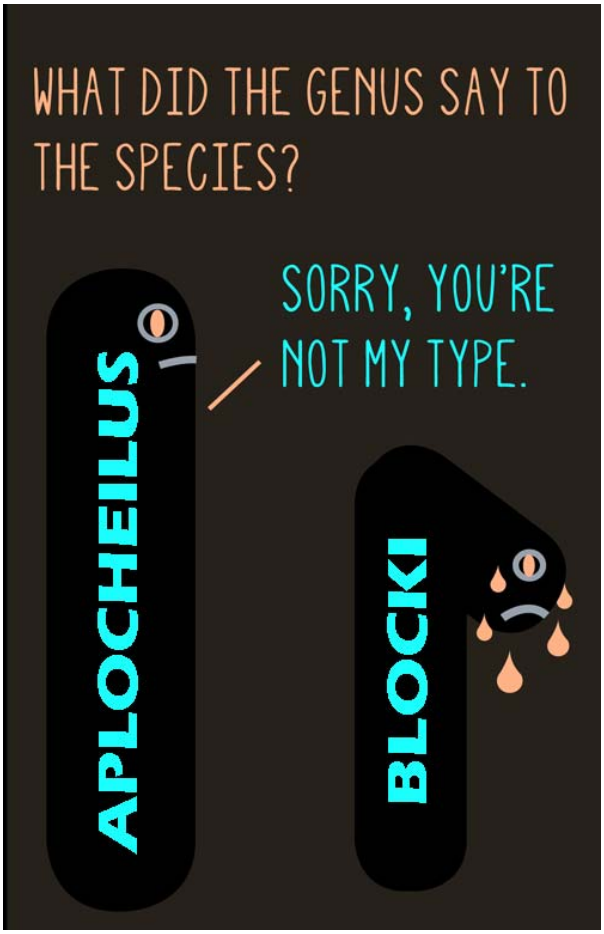
The botanists long ago adopted a system of uniform endings for the names of their higher taxa, but zoologists have never been able to agree on one. In 1950 one zoologist suggested the following endings: Superorder, **-ica**; Order, **-ida**; Suborder, **-ina**; Superfamily, **-icae**.

This provoked a flurry of criticism. Carl Hubbs, for example, pointed out (Hubbs, 1952), if there were an order Poeciliida and a family Poeciliidae, we would not know which was meant when someone wrote familiarly about poeciliid fish. Although there was some support there has been little progress since. At the Colloquium on Zoological Nomenclature held in Copenhagen in 1953 it was decided that the Colloquium was of the opinion that there should be no prescribed terminations for the names of taxa belonging to the Order/Class-Group and the Phylum-Group. No regulations for the nomenclature of higher taxa were included in the New Code adopted by the Colloquium on Zoological Nomenclature held in London in 1958 either.

There is no question concerning the advantages of a system of uniform endings. In fact, it would be analogous to the move out of the confusing world of ounces, grains, pennyweights, drams, scruples, carats, pounds, short tons and long tons into the logic and consistency of the metric system. Even the beginning student would know the rank of each taxon at a glance, an impossibility under the present chaotic system. In 1953, for example, the following list (and this was not all of them) of 16 endings were used for the names of orders: **-ura, -ptera, -ida, -ozoa, -aria, -icha, -ina, -ora, -acea, -oela, -dela, -chia, -ata, -iformes, -tia,** and **-pha.**

Although ichthyologists have agreed on the ending **-morpha** for superorders, **-iformes** for orders and **–iodei** for suborders, there is no agreement on the ending for these taxa among zoologists. Currently the *International Commission on Zoological Nomenclature* (*ICZN*) has no rules for taxa higher than the superfamily (a category between family and suborder) for which it reserves the ending **–oidea**.

Changing to a new system admittedly would be somewhat bothersome to the present generation of taxonomists but if they are reluctant to agree to change names why should we aquarists? I suggest that Alonzo and Calviño buy a copy of Smith and Cornwellth's book, "The Complete Dictionary of Bible Names" (available on Amazon for $16 plus shipping), pick one and leave the killifish and livebearer fanciers in peace.



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The International Code of Zoological Nomenclature: Principles and Problems

By Albert J. Klee, Ph.D.

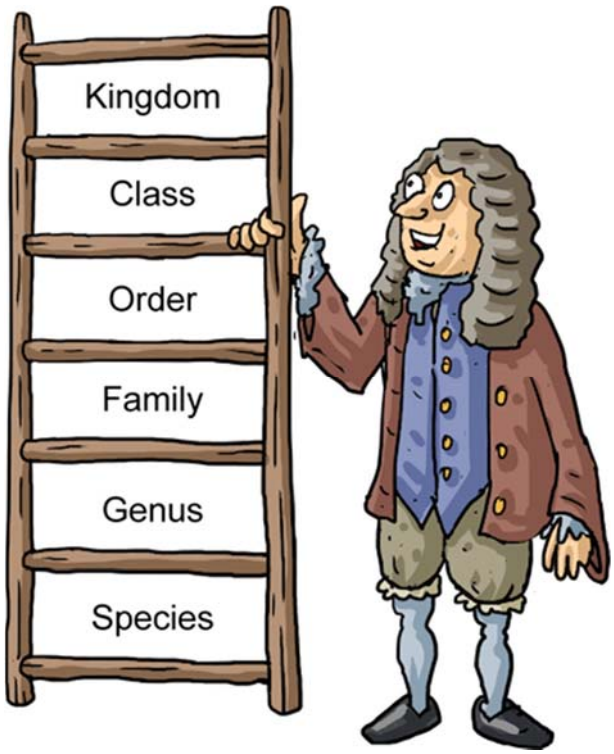
(Aquarium Hobby Historical Society of America, Facebook Files, February 24, 2018)

Taxonomy is how taxa are correctly classified in agreement with a biological system. Nomenclature is how the names of these taxa are defined and correctly spelled. This is a very basic and important difference.

(a) If a scientist finds that a species consists of two reproductively isolated units, this is taxonomy. The scientist is free to classify the two units as two independent species, and it is not necessary to record this anywhere.
(b) Placing a species in another genus, elevating a subspecies to the rank of a species, classifying a genus in a different family, subdividing a genus into various subgenera, placing genera into another family, lumping two species into one single species because they are not reproductively isolated, all this is taxonomy also. These are just proposals for different classifications and no official acts. Such a proposal can be accepted or not.

The founder of botanical and zoological nomenclature, Carl Linnæus (since 1761 Carl von Linné), was primarily a botanist and promoted botanical studies earlier and more intensively than zoological studies. Plants are generally easier to catch and to identify than most animals, so the proportion of early described species in botany was substantially higher than in zoology. The differences between botanical and zoological nomenclature are as follows:

(1) Linnean binominal nomenclature in botany started in 1753, zoology in 1757/1758.
(2) Botanical descriptions must contain a short diagnosis in Latin (since 2012 this can be in English), zoological descriptions have no restrictions to language or form.
(3) Latin errors in specific and generic names are usually corrected or standardized in botany (only one variant accepted for chinensis/sinensis, kamtchatkensis/camtschatensis, etc.). In zoology Latin errors are not corrected (always the original spelling is used).
(4) Botany allows hyphens between words in names (Capsella bursa-pastoris), zoology does not allow such hyphens.
(5) Genus-species tautonymy is allowed in zoology (e.g., *Badis badis*), in botany not.
(6) Family names end **-idae** in zoology, in botany **-aceae**.
(7) Botany has a standardized lists of authors and their abbreviations (with strong recommendations to use these); zoology has nothing (and every taxonomist uses an individual standard).
(8) In botany the author of a new genus-species combination is recorded, in zoology not.
(9) Botanical taxonomy is much more regulated than in zoology.
(10) The term “valid” in botany is used as commonly used in English (valid = correct publication of a name), while in zoology it has the meaning of a name being used as the correct name in an author's current classification.



It may surprise some to learn that no species in zoology has an officially recognized binominal name that must currently be used. The scientific community can accept or reject the results of recent taxonomic studies. However, there are clearly defined rules which determine the names units must receive under a certain taxonomic assemblage. A taxonomist can feel free to regard two taxa as belonging to one species, but the name that must be used for the resulting species is fixed by a frame of nomenclatural rules. Eventually types must be selected, new names must be established, old forgotten names can be suppressed or homonymous names must be replaced - all this is nomenclature. Zoologists are free to classify animals but the International Code of Zoological Nomenclature (ICZN or simply "the CODE) gives no rules for classification; the rules regulate only which names should be used.

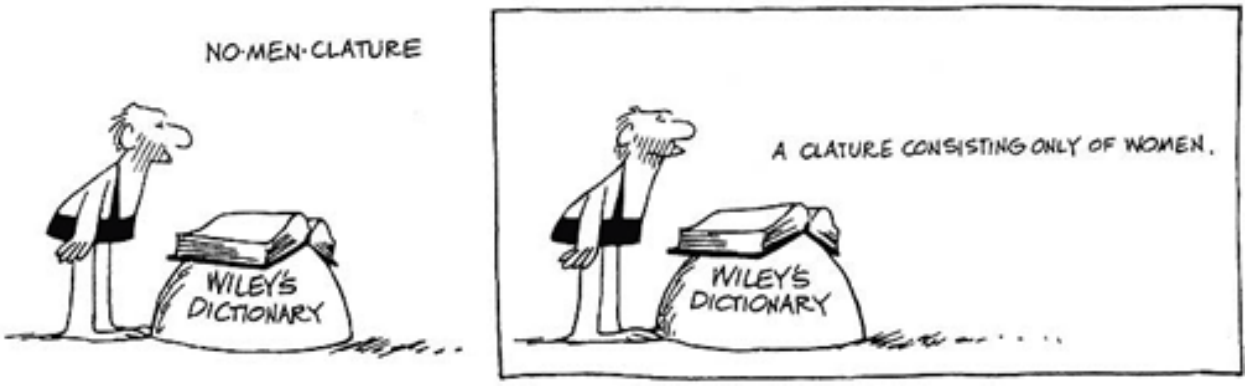
Early drafts of the ICZN existed since the 1840s in several countries, but had not been commonly accepted by all taxonomists until 1895 when international rules were established. Currently effective is the 4th edition of the Code (since 2000). The Code rules only nomenclature, not taxonomy. It is not a legal document and it is not unambiguously considered as a binding law in the sense of a mandatory set of rules and regulations, rather it is based on common acceptance. Zoologists feel themselves invited to apply the Code voluntarily in order to avoid the chaos which would result in the absence of rules. But if they do not consider some of the Code's detailed rules as useful they simply do not apply them. This is no problem if the community accepts the consequences. Names can be used, therefore, that are not acceptable under the Code.

Some rules in the Code are disputed, not all are known, understood, accepted and applied by all taxonomists in all disciplines. Zoology is a very wide field and every single taxonomist is needed to contribute to the knowledge of the community. Contributions of taxonomists who do not accept certain rules are not necessarily rejected for this reason alone.

The nature of the Code is a retrospective law. Every nomenclatural act in the past is exclusively evaluated under the present edition of the Code, and not under a previous edition. A name or nomenclatural act (type selection or whatever) that had been established in 1963 under the then effective edition, is not evaluated under that edition, but under the 4th edition. A name established in France in the 1890s is not evaluated under the rules then commonly accepted in France, but exclusively under the 4th edition.

The Code is not a case law with legal cases establishing precedent to decide subsequent cases with similar issues or facts. The ICZN Commission - an unpaid body of 28 persons not older than 75 years charged to set aside rules of the Code in singular cases - can suppress names or make unavailable names available in Opinions, but every case is singular and other cases cannot be judged using preceding cases as a guideline.

Like most legal works, the Code is extremely difficult to understand by zoologists who are not used to reading legal texts. Like in most other legal works, many regulations allow several interpretations. The Code is used as a guide by zoologists who seek advice how to interpret or spell a name correctly, but it has not been designed as



such. Occasionally it is necessary to know common practice in zoology for understanding provisions in the Code, or in other words, it is necessary to know the backgrounds of why certain articles have been included. As usual in laws, these reasons and backgrounds have never been documented.

A particular feature of the Code is the unnecessary use of internal terms that are not in accordance with their common usage either in dictionaries or in zoology. As I have already mentioned, valid" does not mean that anything is valid as commonly understood. A valid name is the correct zoological name for a taxon, i.e. the oldest potentially valid name of a name bearing type that falls with an author's concept of the taxon. "Potentially valid" means the name must be available, but not otherwise invalid for any other reason, such as being a junior homonym (i.e., a name having the same spelling but different meanings and origins).

"Species-group name" does not refer to a name for a group of species. A species group (superspecies) is a complex of related species that exist allopatrically (i.e., occupy separate habitats and that do not occur together in nature). They are grouped together because of their morphological similarities, and this grouping can often be supported by experimental crosses in which only certain pairs of species will produce hybrids.

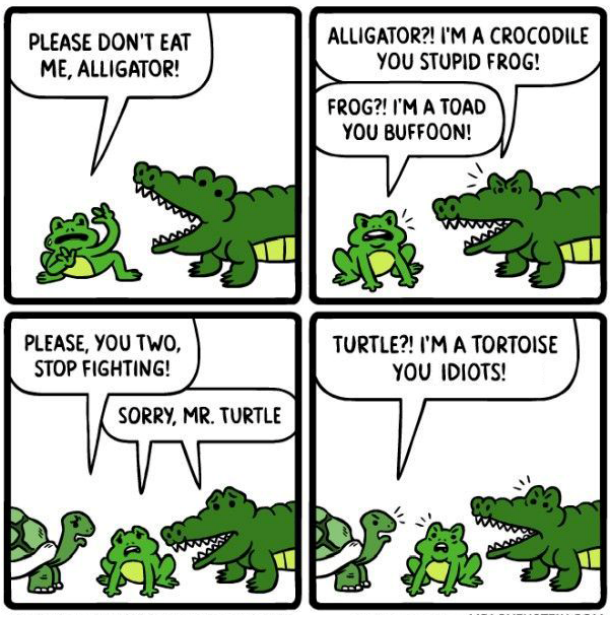
"To conserve" does not mean that something is conserved as is commonly understood. A conserved name is a name otherwise unavailable or invalid that the Commission, by the use of its plenary power, has enabled to be used as a valid name by removal of the known obstacles to such use. Other commonly understood terms also may have vague, undefined or more or less well defined special meanings in the Code, such as "published work," "author" or "word."

The Code leans heavily on Latin and Greek, which were commonly understood languages in scientific communities in the early 1800s, but not anymore today. Problems arise from taxonomists not being linguists, and from the fact that dictionaries do not help in many problems with Latin grammar. Zoologists have repeatedly asked to remove from the Code the need to consult Latin and Greek dictionaries and to abolish gender agreement, but no action has been taken.

Scientific names in zoology are not necessarily Latin names; they may come from any language or can even be fantasy names (Art. 11.3). Many names are based on Latin and Greek, but this is just a tradition. The only requirement is that they must be pronounceable in some language, and it must be possible to treat them as Latin words. Acronyms that cannot be pronounced (the example given in Art. 11.3 is **cbadfg**) are not allowed. However no explanation is given exactly why **cbadfg** is no word in the sense of the Code, and this has led to disputes over whether combinations such as **ansp, anspi or nmnh** or **nmnhi** are admissible as names in the sense of this Article.

The official texts of the Code are written in English and French. Both texts are considered to be equal in force, meaning and authority. If the meaning of the English text is ambiguous, the French text is regarded as decisive. This is an important tool to interpret the Code, and can be very helpful, because linguistically both versions do not cover each other entirely. Examples:

(1) In Art. 30.1.4.2 the English version gives a restriction that is not contained in the French version, probably unintended since it makes no sense



whatsoever. It states that a genus of common gender will be feminine if originally combined with a feminine adjectival specific name in the English version, in the French version with a feminine adjective. (If you have trouble reading this, you are not alone.) The idea behind the passage reflects that the author must have treated the name as feminine, so if the genus was combined with a feminine adjective in a Latin text, the name should be feminine under the French version.

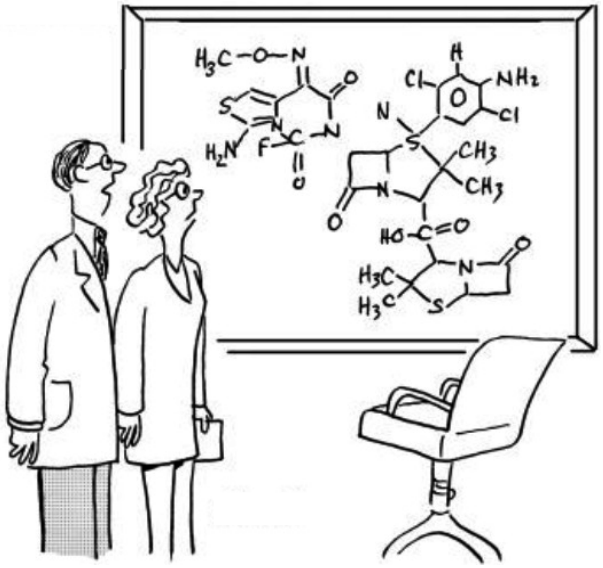
(2) In Art. 32.5.2.6 the French version differs substantially from the English version and looks like a bad translation of a person who did not understand the context. (In the English version numerals must be written in full as Latin words, while in the French version numerical adjectives and adverbs must be translated into Latin.)

(3) In Art. 32.5.1.1 the English and French versions complement each other. The English versions talks of a circulated slip to be inserted in a work, the French version of a slip inserted in a work. The slightly stricter French version makes clear that the slip can have been printed later, but that it must have been inserted by the publisher or printer to the work, after the print and before presenting the work to the public. Sending out a slip later and asking the subscribers or booksellers to insert the slip to the work would not match the French version.

(4) Art. 87 rules that all other officially authorized translations of the Code shall be equal in force, meaning and authority. This certainly indicates a high degree of self-confidence of the Commission, but is not in accordance with experience. Any translation always implies a weak change in the meaning. We can assume that the French Code contains the weakest change because French is probably the second mostly understood language by skilled zoologists. It is obvious that not all 28 Commissioners are able to judge the correctness of a Bengali translation of the 120 pages of the Code.

Like in every legal work, the compilation of the Code is the result of political processes with their proposals and compromises. However, few taxonomists are incorporated in or have influence on the procedure of composing the regulations. In fact, in the past only a minority has ever had access to the small group of persons who have modified the Code (the ICZN Committees, usually consisting of 7 persons). The latest Committees formed have lacked a democratic legitimation. Since 1972 there have neither been regular zoological congress meetings to deal with nomenclatural problems, nor opinion polls, public surveys, queries or public votes offered for zoological taxonomists. The Commission takes its power from a general biological congress (IUBS, International Union of Biological Sciences, Art. 77.2), to which only very few zoologists are invited. In the recent past the members of the official ICZN organs, in particular the Committees, did not literally promote general acceptance by the community. It was also possible that articles were incorporated into the Code by members of the Committee for personal reasons.

For example, in 1993 William Ride established Jackmahoneya (Mammalia, dedicated to Jack Mahoney) and specified its name as masculine. This was literally allowed due to a gap in the 3rd edition of the Code, but contrasted with the commonly accepted basic rules of Latin grammar (such a noun composed of a stem and an ending -a must have feminine gender). In 1999 Ride was chairman of the Committee for the 4th edition and instead of correcting his mistake he managed to insert this as an example in an extended new version of Art. 30.2 for “masculine because its author specified



“Let’s agree to dispense with the rules of nomenclature and call it compound X.”

it" (authors who did the same with names based on Greek words were not allowed to do this).

Some regulations reflect dreams of the future rather than practical life. The List of Available Names in Zoology concept (all family-group, generic and specific names) was inserted in 2000 (Art. 79). More than 10 years later zoologists began to start discussing the purpose of such lists: either to provide a documented record of the previously established names, or to get rid of names that were not used or caused problems as senior homonyms.

Other rules were incorporated without any awareness of a need to consult technical advice. Art. 8.6 was inserted in 2000, based on the assumption that electronic media such as CD-ROMs and DVDs would remain readable for the next 400 years, like printed books.

Some rules unnecessarily contradict the spirit of zoological nomenclature. Art. 3.1 in the version from 2000 defines the names established in Svenska Clerck's work *Svenska Spindlar* to date from 1758 although the indicated and true date was 1757 - contradicting the very basic rule that a name must always carry the true date of publication.

The Committee was rather helpless in face of new technical developments in the 1980s by which textual documents could be published in small quantities by using home printers. It sounds incredible that the present Code (Art. 8.5) still regards two identical prints obtained from a home printer as a fully accepted publication in which a new name can be established.

As a consequence of such shortcomings, the taxonomic community seems to accept only parts of the Code, usually those parts which are commonly agreed to reflect something which may be called the spirit of zoological nomenclature. Clerck's names, therefore, are widely cited with the 1757 date and single sheets issued from home printers are not commonly accepted as published work. This does not mean that the ICZN Code is largely meaningless, but it is necessary to know which parts are accepted, and which parts obviously not.

The force of the ICZN Code was weakened in 2000 by incorporating concepts of "prevailing usage," a largely undefined term intended to promote stable usage of names, that makes nomenclature even more arbitrary and less well defined, and has resulted in many endless disputes on the correct spellings of rarely mentioned names. It is predictable that various disciplines are going to develop different traditions in the interpretation of the meaning of this term. The Rules of Zoological Nomenclature were established in 1905 to overcome the problematic situation that every zoological discipline follows their own rules. Today the trend goes back to a situation before 1905, since many zoologists consider spellings of names as most "stable" if every zoological discipline maintains their own unwritten conventions.

The ICZN Commission has not a very strong position and good reputation either. The main problem concerns communication. Persons who are not elected by the community do not necessarily feel obliged to communicate with the community they represent. Some do it and participate in discussions in international mailing lists, they answer questions, give advice and try to help. But many Commissioners do not even answer their e-mails. This seems to be so much a problem that there are rules to exclude Commissioners after several months from the body if they do not even communicate with the Commission itself (Art. 3.3.3).

Tragedy Strikes at the Linnaean Society Picnic.

One of the major points of criticism is that the Commission is not democratically legitimated, and that its composition is biased towards experienced and well-known persons who know Latin very well, persons who know the Code very well and who speak English fluently.

In contrast, many members of the taxonomic community are young, do not know Latin very well, need a useful and helpful nomenclatural guide and have difficulties in reading the ICZN Code, they communicate in other languages than English, are amateurs with limited financial resources and are not paid for their taxonomic work.

To close this very critical discussion of the ICZN, I should repeat that the basic parts of the Code are commonly accepted by the taxonomic community, and that most Opinions published by the ICZN Commission are almost unanimously accepted. The following presents the spirit of zoological nomenclature as it is intended by the Code:

(1) **Publication**: Everything must be published (except information on type specimens and true dates of publication). No name published before 1758 enters zoological nomenclature (except those of Clerck 1757).
(2) **Binominality**: Names for species consist of two words (Genus species); subspecies have three and all others one word.
(3) **Coordination**: Subspecies are nomenclaturally treated like species, subgenera like genera, subfamilies etc. like families.
(4) **Priority**: If two names refer to the same animal, the oldest name has precedence.
(5) **Stability**: If a very old name was never used, it may be ignored or suppressed.
(6) **Spelling**: Names are spelled in Latin script. The correct spelling of a name must be taken from the original publication. Afterwards a name can usually not be corrected, only the ending of an adjective can change.
(7) **First Reviser**: If two alternative names or spellings were published simultaneously, a First Reviser decides on priority.
(8) **Description**: Any new name must have a description, regardless in which language or script. The content and accuracy of a description is not regulated. Any new name must have been treated as a correct name for a taxon in the author's classification.
(9) **Typification**: The identity of a name is not based on the description but on types. Types are preferably fixed in the original publication.
(10) **Homonymy**: Different animals must not have the same name. An available name that cannot be used can be substituted by a new replacement name.
(11) **Authority**: The author in a name is the person who wrote the description.
(12) **Date**: The year in a name is the true date of publication.
(13) **Accuracy**: For more recent publications, stricter nomenclatural standards apply.
(14) **Legality**: The Code is widely and voluntarily accepted by the community, it is not a binding law. The ICZN Commission can set aside rules in singular cases; these are not regarded as cases of precedence.
(15) **Taxonomy Excluded**: The ICZN Code regulates only nomenclature, not taxonomy. The author who combines a species with another genus is not recorded in the taxonomic name. A species does not have an official taxonomic status, all classifications are only regarded as proposals.

PHYLOGENETIC METHODOLOGIES:
Comment and Critique

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, April 28, 2018)

In my essay, "What's in a Name? That Which We Call a Killifish…" (Klee, 2018), I mentioned that when it came to evolutionary theories most aquarists couldn't care less. This is true in the main but there are exceptions. For example, in the aquarium world there had been a long standing controversy over whether the so-called "Endler's guppy" was a true species or not.

In 2005 Fred N. Poeser (University of Amsterdam) and two of his colleagues published an article based on a morphological study titled "Description of *Poecilia* (*Acanthophacelus*) *wingei* n. sp. from the Paría Peninsula, Venezuela, including notes on *Acanthophacelus* Eigenmann, 1907 and other subgenera of *Poecilia* Bloch and Schneider, 1801" (Poeser, et al., 2005) in which they decided it was a species and named it *Poecilia wingei*, after Dr. Ojvind Winge for his pioneering scientific work on the genetics of the guppy. Shortly afterwards, Susanne Schories (University of Wuerburg, Germany) and two of her colleagues published an article titled "Description of *Poecilia* (*Acanthophacelus) obscura* n. sp., (Teleostei: Poeciliidae), a new guppy species from western Trinidad, with remarks on *P. wingei* and the status of the "Endler's guppy" (Schories, et al., 2005). Schories group, however, disagreed with Poeser's group on the reasons for naming Endler's guppy as a species:

Given the strong variation in male pigmentation the description of *P. wingei* on the basis of coloration was not conclusive. But our molecular data now define the species unequivocally and show that it is a separated taxon from *P. reticulata* and *P. obscura*. Clearly, all fish earlier classified and recognized as Endler's guppies from localities in and around Cumana are *P. wingei*.

They performed a molecular phylogenetic analysis using mitochondrial D-loop and cytochrome *b* sequences. The molecular data were analyzed with maximum likelihood, parsimony and neighbor-joining methods that yielded almost identical phylogenetic results. The topology of the resulting trees was always the same (see Figure 1). The numbers above the branches are bootstrap values - see Section A4).

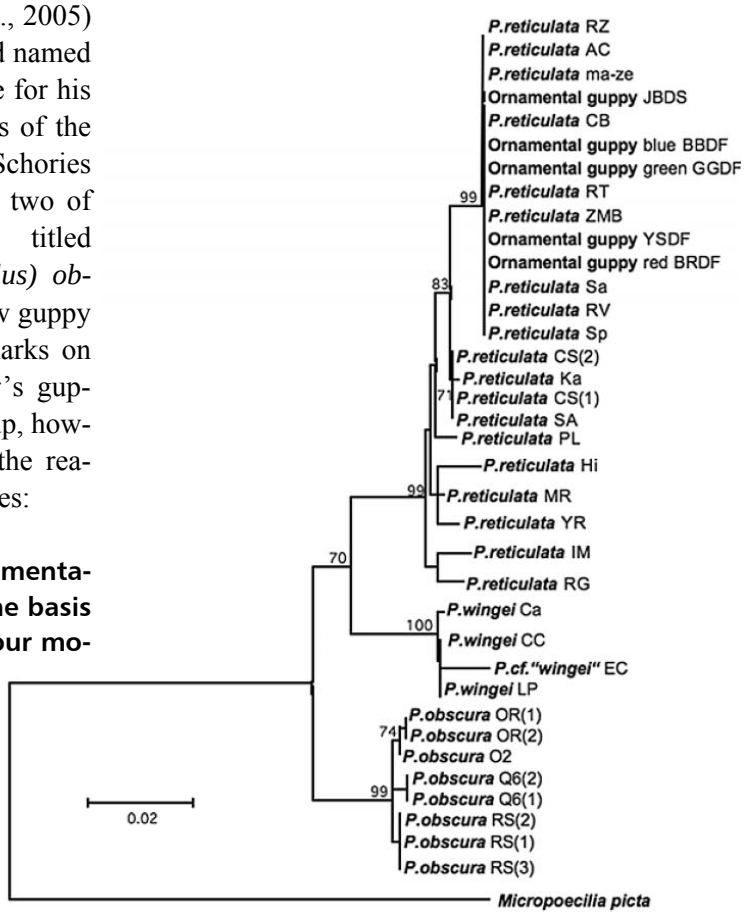


FIGURE 1: PARSIMONY ANALYSIS OF POECILIA.

These two papers caused much turmoil among guppy fanciers and caused me some personal grief as well. On the basis of the Schories paper I brought out a third edition of my book, "The Guppy, 1859-1967" (Klee, 2013), in which I reported the name of Endler's guppy as *Poecilia wingei*. A lot of my friends disagreed with me on this and it caused some ill-feeling that I had "deserted them." These were mostly old-timers used to morphological underpinnings, not molecular ones, but DNA is DNA and it is of course the current basis for our hypotheses about evolution.

A1: SYSTEMATISTS

The task of reconstructing the history of life on earth falls, in part, to **systematists**. Practitioners of systematics study the historical pattern of evolution among groups of living things and this is known as **Phylogeny** (taxonomists merely devise means of grouping or organizing "things" into categories based on a set of rules). Phylogeny is not directly observable; instead, it must be inferred from data that are incomplete at best. Systematists therefore face a set of problems that is similar to those confronted by anyone who makes claims about the past: Is there sufficient evidence? Given the available evidence, what questions can or should be asked and answered? What methods render the most reliable or justifiable conclusions? What are the limits of these methods? In this essay I try to answer some of these questions.

While the shape of these problems is familiar to philosophers and historians, there are particular problems of inference in a field where evidence can be so scarce or difficult to interpret. We can observe fossils, which may give information about common ancestors of living taxa. However, some ancient forms presumably left no descendants, so systematists do not always know what to look for. This situation is compounded by poor or non-existent fossils of soft body parts, as well as by a spotty fossil record.

A2: HOMOPLASY

Before one fires up his or her computer and opens their favorite phylogenetic program, one has to have data because without it, the computer is not going anywhere. There are other kinds of clues to phylogenetic relationships that suggest patterns of ancestry, such as the genetic, morphological and behavioral characters of living taxa. This evidence is sometimes problematic, as it is often difficult to discern whether these characters are similar because of common ancestry or for other reasons. This is called **homoplasy**, the term used when describing a characteristic that two or more different species have in common that was not inherited from their recent ancestor (its counterpart is called **homology**, referring to structures on two or more different species that are similar or the same that came from a common ancestor). In Figure 2, A assumes that the character "Wings" came from a common ancestor. In point of fact, birds are more closely related to *Tyrannosaurus rex* than to pterosaurs. "Wings" in this case is a homoplasy.

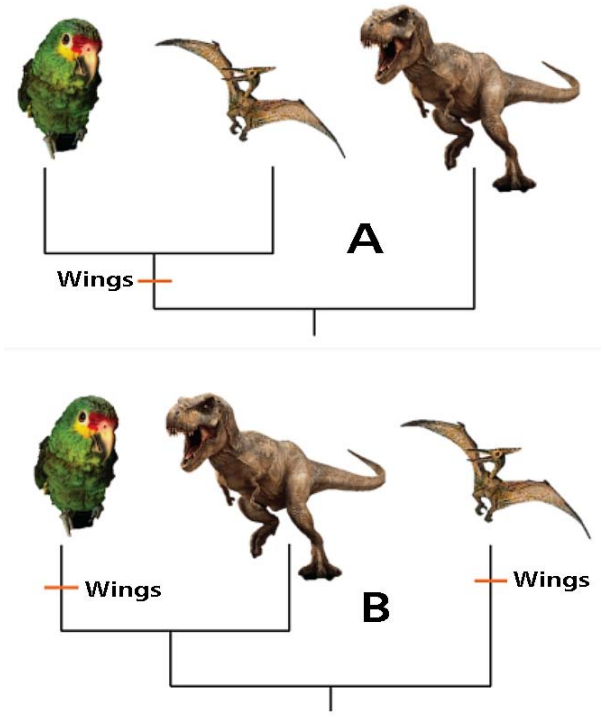


FIGURE 2: A is a Homoplasy.

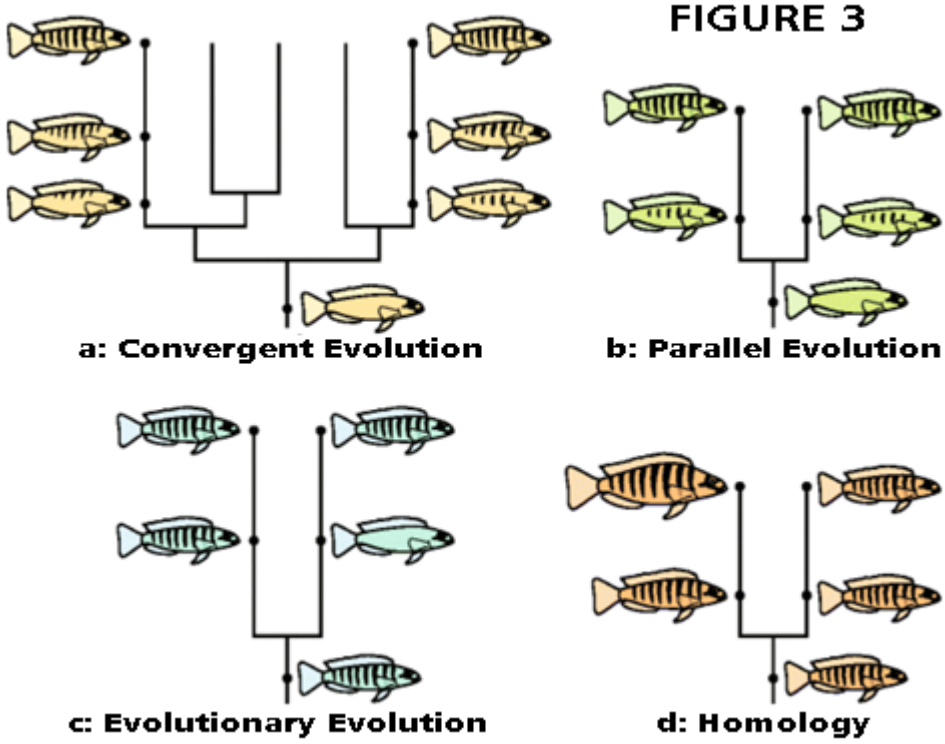
Homoplasy can occur by **convergence, parallelism** or **reversal**. Convergence describes similarities between two species that evolved independently from different features in their common ancestor, often because both lineages face similar environmental challenges and selective pressures. For example, in Figure 3**a**, fish lineages that originally had different body patterns might independently evolve analogous vertical stripes, perhaps because of selection for a particular camouflage pattern.

Parallelism occurs when two groups independently develop similarities from the same structures. This is illustrated in Figure **3b** in which two closely related fish lineages evolve in the same way, resulting in two lineages with a striped body pattern. In a real-life example of parallel evolution in fish, the ancestral stickleback fish was marine-living and heavily armored by sturdy plates. However, several stickleback lineages invaded new, freshwater environments. Many of these now-freshwater lineages independently evolved the same sort of genetic changes that produce a lightly armored body form. Scientists are not sure why the lightly armored trait was favored in so many different lineages, but it may have involved selection for increased body flexibility.

Evolutionary reversal occurs when a lineage evolves toward one of its ancestral traits, effectively losing a more recently evolved trait. If a related lineage has retained the ancestral trait, the two lineages will share a similar feature, not because of inheritance from a common ancestor but because of an evolutionary reversal in one lineage. This is illustrated in Figure 3**c** in which an originally striped fish lineage loses its stripes and then regains them, producing a species similar to a closely related lineage that never lost its stripes in the first place. This occurs when a lineage evolves toward one of its ancestral traits, effectively losing a more recently evolved trait. This is generally thought to involve genetically "reactivating" the ancestral trait. If a related lineage has retained the ancestral trait, the two lineages will share a similar feature, not because of inheritance from a common ancestor but because of an evolutionary reversal in one lineage. Hypothetical examples of the three different categories of homoplasy, as well as homology are shown in Figure 3 (in Figure 3**d**, striping in the descendent fish lineages was inherited from a common ancestor and is homologous).

The bottom line is that the data used cannot be chosen willy-nilly. Bad data in results in a bad

FIGURE 3



evolutionary tree out. Homoplasy is a real problem and characters must be chosen carefully. Unfortunately, there is no infallible way to do this; one basically resorts to the results, experiences and opinions of the researchers themselves and/or of others.

A3: CONSENSUS TREES

I'll mention this subject and the one that follows since they will crop up frequently in this essay. Often a tree building routine will report more than one parsimonious tree. In other words, the data used is compatible with more than one tree. In such circumstances there are two things that one can do. We can choose one of the trees as the one we favor (the criteria by which we do this are varied and usually based on biological or geological arguments) or we can establish the common elements between the trees, i.e., the lowest common denominator. For the second route, consensus trees are constructed.

Let us assume that as a result of an analysis we ended up with three equally parsimonious trees shown in the top row in Figure 4. The simplest way to combine the elements of all three trees into one is to show only those components that appear in all three cladograms. By scanning across the three trees we see that relationships differ between A, B and C, and again between D, E and F. However, the two groups, ABC and DEF, are the same in all trees. Therefore if we combine this information we end up with the tree to the left in the second row. This is known as the Strict Consensus method. The Majority Rule simply takes those solutions that are found in the majority of the trees. Thus the grouping (A,B,C) is found in two out of three trees and the grouping (D (E,F)) is also found in two out of three. Many purists believe that Strict Consensus is the only method that should be considered, all others being tainted by concessions that cannot be justified. Other practitioners think otherwise. These are the sort of arguments that frequent-

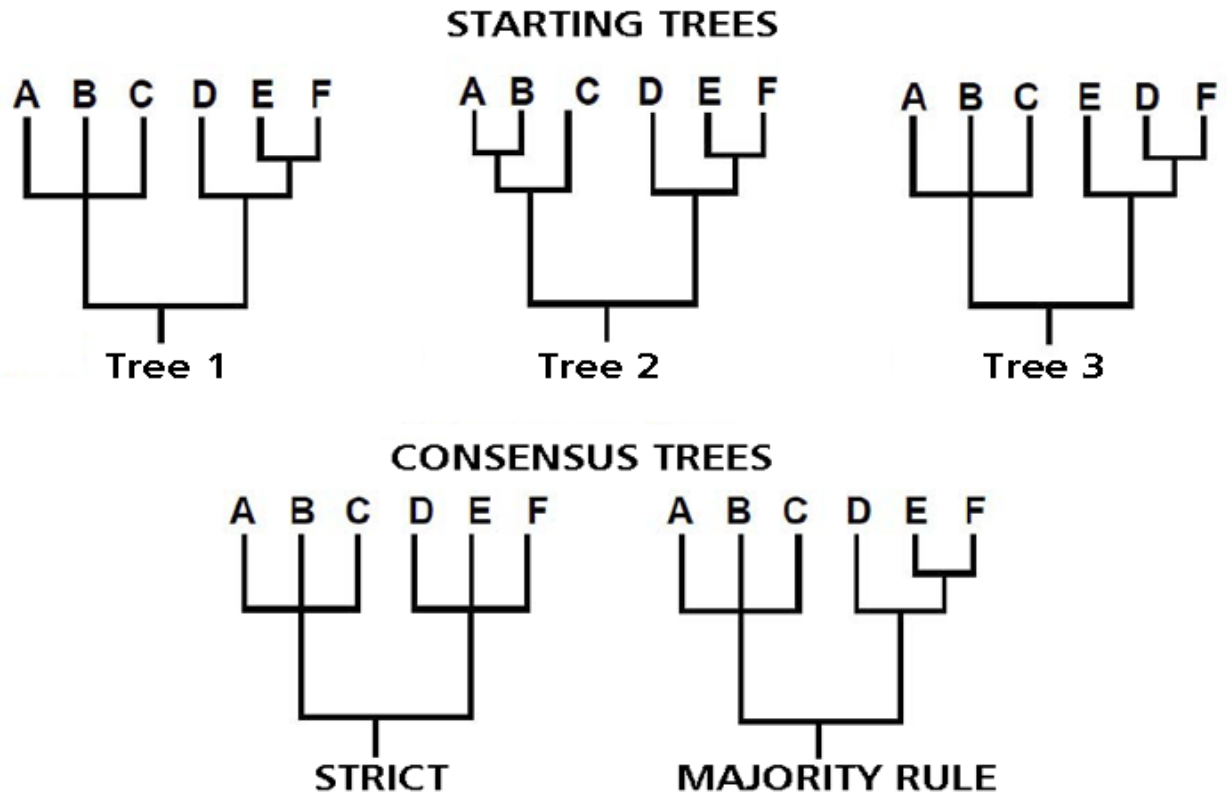


FIGURE 4: CONSENSUS TREES

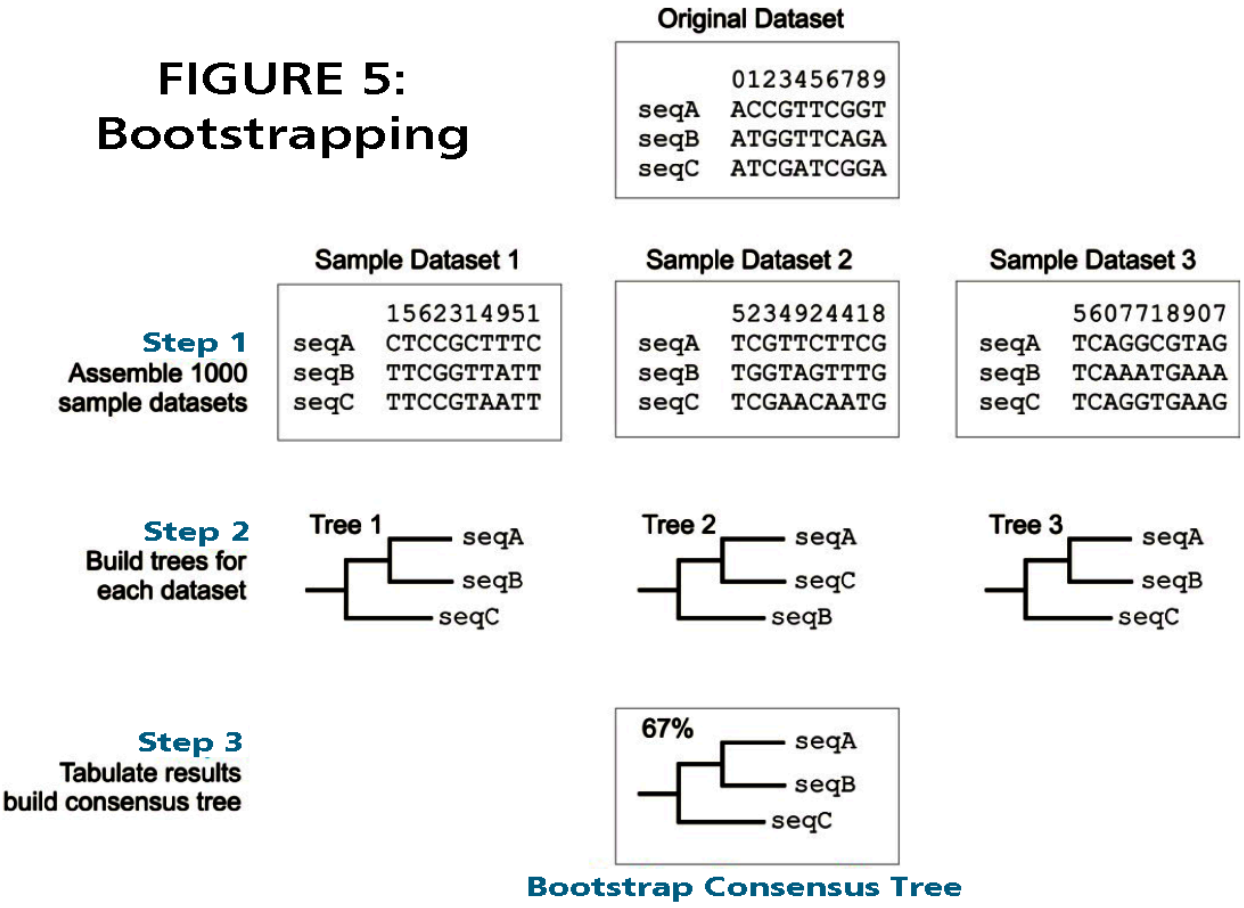
ly crop up in phylogeny when proponents confront each other in print.

A4: BOOTSTRAPPING

In traditional parameter estimation, we attach a confidence interval to indicate the uncertainty involved in the point estimate of the parameter. This has not been possible in molecular phylogenetics, as concepts such as the variance and confidence interval are not meaningful when applied to trees. For distance, parsimony and likelihood methods, the most commonly used procedures to assess the confidence in a tree topology estimate is bootstrap analysis. The expression "bootstrapping" comes from the tales of Baron von Münchhausen who found himself stuck in a deep hole. To get out, he grabbed his boots by its bootstraps and pulled himself upwards until he got out of the hole!

In terms of a phylogenetic tree generated by parsimony or maximum likelihood methods, bootstrapping is accomplished by taking random subsamples of the dataset - each of the subsamples being the same size as the original - which is accomplished by allowing repeat sampling of sites, i.e., random sampling with replacement. Trees are then built from each of these and the frequency with which the various parts of the tree are reproduced in each of these random subsamples is calculated. If group X is found in every subsample tree, then its bootstrap support is 100%; if it is found in only two-thirds of the subsample trees, its bootstrap support is 67%. It is a simple test - non-parametric since no distribution is assumed - but bootstrap analyses of known phylogenies (viral populations evolved in the laboratory) show that it is a generally dependable measure of phylogenetic accuracy, and that values of 70% or higher are likely to indicate reliable groupings.

An example is shown in Figure 5. The bootstrap analysis proceeds in three steps. (1) The dataset



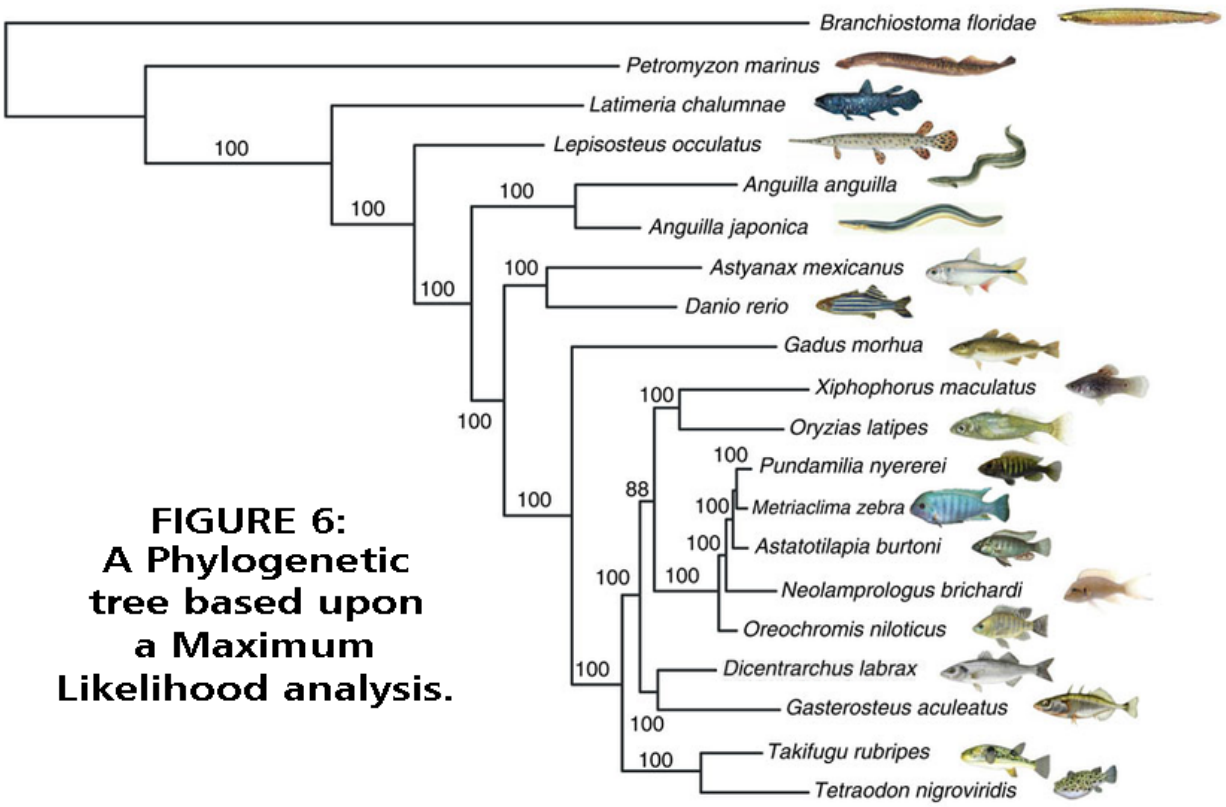


FIGURE 6: A Phylogenetic tree based upon a Maximum Likelihood analysis.

(three taxa and ten molecular characters) is randomly sampled with replacement to create multiple pseudo-datasets of the same size as the original. (2) Individual trees are constructed from each of the pseudo-datasets. (3) Each of the pseudo-dataset trees are scored for which nodes (groupings) appear and how often. In this case, a node uniting seqA plus seqB is found in two of three selected replicate trees. This gives a bootstrap support for this grouping of 2/3 or 67%. As a real example, Figure 6 shows a phylogenetic tree based on a maximum likelihood analysis using molecular data from 20 sequenced fish genomes, showing the relationships that include many common aquarium fish. Bootstrap values are shown above each branch. The lancelet (*Branchiostoma floridae*) was used as the outgroup. Note**:** Figure 1 shows the tree obtained by Schories using molecular data on thirty six variations of *Poecilia.* The bootstrapping values for the *Poecilia wingei* species (i.e., "Endler's guppy) were 100, indicating a very reliable grouping.)

B1: NUMERICAL TAXONOMY (PHENETICS)

So what can biologists meaningfully say about phylogeny? This is one of the central problems in systematics. Broadly, two different issues have been at the center of recent systematics debates: (1) Given the limitations on our knowledge or the degree of its validation, whether any inference of phylogeny may justifiably be drawn; and (2) Given an affirmative answer, what methods ought biologists to use to justifiably infer phylogenies and what are the limits of these inferences? Here I will place these debates in their historical, scientific and conceptual contexts, starting with Numerical Taxonomy or Phenetics.

There is general agreement in the systematics community that meaningful inferences of phylogeny may be drawn. Though the issue of whether phylogeny reconstruction is a legitimate task for biologists is largely settled, the shape of that debate has set the tone for contemporary conceptual debates in systematics. The publication of Linnaeus' *Systema Naturae* in 1735 may mark the

beginning of modern systematics, and the publication of Darwin's *On the Origins of Species* in 1859 obviously had a major impact on biologists. Numerical taxonomy (more commonly referred to today as "phenetics," from the Greek word "phainein," to appear), which started in the 1950s, is the numerical evaluation of the affinity or similarity between taxonomic units and the ordering of these units into taxa on the basis of their affinities. In practice, measurements were made of a large number of characters of a taxon, at least 60 per taxon and often 100 or more. No special importance was attributed to any one of the characters. After the measurements were complete on hundreds of individuals, the data were analyzed statistically with computer programs using cluster analysis or other methods to show purported natural groupings of plants or animals with overall similarities. An example of numerical taxonomy is shown in Figure 7 where three measurements are made on a number of fishes and three groups obtained on the basis of the inter -cluster and intra-cluster distances shown.

Numerical taxonomy arose in response to the then entrenched methods of taxonomy. For advocates of phenetics, a scientific approach to taxonomy amounted to using transparent, explicit methods that produced repeatable outcomes that could be tested by anyone familiar with the methodology and with access to the data set. This stood in contrast to traditional practice in taxonomy, where researchers relied primarily on intuition and appeals to authority. The primary criticism from pheneticists was that taxonomy was being practiced more as an art than as a science. They argued that taxonomists ought to strive for a scientific approach to taxonomy - namely, using methods that were both objective and repeatable. This amounted to a demand for rigor and articulation of method, i.e., a dispute over what could be justified as a scientific explanation or hypothesis.

Pheneticists purge all intuition and subjectivity and strive to be theory-neutral, objective and quantitative, with observation, description and ordering performed as precisely, objectively and repeatably as possible. Hence all evolutionary and phylogenetic interpretations are rejected by them as being too difficult and subjective. They consider that phylogenetic reconstruction is nearly impossible to know with any degree of certainty, and therefore, if classification were to be scientific, this futile quest should be abandoned.

Testability, repeatability and transparency of methodology were tied to a notion of objectivity, in particular to the notion that overall similarity

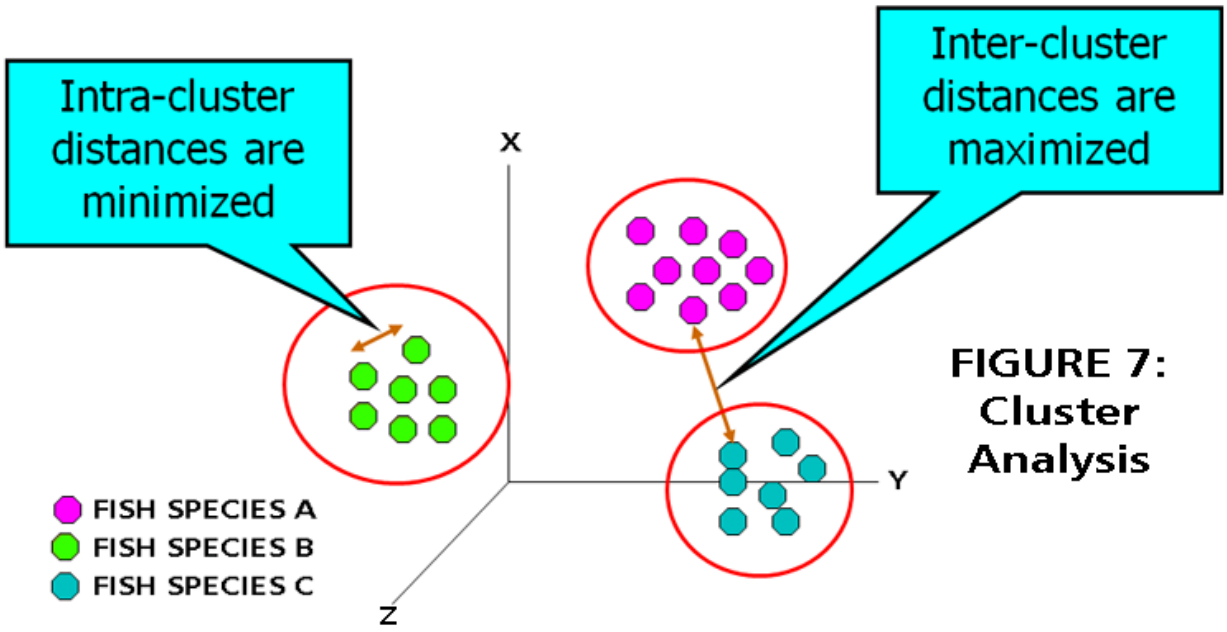


FIGURE 7: Cluster Analysis

between organisms is a function of the similarity of the characters being compared between the organisms. "Objective" was not meant to imply that the affinities between entities were theory free; simply that given some set of parameters and data, a mean similarity could be determined without resort to subjective interference. There is an underlying assumption in numerical taxonomy that selection and identification of characters was a strictly empirical procedure, and that theory should not enter into such selections.

Whether the notions of "objective" advocated by pheneticists in theory are consistent with phenetic methodology in practice and whether its notions are coherent, however, is a matter of some controversy. A phenetic classification represents the morphological similarity for a large numbers of characters. Any consistency in a classification of this sort does not follow from the phenetic system itself since there is no hierarchy of morphological similarity which exists in nature.

A phenetic classification is imposed subjectively based on feature similarity by the taxonomist. This is shown in Figure 8. There are five species with two characters: length of tibia and length of wing vein. We start by grouping each species with its phenetically nearest neighbor. Two clusters of species 1 and 2, and 4 and 5 are created. But to which of these clusters should we join species 3? Using the Nearest Neighbor approach the nearest species is 2, and so we put it with cluster A, forming the tree on the lower left. However, if we use the Average Neighbor approach where we calculate average distance of each cluster as a whole, the answer is the opposite - cluster B has the nearest average neighbor to species 3 and we form the tree on the lower right. Phenetic classification, therefore, even in its modern numerical form, is not objective. It can produce classifications, but classifications that lack a deep philosophical justification.

However, it is insensitive to outliers where accuracy can be affected from noise or irrelevant features and there are no assumptions about data. It is a simple algorithm to explain and interpret, and it has a relatively high accuracy.

In the end, Phenetics was unsuccessful and eventually abandoned in favor of cladistics for a number of reasons, including numerous difficulties encountered owing to homoplasy and a shortage of diagnostic characters. Even so, certain phenetic methods, such as neighbor-joining, have found their way into cladistics as a reasonable approximation of phylogeny when more advanced methods (including parsimony, maximum likelihood and Bayesian inference) are too computationally expensive. Also, with the rise of molecular systematics, distance methods, which are basically phenetic methods, have become popular.

C1: CLADISTS AND PARSIMONY

It is only rather recently that the broad goal of systematics has been to display the evolutionary relations of taxa using phylogenetic trees. The cladistic school arose in the late 1960s/early 1970s and challenged phenetics. Phylogeneticists argued that no such objective classification was possible based on the inductive methods of phe-

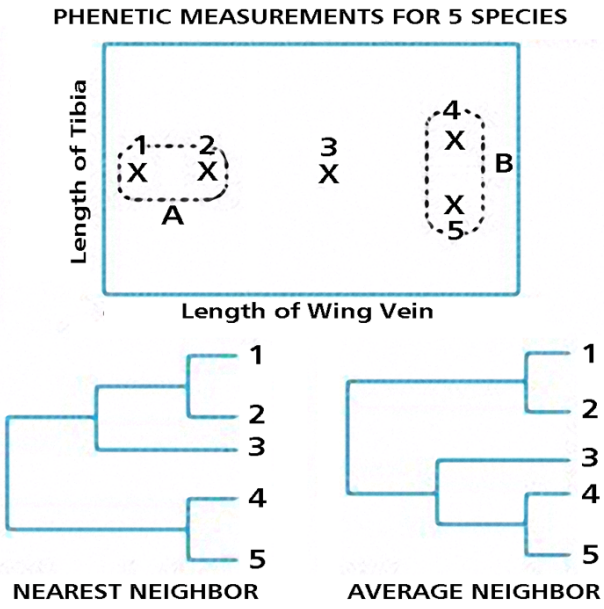


FIGURE 8: Phenetic Classifications.

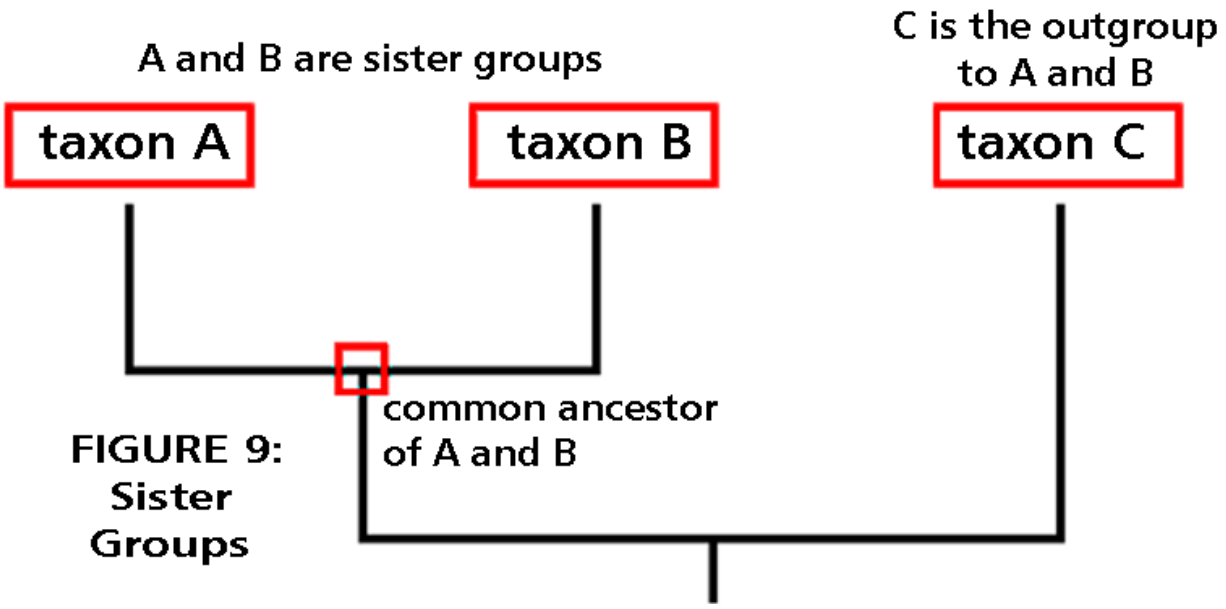


FIGURE 9: Sister Groups

netics, and that inferences of evolutionary relationships of taxa could indeed be justified.

Phylogeneticists followed Willi Hennig in taking the aim of systematics to be the construction of phylogenetic trees that reflected nested sets of sister-taxa, that is, taxa that are descended from a common evolutionary ancestor or ancestral group, especially one not shared with any other group (Figure 9). These sets of sister-taxa were called *clades*, hence the term *cladistic analysis*.

Phylogenetic analyses produce *cladograms* that display phylogenetic relationships but do not necessarily convey any objective similarity between the taxa. This reflects the phylogenetic claim that morphological similarity alone does not necessarily correlate to evolutionary relatedness and that only derived traits are informative in systematic analysis. Not surprisingly, phenetic and phylogenetic analyses of data can produce significantly different results (Figure 10).

Indeed, cladist criticisms of phenetics call into question the entire notion of objective similarity in evolutionary analysis. In its place, cladists argued that in a phylogenetic context, relevant similarity should be understood in terms of a shared, derived history. This argument amounts to the claim that absent some theoretically justifiable

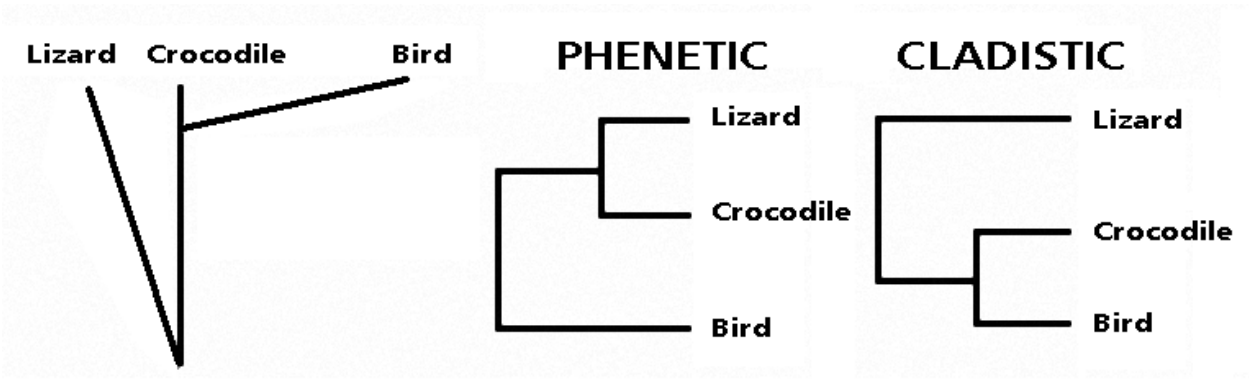


FIGURE 10: Phenetic versus Phylogenetic Analyses.

notion of relevance, similarity is an empty claim. Specifying phylogenetic context as a theoretical basis for relevance, however, provides content to claims of similarity.

Cladists rejected the notion that objective similarity was something that could be discovered using quantitative analysis and instead advocated a systematic analysis justified by an appeal to theoretically driven notions of relevance. Nonetheless, cladists embraced the notions of repeatability and testability as criteria of scientific methodology that must be met to produce satisfactory hypotheses of phylogeny. These criteria concern which techniques are suitable for inferring phylogeny; hence the shift in systematics from debates over *whether* to infer phylogeny to debates concerning *how* to infer phylogeny.

The cladist's method of building phylogenetic trees is based purely on parsimonious principles, i.e., *Pluralitas non est ponenda sine necessitate* (plurality should not be posited without necessity). This rule comes from theologian and philosopher **Wilhelm of Ockham** (~ 1280-1349), and is now called the **Principle of Parsimony** (in the popular literature, **Ockham's razor**). It states that when trying to explain a phenomenon, it is always better to make the least number of assumptions (in other words, when you hear hoof beats, don't start looking for zebras). A rock stays on the ground because of gravity and density, not because an assumed invisible man is pushing it down.

In Figure 11, Hypothesis A requires five evolutionary changes and Hypothesis B requires six. Although both fit the available data, the parsimony principle says that Hypothesis A is better since it does not hypothesize unnecessarily complicated changes. However, do not confuse this with meaning that the simplest possible explanation is the correct one. The simplest possible explanation for whale evolution, for example, is that whales evolved directly from already-marine fish, but their physiology and fossil record make it clear that a more complex scenario happened (i.e., secondary evolution to an aquatic lifestyle). What the principle of parsimony in this case states is that if you had to explain it, it's better to assume a complicated origin of aquatic whales from terrestrial ancestors rather than a simpler origin from fish, *given that there is no evidence supporting a simpler origin*.

In evolutionary biology, the principle of parsimony is very important because of the chaotic nature of evolution. The probability of the same mutations and developmental processes evolving independently is low, consequently it's safer to assume that similarities between organisms are due to common descent (i.e. the mutations occurred once in a common ancestor and have been passed on) rather than due to convergence (i.e. that they occurred multiple times independently).

Many leading cladistic theorists initially justified parsimony techniques by explicitly appealing to philosopher of science Karl Popper's falsifica-

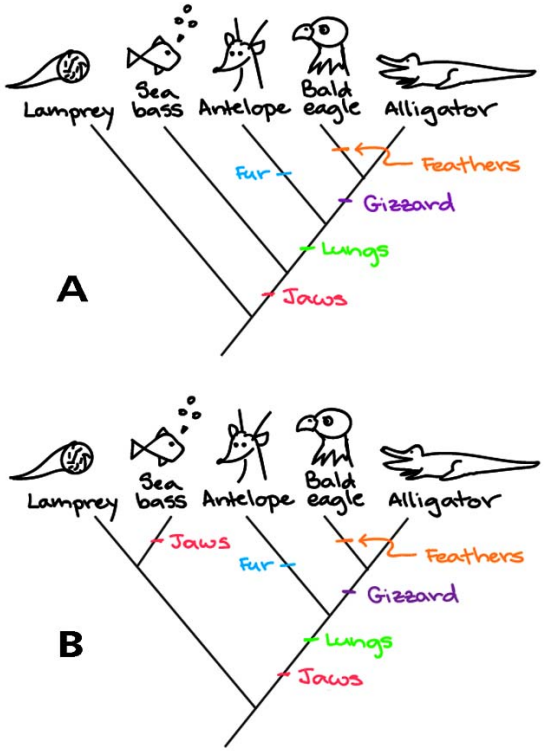


FIGURE 11: The Parsimony Principle.

tionism (Popper, 1959), i.e., experiments producing confirming evidence of a theory are of little to no value; only experiments that test scientific theories by seeking falsifying evidence offer evaluative information conforming to the scientific method. They are falsifiable if it is possible to conceive of an observation or an argument which could negate them. Thus, the term falsifiability is synonymous with testability. For example, the universal generalization that all swans are white is falsifiable since it is logically possible to falsify it by observing a single swan that is not white. Some statements, such as it will be raining here in one million years, are falsifiable in principle, but not in practice.

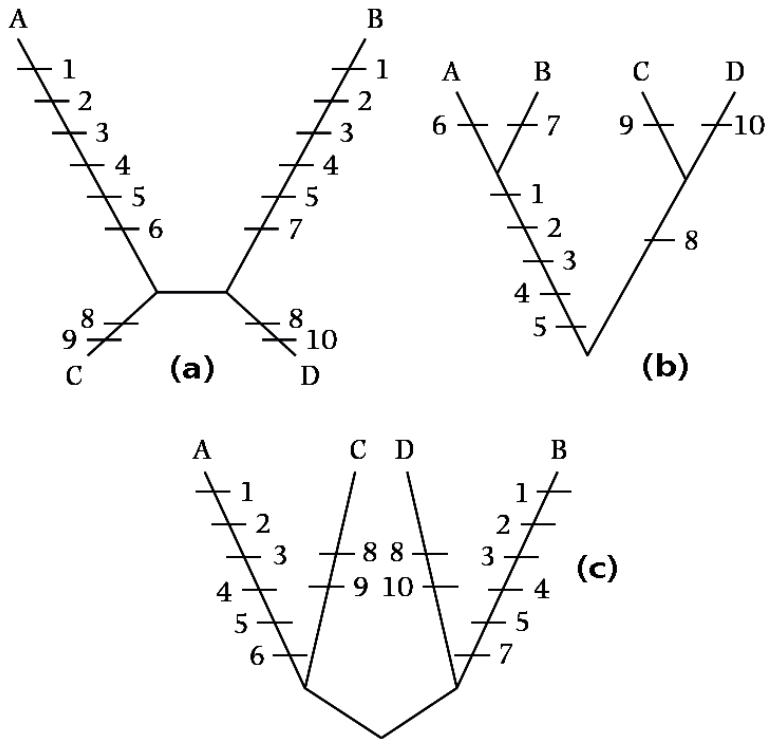


FIGURE 12: The Long Branch Attraction.

Cladists pressed falsificationism into service to solve the problem of phylogenetic inference, while simultaneously satisfying the criteria of scientific methodology inherited from prior debates in systematics. Phenetic methods were decried as confirmationist, while parsimony analysis was framed in a falsificationist framework. The most parsimonious phylogenetic tree was said to be the most corroborated phylogenetic hypothesis. This phylogenetic tree was subject to being falsified if the discovery or addition of new characters revealed a more parsimonious phylogenetic tree.

Most contemporary philosophers of science are critical of the idea that falsificationism is the *only* acceptable method of science. Many question whether it is even a very good thesis about scientific methodology and most have come to reject the thesis that any scientific hypothesis can be falsified in isolation.

C2: LONG BRANCH ATTRACTION

In the late 1970s, phylogeneticist Joseph Felsenstein discovered that lineages of a certain shape were subject to a systematic error in parsimony analysis (Felsenstein, 1978). One example of this problem is called **long-branch attraction (LBA)**. In phylogenetic trees, branches connect nodes to other nodes or taxa. The length of these branches can be used to represent the amount of evolutionary change along a branch. In long-branch attraction, the taxa at the ends of long branches of lineages are mistakenly grouped together by parsimony instead of with the groups with which they actually share a more recent common ancestor.

In Figure 12, (a) represents the actual pattern of evolution (i.e., the actual historical lineage of A, B, C, and D), with the branch lengths indicating amount of evolutionary change; (b) is a parsimony analysis of the data from (a), whereas (c) is a Maximum Likelihood (ML) analysis of the same data. ML picks out the phylogenetic tree that has the highest likelihood conditional on the data. The evolutionary relationships displayed in the parsimony phylogenetic tree in Figure 12 are not

identical with the actual evolutionary relationships. The long-branch error occurs in (b) in hypotheses based on the number of proposed evolutionary events needed to account for all the characters exhibited by the taxa. For example, hypothesis (b) would receive a parsimony score of 10, whereas (c) would receive a parsimony score of 16; (c), however, is the correct solution.

Long-branch attraction is not merely a problem at an operational level, but also presents a challenge to the falsificationist underpinnings of parsimony. As more data (in the form of characters) are discovered or added to analyses, the previously most parsimonious phylogenetic trees are subject to being falsified in favor of more parsimonious phylogenetic trees. These new phylogenetic trees, then, are held up as bold hypotheses and either corroborated or rejected in favor of ever more parsimonious trees that are subject to being tested.

Felsenstein showed that as more characters are added, parsimony techniques become *more subject* to making a long-branch attraction error. This is because as more characters are added, it raises the possibility that there will be a long branch in the tree. In other words, parsimony techniques are more prone to rejecting hypotheses that correctly capture actual phylogenetic relations while corroborating less accurate but more parsimonious phylogenetic hypotheses – seemingly producing a systematic inferential error.

To avoid long-branch attraction, Felsenstein proposed using maximum-likelihood (ML) techniques to formulate phylogenetic trees (Felsenstein, 1981). Simulation studies at the time showed that ML methods were not subject to long-branch attraction. However, the tree space modeled was always one in which the two long branches never occurred as sister taxa, and a number of studies have shown that ML can also become inconsistent and suffer from LBA artifacts when the model assumptions are violated. When Siddall (1998) modeled a tree space where the long branches were sister taxa, parsimony outperformed likelihood methods, which instead, according to Siddall suffered from "long-branch repulsion." The following is a quote taken from the paper, "Performance of maximum parsimony and likelihood phylogenetics when evolution is heterogeneous" (Kolaczkowski and Thornton, 2004):

All inferences in comparative biology depend on accurate estimates of evolutionary relationships. Recent phylogenetic analyses have turned away from maximum parsimony towards the probabilistic techniques of maximum likelihood and Bayesian Markov chain Monte Carlo (BMCMC). These probabilistic techniques represent a parametric approach to statistical phylogenetics, because their criterion for evaluating a topology - the probability of the data, given the tree - is calculated with reference to an explicit evolutionary model from which the data are assumed to be identically distributed. Maximum parsimony can be considered nonparametric, because trees are evaluated on the basis of a general metric - the minimum number of character state changes required to generate the data on a given tree - without assuming a specific distribution.

The shift to parametric methods was spurred, in large part, by studies showing that although both approaches perform well most of the time, maximum parsimony is strongly biased towards recovering an incorrect tree under certain combinations of branch lengths, whereas maximum likelihood is not. All these evaluations simulated sequences by a largely homogeneous evolutionary process in which data are identically distributed. There is ample evidence, however, that real-world gene sequences evolve heterogeneously and are not identically distributed. Here we show that maximum likelihood and BMCMC can become strongly biased and statistically inconsistent when the rates at which sequence sites evolve change non-identically

over time. Maximum parsimony performs substantially better than current parametric methods over a wide range of conditions tested, including moderate heterogeneity and phylogenetic problems not normally considered difficult.

The bottom line is that although in the beginning LBA was only discussed as a potential problem for parsimony, subsequent research has shown that no method is perfect under all conditions. The main objection that has been made against parsimony is that the simplest hypothesis is not necessarily the true one.

C3: AN EXAMPLE OF PARSIMONY ANALYSIS

Figure 13 shows a parsimony analysis of the family Cichlidae based upon molecular data (Farias, et al., 1999). The numbers above the branches are bootstrap values (only values above 50 are shown). Cichlids from Madagascar and India were found to be the most basic groups of the family Cichlidae and sister to African-Neotropical cichlids. Important phylogenetic findings included the placement of the controversial genus *Heterochromis* basic among African cichlids, the South American genus *Retroculus* as the most basic taxon of the Neotropical cichlid assemblage, and the close relationship of the Neotropical genera *Cichla* with *Astronotus* rather than with the crenicichlines. Based on a large number of South American genera, the Neotropical cichlids harbor significantly higher levels of genetic variation than their African counterparts. Relative rate tests suggest that Neotropical cichlids have experienced accelerated rates of molecular evolution. But these high evolutionary rates were significantly higher among geophagine cichlids.

D1: MAXIMUM LIKELIHOOD (ML)

Sir Ronald Aylmer Fisher was a British statistician and geneticist. For his work in statistics, he has been described as "the genius who almost single-handedly created the foundations for modern statistical science" and "the single most important figure in 20th century statistics." His method of maximum likelihood was first proposed in 1922, but his advisors didn't think it was such a useful idea!

In probability theory we consider some underlying process which has some randomness or uncertainty modeled by random variables, and we figure out what happens. In statistics we observe something that has happened, and try to figure out what underlying process would explain those observations. For example, a probabilist starts by knowing the proportion of red and green jelly beans in a jar and finds the probability of drawing a red jelly bean. A statistician infers the proportion of red jelly beans by sampling from the jar.

Since ML requires an underlying model, I have picked as an example the Bernoulli distribution, named after Swiss mathematician Jacob Bernoulli, which is the probability distribution of a random variable which takes the value 1 with probability p and the value 0 with probability 1-p. We want to estimate the probability p of getting a head upon flipping a particular coin. We flip the coin "independently" 10 times (i.e., we sample n = 10 flips), obtaining the following result: HHTHHHTTHH. Assuming n equals the number of observations and k equals the number of heads, the probability of obtaining this sequence - in advance of collecting the data - is a function of the unknown parameter p of the Bernoulli distribution (the vertical line in the equation means "given"):

$$\Pr(\text{data}|\text{parameter}) = \Pr(\text{HHTHHHTTHH}|\ p)$$
$$= p^k(1-p)^{n-k}$$

But the data for our particular sample are *fixed*: We have already collected them. The parameter p also has a fixed value, but this value is unknown, and so we can let it vary in our imagination between 0 and 1, treating the probability of the observed data as a function of p. This function is called the likelihood function, L:

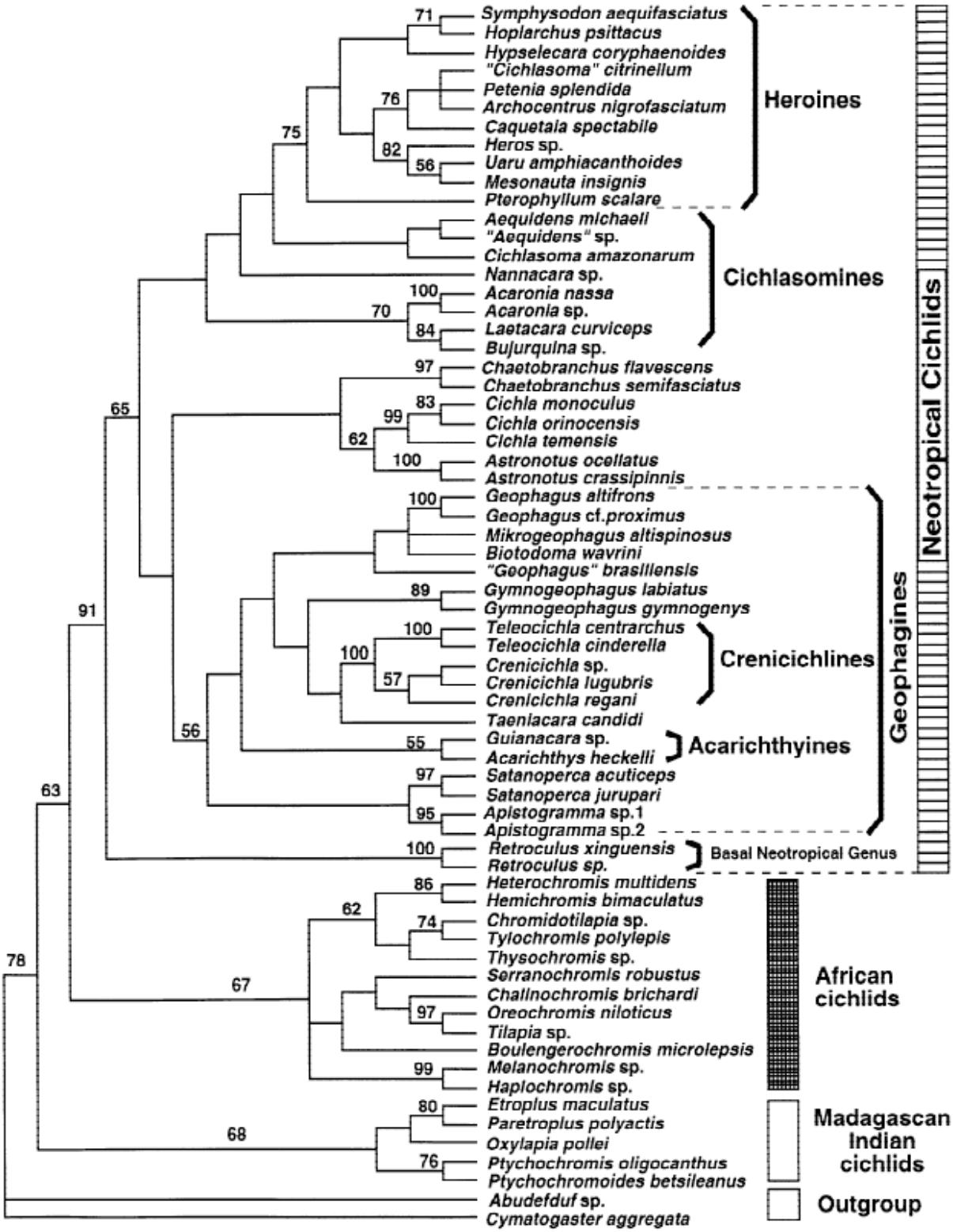


FIGURE 13: A Parsimony Analysis of the Family Cichlidae.

TABLE I

π	$L(\pi \mid \text{data}) = \pi^7(1-\pi)^3$
.0	.0
.1	.0000000729
.2	.00000655
.3	.0000750
.4	.000354
.5	.000977
.6	.00179
.7	.00222
.8	.00168
.9	.000478
1.0	.0

L(parameter|data) = L(p| HHTHHHTTHH)
= $p^k(1-p)^{n-k}$

The probability function and the likelihood function are given by the same equation, but the probability function is a function of the data with the value of the parameter fixed, while the likelihood function is a function of the parameter with the data fixed. Table I lists some representative values of the likelihood for different values of p where n = 10 and k = 7.

The complete likelihood function is graphed in Figure 14. Although each value of L(p |data) is a notional probability, the function L(p |data) is NOT a probability or density function - it does not enclose an area of 1. Note that the probability of obtaining the sample of data that we have in hand, HHTHHHTTHH, is small regardless of the true value of p. Any specific sample result - including the one that is realized - usually will have low probability.

The value of p that is most supported by the data is the one for which the likelihood is largest. This value is the *maximum-likelihood estimate* (MLE), denoted L_{max}. Here, p = 0.7, which is the sample proportion of heads, 7/10. (I won't go into the calculus here but more generally, for n independent flips of the coin, producing a particular sequence that includes k heads and n-k tails, the ML estimator of p, L_{max}, is k/n.)

The method of maximum likelihood is very broadly applicable and is simple to apply. Once a maximum-likelihood estimator is derived, it provides standard errors, statistical tests and other results useful for statistical inference but this is true only for infinite populations. For example, maximum likelihood estimators from small samples are biased. The major disadvantage of the method, however, is that it frequently requires strong assumptions about the structure of the data.

D2: THE PROBLEM WITH MAXIMUM LIKELIHOOD

I am not suggesting that statistical estimation is beyond the pale of serious science, but it is limited to abstractions. Statistical estimation procedures are designed to make generalities about the universe. Whether or not some killifishes are more closely related to some livebearing cyprinodontiforms than to some other killifishes is not an

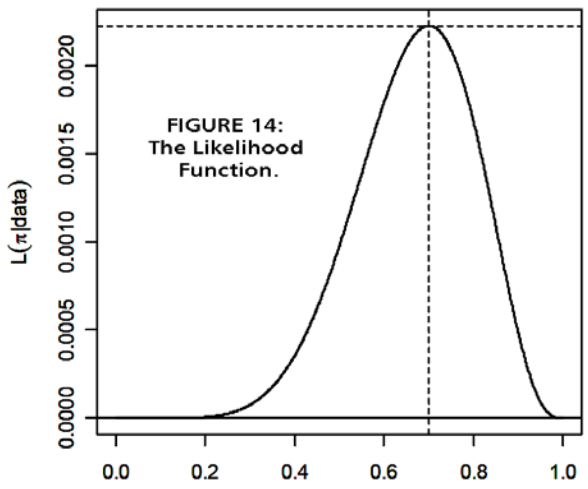


FIGURE 14: The Likelihood Function.

abstract generality. When this logical relation is taken to be a symmetrical one, that is, when *specifics* are inferred from *generalities*, probability theory steps beyond its logical bounds.

Bernoullian probability theory, for example, states that in the case of large numbers, the objective probability p will lie very close to the observed frequency and thus the observed frequency will probably be a good estimate of the objective probability. What likelihoodists confuse in this theoretical framework is that this relies on *repetitive* cases and large numbers (truth being obtained in the infinite). In phylogenetics we are NOT faced with large numbers or repetitive cases. So long as time is taken to be linear, history has occurred but once. Large numbers and their generalities cannot be relevant to finite singular cases.

Consider some event's occurrence (1) or non-occurrence (0) and the series of observations:

0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1.

We will assume that the relative frequency of occurrence is $f(0) = 0.5 = f(1)$ and in the infinite this holds as well. In the more limited case, however, it does not. Suppose we only observed five of these in a row. There are 26 ways in which we could have done this and these are listed in Table II. From these 26 samples we estimate the likelihood, which in this case is the average of each of the 26 samples. For five flips per sample the only possible averages are 0, 0.2, 0.4, 0.6, 0.8 and 1. The number of each of these averages is shown in the small table below the main table and is converted into probabilities (or likelihoods) by dividing by 26. The maximum of these occurs with the mean of 0.4; thus the L_{max} of p is 0.4, an estimate that is 25% too low.

Even if we observed all possible series of five observations in a row we would come to the conclusion that $f(1) = 0.48$. The reason for this anomaly that in the above series of events, even though under the law of large numbers given the series in its infinite iteration we can be certain that $f(1) = 0.5$, in the finite case there is more structure to the data than a mere stochastic process. Bernoullian laws, for example, cannot distinguish the above series from the following:

0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0.

The observation that some phenomenon matches the expectations of a random process "in the long run" does not allow us to infer that the process is, in fact, random or that it will have been in any particular case. Consider flipping a coin 10 times. In one series we obtain:

H, H, H, H, H, H, H, H, H, H.

In another series we get:

H, T, H, H, H, T, H, T, H, H.

Assuming the coin is equally weighted, which observation is more probable? The likelihoodist

TABLE II

No.	Sample	Mean
1	0, 1, 0, 0, 1	0.4
2	1, 0, 0, 1, 1	0.6
3	0, 0, 1, 1, 0	0.4
4	0, 1, 1, 0, 0	0.4
5	1, 1, 0, 0, 0	0.4
6	1, 0, 0, 0, 0	0.2
7	0, 0, 0, 0, 1	0.2
8	0, 0, 0, 1, 1	0.4
9	0, 0, 1, 1, 1	0.6
10	0, 1, 1, 1, 1	0.8
11	1, 1, 1, 1, 0	0.8
12	1, 1, 1, 0, 0	0.6
13	1, 1, 0, 0, 0	0.4

No.	Sample	Mean
14	1, 0, 0, 0, 0	0.2
15	0, 0, 0, 0, 0	0.0
16	0, 0, 0, 0, 0	0.0
17	0, 0, 0, 0, 0	0.0
18	0, 0, 0, 0, 0	0.0
19	0, 0, 0, 0, 1	0.2
20	0, 0, 0, 1, 1	0.4
21	0, 0, 1, 1, 1	0.6
22	0, 1, 1, 1, 1	0.8
23	1, 1, 1, 1, 1	1.0
24	1, 1, 1, 1, 1	1.0
25	1, 1, 1, 1, 1	1.0
26	1, 1, 1, 1, 1	1.0

Mean	Number	Probability
0.0	4	0.154
0.2	4	0.154
0.4	7	0.269
0.6	4	0.154
0.8	3	0.120
1.0	4	0.154
Total	26	1.000

would hasten to judge the second to be more probable than obtaining 10 heads in a row. However, if the events are conjoined somehow, this need not be so. That is, if getting "heads" depends on what happened before it (is historically contingent), probability theory falls apart in the face of its requirement for sampling independence.

What, then, if the events are wholly independent? If the coin is equally weighted, the probability of getting a heads on a toss is 0.5, and so is tails. Using the formula = $p^k(1-p)^{n-k} = p^7(1-p)^3$ then

p(H, H, H, H, H, H, H, H, H, H) = 0.001 and
p(H, T, H, H, H, T, H, T, H, H) = 0.001.

They are equally probable. What if we take the likelihoodist's perspective of saying that the probability of heads, as ascertained from the second series, is 0.7? In this case, the first series of throws (p= 0.028) is actually *more* likely than the second (p = 0.002) from which the rule was derived. Again, this is only damning of frequency probability calculus applied to the particularness of the singular series, not of its relevance to abstract generalities like "a throw on average." Regarding phylogenetic inference, arguments for efficiency measured in terms of finding the correct solution at a given frequency might be germane if, in fact, there were frequencies of history. Insofar as there is but one history for a given set of taxa, this statement is not applicable to phylogenetics.

There is a fundamental distinction that can be drawn between the task of statistics and that of phylogenetics. Statistical measures are required for making estimations regarding collections of observational propositions by way of an abstract generality. That is, there is no real thing belonging to both space and time that we can point to called a "mean" or a "variance." These are useful abstractions that exist only in our psychology as scientists. "Mean," "median" and "mode," for example are simply measures of central tendency for a population of individuals. But neither does "central tendency" exist in any physical objective reality. Consider that the mean number of dorsal fin rays in a group of snakehead fishes can be said to be 51.5. Whereas this may be a useful construct for estimating whether or not this group of snakeheads has more rays than some other group, we can simultaneously be certain that there is no snakehead anywhere that has 51.5 dorsal fin rays. We can also reasonably state that even though this group of snakeheads can be said to have "significantly more" dorsal fin rays than some other group, this does not mean that all snakeheads in this group necessarily have more dorsal fin rays than all snakeheads (or a particular snakehead) in the other group.

Genealogical hypotheses that describe how various species are related to each other do not, by themselves, confer probabilities on the observations and so likelihood methods require the adoption of a model. The main objection that has been made against likelihood methods is that in practice they require one to adopt a model of the evolutionary process that one has scant reason to think is true.

The reason likelihood methods require the adoption of a model in the first place is that genealogical hypotheses that describe how various species are related to each other do not, by themselves, confer probabilities on the observations. Pierre Duhem (1914) was a French physicist, historian and philosopher of science who contended that physical theories do not involve observations as a necessary or inevitable part or consequence unless they are supplemented with auxiliary assumptions. Forty-some years later, the American philosopher W.V. Quine (1953) generalized Duhem's thesis, claiming that *all* theories (indeed, all hypotheses), whether or not they are in physics, fail to entail observational predictions. From a likelihood point of view, it isn't essential that the hypothesis we wish to evaluate *deductively involves* observational claims about the characteristics of species. What is required is that they *confer probabilities* on these statements. The

problem is that they do not. In the language of statistics, genealogical hypotheses are composite, not simple.

D3: AN EXAMPLE OF MAXIMUM LIKELIHOOD

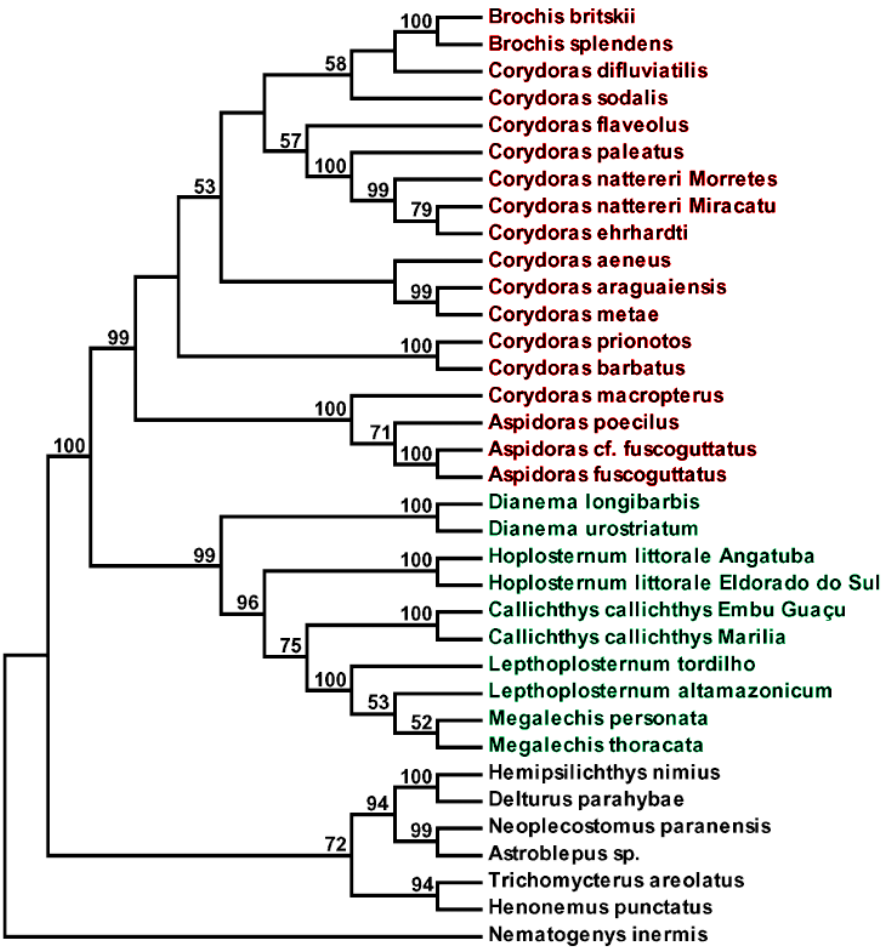
The family Callichthyidae comprises eight genera of fishes widely distributed across the New World. In the present molecular study of this phylogeny of the armored catfish family (Shimabukuro-Dias, et. al, 2004), sequences of five mitochondrial genes were obtained from 28 callichthyid specimens. The sample included 12 species of *Corydoras*, three species of *Aspidoras*, two species of *Brochis, Dianema, Lepthoplosternum*, and *Megalechis*, and two local populations of *Callichthys* and *Hoplosternum*. Sequences of *Nematogenys inermis* (Nematogenyidae), *Trichomycterus areolatus*, and *Henonemus punctatus* (Trichomycteridae), *Astroblepus sp.* (Astroblepidae), and *Neoplecostomus paranensis*, *Delturus parahybae*, and *Hemipsilichthys nimius* (Loricariidae) were included as the outgroup.

Phylogenetic analyses were performed by using the methods of maximum parsimony and maximum likelihood. The results of almost all analyses were very similar (the maximum likelihood results are shown in Figure 15; the numbers above the branches are bootstrap values, but only values above 50 are shown). The results showed that the family Callichthyidae is monophyletic and comprises two natural groups: in red, the subfamilies Corydoradinae (*Aspidoras, Brochis*, and *Corydoras*) and in green, Callichthyinae (*Callichthys*, *Dianema, Hoplosternum, Lepthoplosternum*, and *Megalechis*), as previously demonstrated by morphological studies. The relationships observed within these subfamilies are in several ways, however, different from those previously proposed on the basis of morphological data.

E:1 BAYESIAN PHYLOGENETIC METHODOLOGIES

Bayesian phylogeneticists, as the name implies, use Bayesian phylogenetic techniques to construct phylogenetic trees. Its goal is to distribute posterior probabilities (probabilities that take into account evidence and prior knowledge) over a range of possible phylogenetic trees. Bayesians

FIGURE 15: Maximum Likelihood Analysis of Catfish Data



use what are known as Markov Chain Monte Carlo (MCMC) algorithms to approximate the rational distribution of these posterior probabilities that lead to the selection of which phylogenetic (or consensus) trees are most probable.

The setting for Bayesian statistics is a family of distributions having one or more parameters along with a prior distribution for those parameters. I'll use terminology and notation in the general case where X is a discrete random variable and there is only one discrete parameter θ. In statistics, we don't know what the value of θ is; our job is to make inferences about θ. The way to find out about θ is to perform many trials and see what happens, that is, to select a random sample from the distribution, $\mathbf{X} = (X_1,X_2,...,X_n)$ where each random variable X_i has the given distribution. The actual outcomes that are observed I'll denote as $\mathbf{x} = (x_1, x_2,\ldots, x_n)$. Now, different values of θ lead to different probabilities of the outcome **x**, that is, $P(\mathbf{x} \mid \theta)$ varies with θ. In contemporary statistics this probability is called the likelihood of θ given the outcome **x** and denoted as $L(\theta \mid \mathbf{x})$. The reason the word likelihood is used is the suggestion that the real value of θ is likely to be one with a higher probability $P(\mathbf{x} \mid \theta)$. But this likelihood $L(\theta \mid \mathbf{x})$ is **not** a probability about θ. What Bayesian statistics does is replace this concept of likelihood by a real probability.

Using Bayes' theorem, $P(\theta \mid \mathbf{x}) = P(\mathbf{x} \mid \theta)P(\theta)/P(\mathbf{x})$.

This conditional probability $P(\theta \mid \mathbf{x})$ is called the posterior distribution on θ. It's the probability you have after taking into consideration new information from an observation. Note that the denominator $P(\mathbf{x})$ is a constant, so the equation says that the posterior distribution $P(\theta \mid \mathbf{x})$ is proportional to $P(\mathbf{x} \mid \theta)P(\theta)$. I'll write proportions with the traditional symbol ∝ so that the last statement can be written as

$$P(\theta \mid x) \propto P(x \mid \theta)P(\theta).$$

Using proportions saves a lot of symbols and we don't lose any information since the constant of proportionality $P(\mathbf{x})$ is known.

Note that the random variable X will be either discrete or continuous, but our parameters in the phylogenic case will all be continuous, not discrete. Therefore, I can't use the symbol *P* since that is used for probability mass functions. In the continuous case there are, however, analogous statements using the symbol *f* instead of *P*. In particular, $f(\theta \mid x) \propto f(x \mid \theta)f(\theta)$ where $f(\theta)$ is the prior density function on the parameter θ, $f(\theta \mid x)$ is the posterior density function on θ, and $f(x \mid \theta)$ is a conditional probability or a conditional density depending on whether X is a continuous or a discrete random variable. With this background we are now ready to explore the Bernoulli process, a process I have previously to explain Maximum Likelihood earlier in this essay.

E2: THE BERNOULLI PROCESS

A single trial X for a Bernoulli process, called a Bernoulli trial, ends with one of two outcomes; success where X = 1 and failure where X = 0. Success occurs with probability p while failure occurs with probability q = 1 - p. The term Bernoulli process is just another name for a random sample from a Bernoulli population. Thus, it consists of repeated independent Bernoulli trials $\mathbf{X} = (X_1,X_2,...,X_n)$ with the same parameter p. Let's suppose you have a large number of coins but you have no idea what the probability of heads (p) is. We'll consider here that the outcome "heads" is a success and the outcome "tails" is a failure.

The problem for statistics is determining the value of this parameter p. All we know is that it lies between 0 and 1. We also expect the ratio of the number of successes k to the number trials n to approach p as n approaches 1, but that's a theoretical result that doesn't say much about what p is when n is small. Let's see what the Bayesian approach says here. We start with a prior density function $f(p)$ on p, and take a random sample $\mathbf{x} = (x_1, x_2,\ldots, x_n)$. Then the posterior density function

is proportional to a conditional probability times the prior density function,

$f(p \mid \mathbf{x}) \propto P(\mathbf{x} \mid p) f(p)$.

Suppose, now, that k successes occur among the n trials x. Then referring back to Section D1,

$P(\mathbf{x} \mid p) = p^k(1 - p)^{n-k}$

and therefore, $f(p \mid x) \propto p^k(1 - p)^{n-k} f(p)$.

Thus, we have a formula for determining the posterior density function $f(p \mid \mathbf{x})$ from the prior density function $f(p)$. (In order to know a density function, it's enough to know what it's proportional to, because we also know the integral of a density function is 1.) But what should the prior distribution be? That depends on your state of knowledge. You may already have some knowledge about what p might be. But if you don't, maybe the best thing to do is assume that all values of p are equally probable. Let's do that and see what happens.

Assume now that the prior density function $f(p)$ is uniform on the interval [0, 1]. So $f(p) = 1$ on the interval and 0 off it. Then we can determine the posterior density function.

On the interval [0,1],

$f(p \mid x) \propto p^k(1 - p)^{n-k} f(p) = p^k(1 - p)^{n-k}$.

Well now, that's enough to tell us this is the beta distribution, Beta(k+1, n+1-k), because the probability density function for a beta distribution is

$f(x) = x^{\alpha-1}(1-x)^{\beta-1}/B(\alpha,\beta)$

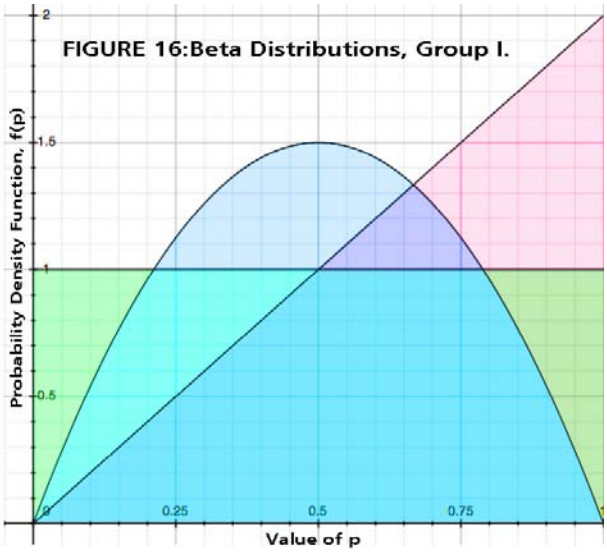
for $0 \leq x \leq 1$, where $B(\alpha,\beta)$ $[=(\alpha-1)!(-\beta)!/(\alpha+\beta-1)!]$ is a normalizing constant to make the integral of the probability distribution sum to one.

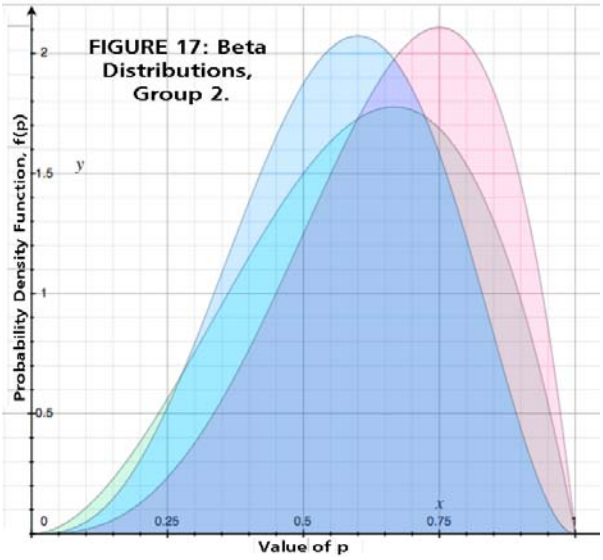
E3: CONJUGATE DISTRBUTIONS

Every time we apply Bayes' Theorem in this example, the Prior and Posterior distributions are Betas and the Likelihood is Bernoulli. Whenever the prior and posterior belong to the same family of distributions, we call the prior and posterior Conjugate Distributions, and the prior is called a Conjugate Prior for the likelihood function. Having a conjugate prior for a likelihood greatly simplifies Bayesian inference as the posterior is obtained simply by updating the parameters of the prior.

Note that the prior distribution $f(p)$ we chose was uniform on [0, 1], and that's actually the beta distribution Beta(1,1). This uniform prior density is shaded green in Figure 16. Now you select a coin, flip it once and put it back. If it was heads, your new distribution on p is Beta(2,1). The density function of this distribution is $f(p) = 2p$ and is shaded pink in Figure 16. The probability is now more dense near 1 and less near 0.

Let's suppose we do it again and get a heads. Now we've got Beta(2,2). So far, one heads and one tails, and the probability is shifted back towards the center. Now $f(p) = 6p(1- p)$ and is shaded blue in Figure 16. Note that the constants α or β increase by one after each pick, α if the pick was red or β if it was green.





Suppose the next three are heads, heads, and tail, in that order. After each one, we can update the distribution. Next will be Beta(3,2), then Beta (4,2), and then Beta(4,3) They appear in Figure 17, the first green, second pink and third blue.

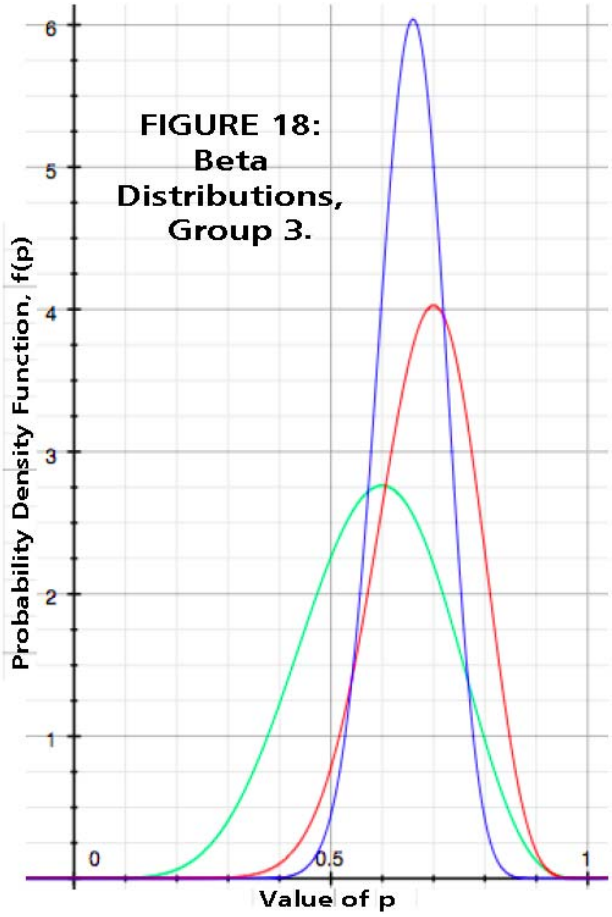
With each new piece of information the curve slowly narrows. We can't say much yet with only 5 flips, 3 heads and 2 tails. A sample of size 5 doesn't say much. Even with so little information, we can still pretty much rule out p being less than 0.05 or greater than 0.99. Let's see what the distribution would look like with more data. Take three more cases. First, when n = 10 and we've drawn heads 6 times. Then when n = 20 and we've gotten 14 heads. And finally when n = 50 and we got 33 heads.

Those have the three distributions Beta(7,5) graphed in green, Beta(15,7) graphed in red, and Beta(34,18) graphed in blue in Figure 18. These are much skinnier distributions, so we'll squeeze the vertical scale a bit. The mean of a Beta distribution is $\alpha/(\alpha + \beta)$ and its variance is $\alpha\beta/[(\alpha + \beta)^2 (\alpha + \beta + 1)]$. Thus for the blue curve its mean is $34/(34+18) = 0.65$, its variance is $34*18/[(34 + 18)^2(34 + 18+ 1)] = 0.00427$ and its standard deviation is 0.065. We can actually graph the complete curve as well, since we have a distribution on p, although the high values of α and β make hand calculations of the value of B(α,β) difficult without consulting factorial tables.

Conjugate priors are possible only for special combinations of the prior and likelihood. As we have just seen, they are theoretically convenient as the integrals are tractable analytically, but they may not be realistic models for every problem at hand.

E4: BAYESIAN METHODOLOGY

Although Bayesian phylogenetic methodologies were first developed in the 1960s, the approach remained relatively obscure until the initial release of the software application, "MrBayes." Since that time, the popularity of Bayesian phylogenetics has increased tremendously, and it now must be considered a primary method of analysis on a par with maximum likelihood, parsimony and distance methods. The popularity of Bayesian



analysis can be attributed to computational efficiencies that allow for explicit model-based analyses of large data sets in real time with simultaneous estimation of nodal support in the form of posterior probability values.

Despite the initial enthusiasm generated by the availability of a fast likelihood-based approach, Bayesian phylogenetic analysis remains somewhat controversial. Much of the controversy is focused on two related issues: (1) the relationship between posterior probability values and nonparametric bootstrap proportions with the nagging suspicion that the posterior probabilities are too liberal, and (2) the influence of prior probabilities, especially so-called flat or uninformative priors. Although there has been a spate of simulation studies published during the past 2 years, most have focused on the relationship between posterior probabilities and bootstrap proportions. The relative impact of priors on posteriors has only recently received the detailed study that is required to determine if current Bayesian implementations are appropriate and, if not, how they might be corrected.

Bayesian phylogenetic analysis requires the designation of prior probabilities for each parameter in the analysis including those for alternative tree topologies, branch lengths and the nucleotide substitution model. In each case, we usually have little a priori information that would allow us to select an appropriate informative prior distribution, thus researchers generally attempt to accommodate their ignorance by applying uninformative priors. Because the posterior probability is proportional to the product of the prior probability and the likelihood, a truly uninformative prior should allow the likelihood function to drive the outcome of the analysis. Unfortunately, the designation of truly uninformative priors is notoriously difficult, and advocates proceed with the hope that the likelihood will overwhelm inappropriately informative priors when they cannot be avoided. The viability of Bayesian phylogenetics may depend on inferences being robust to these unavoidably informative priors.

The computation time required by bootstrapping limits its application so as an alternative, the much faster Bayesian inference of phylogeny, which expresses branch support as posterior probabilities, has been used. However, it has been observed that bootstrap support values, calculated under parsimony or maximum likelihood, tend to be lower than the posterior probabilities obtained by Bayesian inference even when the trees are clearly incorrect. This fact leads to a number of questions such as: Do posterior probabilities lead to overconfidence in the results? Are bootstrap values more robust than posterior probabilities? However, a bootstrap proportion is an index of repeatability, *not* of the accuracy of the results. A Bayesian posterior probability, conversely, is a direct probability statement that the results reached are true, given the data. Although both posterior probabilities and bootstrap supports are of great interest in phylogeny as potential upper and lower bounds of node

reliability, they are surely not interchangeable and cannot be directly compared.

E5: THE PROBLEM OF PRIORS

Bayesian estimation is unique among phylogenetic methods because, along with the usual assumptions about the evolutionary process that generated the observations, it forces the investigator to specify any prior beliefs. The necessity to specify a prior, however, is one of the more controversial pieces of Bayesian analysis. All parameters in the evolutionary model, including phylogeny, branch lengths and substitution model parameters, must be associated with prior probability distributions. But why is it necessary to specify prior beliefs? Doesn't the explicit incorporation of prior beliefs make all Bayesian probabilities subjective?

One can turn the first question around and ask, "Why should background knowledge be ignored?" It is not only sensible to base conclusions on all the available information (total evidence); in some cases, it is even critical. Assume, for instance, that you are asked to bet money on the relative probability, *P*, of turning up heads with a particular coin. You are only allowed to toss the coin twice, and it turns up heads both times. Maximum likelihood estimation based on these observations would give the estimated value $P = 1.0$. Of course, you cannot exclude the possibility that the coin is so heavily biased that it always turns up heads. However, the coin was taken from your wallet and it looks and feels just like a normal coin. If the coin were fair, there would still be a probability of 0.5 of turning up either heads or tails twice in two tosses. Given this information, it seems unlikely that the maximum likelihood estimate is close to the true value. In situations like this, the only sensible approach is to combine the information from your observations with the available background information, in this case suggesting that the true value of *P* is likely to be closer to 0.5 than to 1.0.

As more and more data are added to a Bayesian analysis, the influence of the prior beliefs on the posterior distribution decreases. In a typical Bayesian analysis of phylogeny, the results are likely to be rather insensitive to the prior. Even if it is unlikely to be a problem in most Bayesian analyses of phylogeny, the sensitivity to the chosen priors remains a legitimate concern. It is good practice to describe the priors of a Bayesian analysis carefully, particularly if they are nonstandard. If there is reason to believe that the data are weak, the influence of the priors on the posterior distribution can be examined by rerunning the analysis with different priors. A good way of illustrating the relative contributions of priors and data to the posterior probability distribution is to formulate the support for a particular hypothesis before and after analysis in terms of odds.

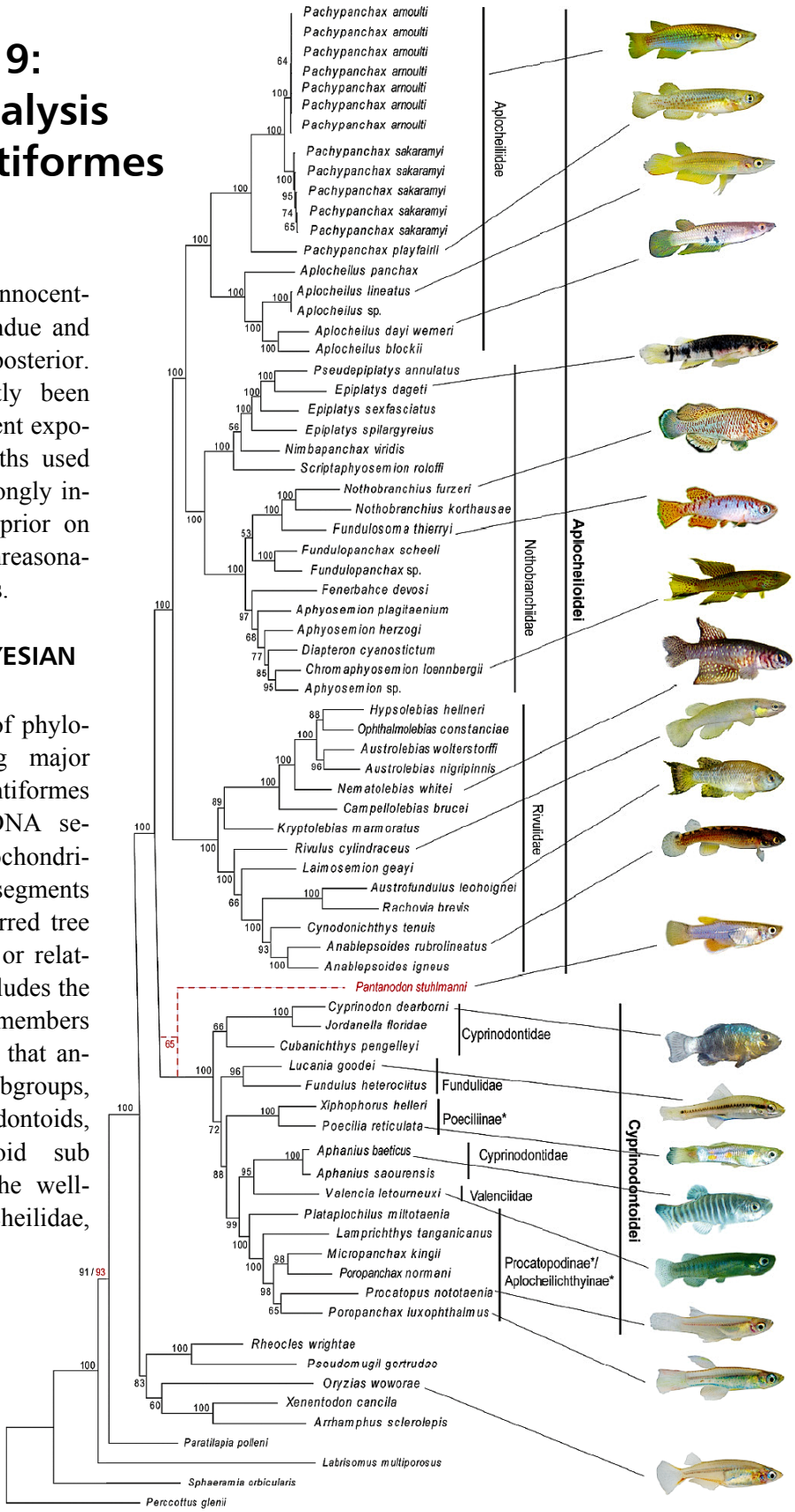
However, such information is rarely available, and specification of the prior is most often a burden on the user. Priors can be created using a number of methods. A prior can be determined from past information, such as previous experiments. A prior can be elicited from the purely subjective assessment of an experienced expert. An uninformative prior can be created to reflect a balance among outcomes when no information is available. Almost all data analyses are conducted using the "default" priors in the computer program. High-dimensional priors are notoriously

FIGURE 19: Bayesian Analysis of Cyprinodontiformes

hard to specify, and an innocent-looking prior can have an undue and unexpected influence on the posterior. For example, it has recently been pointed out that the independent exponential prior on branch lengths used by MrBayes can induce a strongly informative and unreasonable prior on the tree length, producing unreasonably long trees in some datasets.

E6: AN EXAMPLE OF BAYESIAN ANALYSIS

Figure 19 shows the results of phylogenetic relationships among major branches in the Cyprinodontiformes based on a concatenated DNA sequence alignment of two mitochondrial and three nuclear gene segments (Pohl, et al., 2015). The inferred tree supports monophyly (i.e., of or relating to a group of taxa that includes the common ancestor of all the members as well as all descendants of that ancestor) of the major subgroups, aplocheiloids and cyprinodontoids, and of several aplocheiloid sub branches corresponding to the well-established families Aplocheilidae,



Nothobranchiidae and Rivulidae, each of which is restricted to the major continental settings, India-Madagascar, Africa and South America. Contrary to previous molecular studies, this research supported a sister-group relationship of the aplocheilids and nothobranchiids, rather than a nothobranchiid-rivulid branch. Within cyprinodontoids, the phylogeny matched more closely continent-scale distribution than current classifications, suggesting that the definitions of the families Cyprinodontidae, Poeciliidae and Valenciidae are in need of revision. The East African *Pantanodon stuhlmanni* did not show close relationships with any other taxon in their analysis, suggesting that the phylogenetic position and classification of this rogue taxon is in need of further study.

F1: CONCLUSIONS

Using the principle of parsimony as a tool relating to the theory of knowledge (especially with regard to its methods, validity and scope) and the distinction between justified belief and opinion, ensures that we have the most robust empirical result given the data; adopting the most parsimonious summary of the data with respect to outgroup comparisons ensures that the most robust result can be interpreted phylogenetically.

Likewise, fitting data to a model provides explanations, but only if the model is known or assumed to be true. That is, there is no means by which model-based methods can test the veracity of any given model or its assumptions. Researchers generally choose a model for a given set of data based only on an ad hoc preference for simplicity in showing the relations between the concepts and categories in a subject area (this is known as ontological parsimony).

As more data are added to the study, however, frequency methods such as Maximum Likelihood and Bayesian analysis generally move more quickly to the most complex model. The principle of maximum entropy in Bayesian theory provides a rationale for choosing the most complex model, rather than simplest, for explaining a complex system by reasoning that adopting the most complex model among all those that explained a system completely would expose our ignorance of possibilities, while adopting the simplest would give us a false sense of security, leading us to think we had more complete knowledge than we had.

If all three methods produce identical results (and frequently this is the case), there is no way, or even reason, to choose between them. Conflicting results in part of the tree highlight peculiarities in the data set (e.g., long branch attraction, rapid diversification, heterogeneity, etc.). In this situation, the choice of method depends upon the resistance of each method to the particular vagaries of the data. Parsimony analysis is the best *discovery* method we have in phylogenetics because its results are dependent on a minimum of *a priori* assumptions and thus the range of potential discoveries indicated by the data is greater than for any other approach. In a complementary manner, the maximum likelihood and Bayesian approaches are admirably suited as *evaluation* methods, methods allowing us to investigate the processes potentially underlying phylogenetic patterns. The most complete explanation for phylogeny is thus the one that incorporates information from both parsimony and frequency approaches.

However, there are no objective means by which one can choose among these methods. Consequently, it is no surprise that some of the most contentious interactions among phylogeneticists concern the very subjective issue of which methods are "best" or "proper" or "correct." It is common for groups of contending scientists, faced with such a situation, to resort to philosophical arguments in an attempt to claim priority for one viewpoint over another on the basis of some set of first principles. This has certainly been the case with phylogenetics.

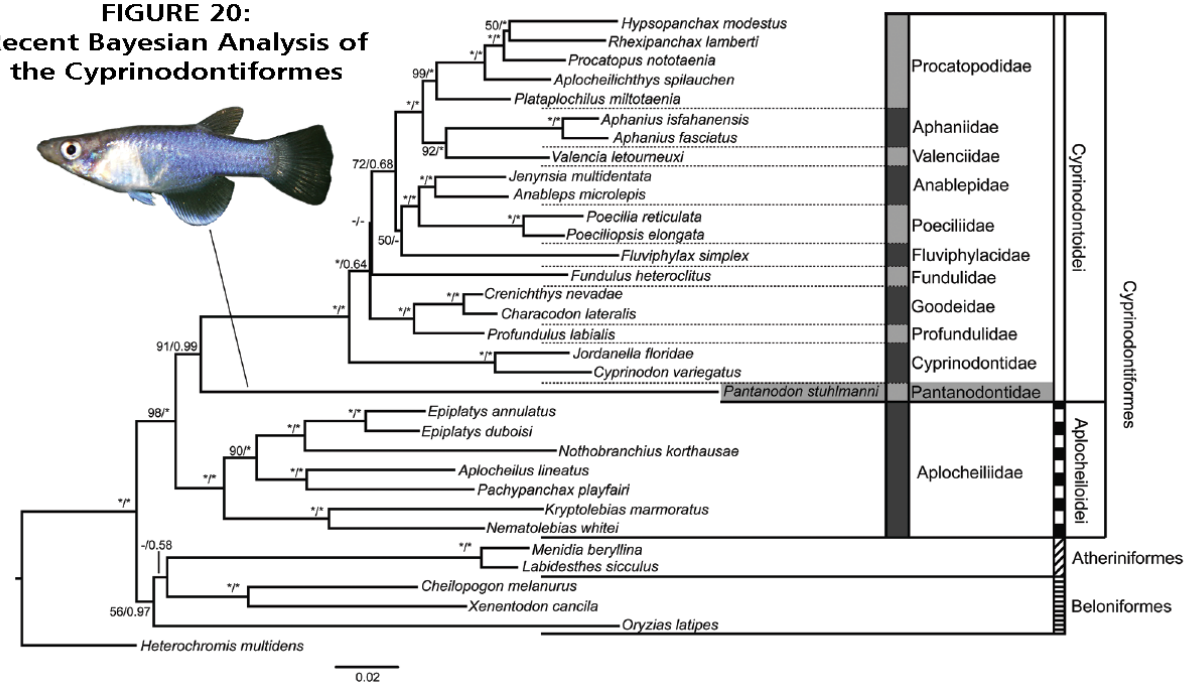
While it is often true that disputes among scientists are the engines of innovation and development, they can also have the opposite effect. There is no

doubt that quantitative phylogenetic analysis has revolutionized evolutionary studies and has had significant impacts in many areas of biology, both basic and applied. Much of the academic infighting associated with the development and deployment of different methods for phylogenetic analysis, however, has obscured the real progress that has been made in reconstructing the phylogenetic history of life. This, in turn, has undermined efforts by systematists to gain proper credit for their role in making possible the explosion of comparative evolutionary biology during the past 30 years and, more recently in dealing with the global biodiversity crisis.

With the rapid advance of phylogenetic techniques that use molecular data, aquarists should be prepared that the classifications they are currently using will be changing fast also. In Section E6 I described a 2015 classification of the Cyprinodontiforms that concluded that a number of families needed revision and that the relationship of the East African *Pantanodon stuhlmanni* within the order essentially was a mystery. *Pantanodon*, containing two African extant species and four European fossil species, for a long time had an uncertain position among the Cyprinodontiformes due to its peculiar morphology. In the last decades, *Pantanodon* has been considered closely related to African lampeyes of the Procatopodinae, which is contained in the Poeciliidae, a teleost fish family with a broad geographical distribution in Africa and the Americas.

In a very recent paper (Braganza, et al., 2018), using both maximum likelihood and Bayesian methods (which essentially produced the same results) the researchers analyzed one mitochondrial and five nuclear loci for 27 cyprinodontiform taxa and 6 outgroups, and obtained a well-supported phylogeny, except for Poeciliidae where the monophyly as previously supported by morphological data was refuted (Figure 20). *Pantanodon stuhlmanni*, the type species of the genus, was identified as the most basal cyprinodontoid lineage, and other African taxa formerly placed in Poeciliidae were found to be more closely related to European non-poeciliid cyprinodontoid genera than to other taxa (numbers on each node are bootstrap percentages of the Maximum Likelihood analysis and posterior probabilities of the Bayesian analysis; asterisks indicate maximum values, 100 or 1.00 respectively, and a dash refers to values under 50 or 0.50 respectively.

FIGURE 20:
Recent Bayesian Analysis of the Cyprinodontiformes



Since this tree topology was not compatible with the present classification of the suborder Cyprinodontoidei, a new classification using available family group names was provided: Pantanodontidae is used for *Pantanodon*; Procatopodidae, for the African lampeye branch; and Fluviphylacidae, for the South American genus *Fluviphylax*. Poeciliidae is now restricted to the American livebearers, hence restoring the classification generally used prior to 1981.

"But to us, probability is the very guide of life." *(Bishop Joseph Butler, 1692-1752)*

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The Case That Changed the World of Plants

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, October 27, 2018)

PART I: THE WARDIAN CASE

The simple Wardian case - it was nothing more than a box with a tight seal of a glass cover - was the direct forerunner of the modern terrarium and the inspiration for the glass aquarium. It also found great use in the 19th century in protecting foreign plants imported to Europe from overseas, the great majority of which had previously died from exposure during long sea journeys, frustrating the many scientific and amateur botanists of the time. The Wardian case was the accidental discovery of Dr. Nathaniel Bagshaw Ward (1791–1868) of London. In the summer of 1829 Ward had buried the chrysalis of a sphinx in some moist mold contained in a wide-mouthed glass bottle and covered with a lid. In watching the bottle from day to day he observed that the moisture that, during the heat of the day, arose from the mold, condensed on the surface of the glass, and returned whence it came, thus keeping the earth always in the same degree of humidity. About a week prior to the final change of the insect, a fern seedling and a grass made their appearance on the surface of the mold. some grass had sprouted. The fern was more important than the insect since for years Ward was unsuccessful in his attempt to propagate ferns in his Wellclose Square home in East London. The sooty, dark and polluted conditions were not ideal for growing ferns and the idea of growing them and other plants in closely glazed cases was a solution.

Figure 1:
Dr. Nathaniel Bagshaw Ward (1791-1868).

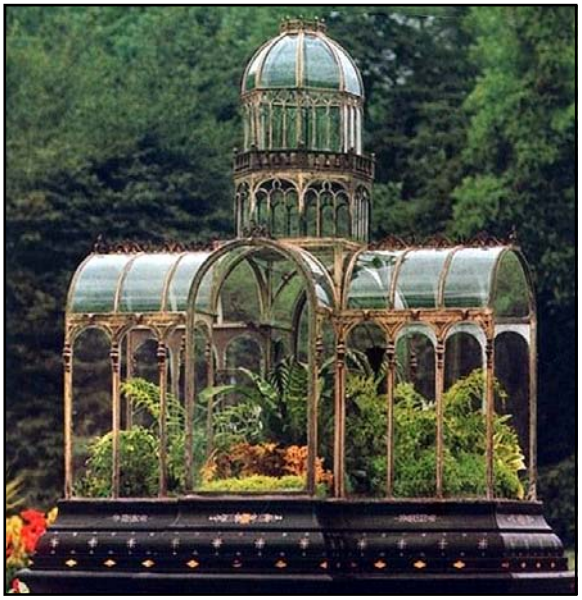


Figure 2: A Wardian case, modeled after the Tintern Abbey.

In 1834 he wrote an article for a gardening magazine titled “On growing ferns and other plants in glass cases, in the midst of the smoke of London and on transplanting plants from one country to another by similar means,” in 1836 the Director of the Kew Gardens wrote an account in a botanical magazine on the subject of Ward’s improved method of transporting living plants, and in 1842 Ward published a book titled *On the Growth of Plants in Closely Glazed Cases*. After experimenting with hundreds of ferns and obtaining success with his cases, he built a small house about eight feet

square outside of one of his staircase-windows facing the north and, proceeding from ferns to those plants with which they were associated, filled it with a mixed vegetation. This was his "The Tintern Abbey House" (The abbey fell into ruins after the "Dissolution of Monasteries" in the 16th century but its remains have been celebrated in poetry and painting from the 18th century onwards) and was followed by The Alpine Case, The Drawing-room Case, Crocuses and Winter Aconites Case, Crocuses with Artificial Light, Case, Case with Spring Flowers, Fairy Roses Case and the Aquarium for Fish and Plants. In his 1842 book, Ward described the last-named as follows:

Aquarium for fish and plants.—I commenced my experiments on fish and plants about ten years ago, in a large earthen vessel, given to me for the purpose by my friend Mr. Alfred White. This vessel contained twenty gallons of water, and in it I placed ten or twelve gold and silver fish, in company with several aquatic plants, viz. *Valisneria spiralis, Pontederia crassipes, Papyrus elegans*, and *Pistia Stratiotes*, which plants, by means of their vital actions, as had long been well known, maintained the purity of the water, and, as in the atmosphere, kept up the balance between the animal and vegetable respirations. Placed in the centre of my fernhouse and nearly surrounded by rock work (rising five or six feet above the margin of the vessel, clothed with *Adiantum* and other lovely ferns, and partially overshadowed with the palmate leaves of *Corypha australis*, the plants and fish continued to flourish for years, prior to their removal to Clapham in 1848. The only enemy I had to contend with was a species of *Vaucheria*, which, from its rapid growth, required to be kept constantly in check. My friend, Mr. Bowerbank, always alive to scientific inquiries, followed up these experiments with equal success, but substituted stickle-backs and minnows for the gold fish. (Mr. Warington, who subsequently experimented upon the same subject, states that he found it necessary to introduce a few snails - *Limeus stagnalis* - to get rid of a slime produced by the decaying leaves of *Valisneria spiralis*.)

It should be noted that it was this jar of Bowerbank's that attracted the attention of the Secretary of the Zoological Society, David Mitchell, and gave him the idea for the public aquarium that was opened in 1853 in the Zoological Gardens in Regent's Park. It also should be noted that the "aquarium" mentioned here by Ward was not the "aquarist's aquarium" but the "gardener's aquarium" dating back to Linnaeus in 1748, which was simply a pond, basin or cistern of water for the growth of water plants. Ward was not the first to consider the addition of fish to the gardener's aquarium. This was first suggested by John Loudon in 1824 in his 1,311 page Encyclopaedia of Gardening in which he showed several exam-

Figure 3: Ward's cases (lower right in this illustration) appeared in the Crystal Palace Great Exhibition of 1851.

ples of the more ornate aquaria and suggested that fish might be added to them (see Klee, 2014).

ALLAN ALEXANDER MACONOCHIE

Professor Allan Alexander Maconochie of Meadowbank and Garvock in Scotland was born in 1806 the eldest son of Alexander Maconochie, 2nd Lord Meadowbank. His grandfather was the 1st Lord Meadowbank, having received the title as a member of The Senators of the College of Justice. The College is a set of legal institutions involved in the administration of justice in Scotland. Senators of the College use the title Lord or Lady, along with a surname or a territorial name. *Meadowbank* is a suburb of Edinburgh and Garvock is about 10 miles northwest of Edinburgh.

Maconochie qualified as an advocate in 1829 and in legal documents he was referred to as A. A. Maconochie.. Advocates in Scotland are comparable to barristers in England and Wales; they work as independent lawyers offering advice about legal cases to clients and conducting defense and prosecution work within courts.

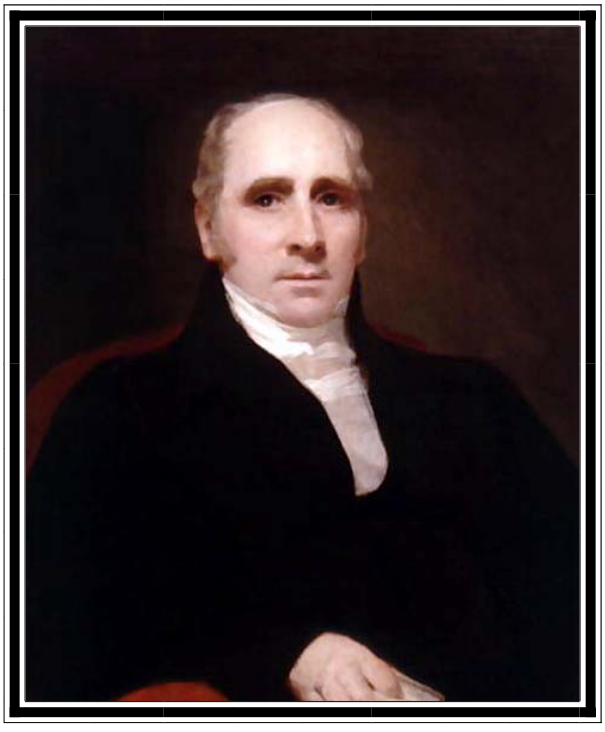


Figure 4: Thomas Charles Hope (1766-1844).

In 1840 he was elected a Fellow of the Royal Society of Edinburgh, his proposer being Thomas Charles Hope. Thomas Charles Hope (1766-1844) was a Scottish physician, chemist and lecturer at the University of Edinburgh. He proved the existence of the element strontium and gave his name to "Hope's Experiment," which shows that water reaches its maximum density at 4 °C (39 °F). Charles Darwin was one of Hope's students, and Darwin viewed his chemistry lectures as highlights in his otherwise largely dull education at the University. For Maconochie to be nominated by Hope to the Royal Society of Edinburgh was quite an honor.

From 1829 until his appointment as professor of Roman and Scots law at Glasgow University in 1842, "He was an enthusiastic professor, who took much interest in his students and endeavoured to assist them in other ways than by lectures," according to a memoir about the school published in 1927. In 1855 he received an honorary doctorate (LLD) from Glasgow University. Succeeding his father to the family estates in 1861, he became Allan Alexander Maconochie-Welwood, 3rd Lord Meadowbank, adopting the name after his grandmother, Elizabeth Welwood of Garvock. Maconochie died on 29 May 1885.

THE AMATEUR BOTANIST

Besides bring an advocate, Maconochie was an accomplished amateur botanist. It was while he was considering the experiments of Nicolas-Théodore de Saussure (1767-1845), a Swiss chemist and student of plant physiology who made seminal advances in phytochemistry and was one of the major pioneers in the study of the respiration of plants, together with Alexander von Humboldt's observations on a plant of *Fucus vitifolius* found growing and preserving its usual color at an immense depth in the ocean where the light must have been less than a hundredth part of that afforded by a common candle viewed from the distance of a quarter of a mile, that the idea struck him that plants, whose habitats afforded

them decomposed light only, might, if supplied with soil and moisture, vegetate in a confined atmosphere and in a light more or less decomposed by the refraction of two surfaces of window glass.

It should be mentioned that simply living in Glasgow was damaging to health. The 1830s witnessed major cholera outbreaks in the city as elsewhere, affecting rich and poor alike. Air quality was bad due to industrial pollution and coal fires, which is why the middle classes migrated up-wind to the West End.

Around 1825 Maconochie experimented with exotic ferns and clubmosses obtained from the Glasgow Botanic Gardens, which he planted out in peat in a goldfish bowl. The success of this first experiment induced him to get a glazed case, or " Miniature Greenhouse," made by a country carpenter. Of the plants that he found to grow most luxuriantly in its confinement, none surpassed *Hoya carnosa* (the porcelainflower or wax plant), the whole tribe of *Cypripediums* (orchids), *Trilliums* (part of the lily order), nearly all Ferns and *Lycopodiums*, several *Euphorbias* (a group of which the poinsettia is a member) and the *Melocacti* (the melon cacti).

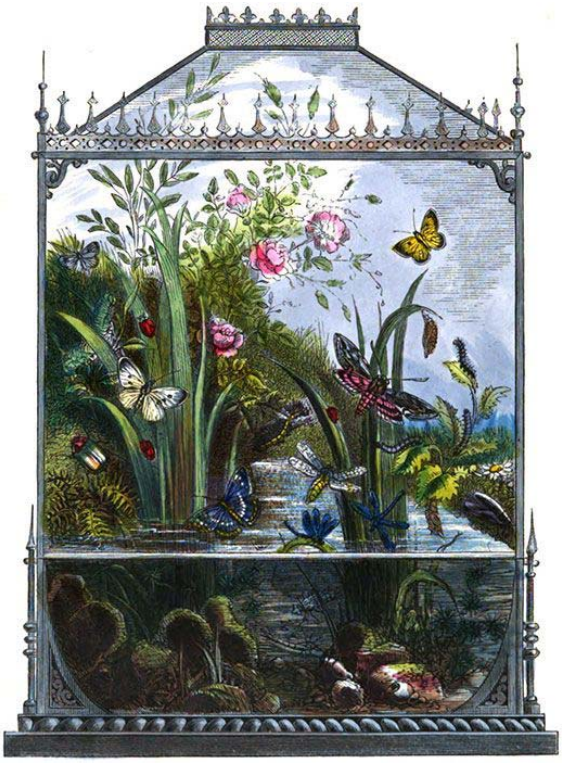


Figure 5: A Wardian case, combination terrarium and aquarium.

Thus, Maconochie was truly the inventor of the so-called "Wardian case." Based upon the botanical research of de Saussure and Humboldt, he designed and had built what Ward accidentally discovered four years later.

To his credit, Ward never patented a design for his case. He held the benevolent view that his cases could be of benefit to many, not just scientists and nurserymen. In 1845. Ward wrote in a letter to the Harvard botanist Asa Gray:

"My closed cases are gradually extending amongst all classes of the community, and have been recommended in an official report to Government by the "Health of Towns Commission" as a means of improving the condition of the labouring poor." It was a technology that he promoted through his many networks both at home and abroad.

WARD'S REACTION TO MACONOCHIE'S PAPER OF 1840

In 1840 Maconochie published a paper in the *Annual Report and Proceedings of the Botanical Society of Edinburgh*, "On the Use of Glass Cases for Rearing Plants Similar to those Recommended by N.B. Ward. Esq." In this paper he described his experiences with the Wardian case he had built in 1825, which was some four years earlier than Ward's discovery in 1829. Ward, normally a positive and encouraging man, was quite affronted by Maconochie's claims to the invention and in 1840 after the publication of Maconochie's article he wrote a letter written to William Jackson Hooker (1785-1865), the Director of Kew Gardens at the time, in which he described the claims as "one of the most barefaced falsehoods ever uttered." This was, of course, both intemperate and without any evidence.

In his paper Maconochie stated that, although it was well known to many of his personal friends

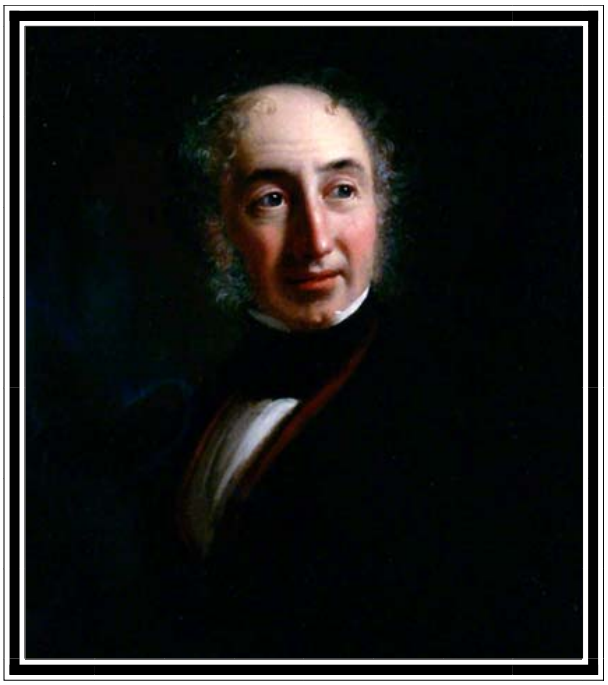


Figure 6: William Jackson Hooker (1785-1865), Director of the Kew Gardens.

and acquaintances that he had had a glass case very similar to those employed by Ward for more than fourteen years, still **"he had no wish to detract from Ward the merit of also having made the discovery, or that of having first made it known to the public."** Under the circumstances, Maconochie was magnanimous in this respect.

Although Ward knew nothing about Maconochie, Hooker certainly did. In 1820 he accepted the Regius professorship of botany in the University of Glasgow, a position he held until 1841, and where he soon became popular as a lecturer. He worked with the Glasgow botanist and lithographer Thomas Hopkirk to establish the Royal Botanic Institution of Glasgow and to lay out and develop the Glasgow Botanic Gardens. Ward's tantrum was not known to outsiders and I suspect that it was Hooker who quieted him down. Hooker was in a position to describe Maconochie's status in Scotland and point out that Macononochie's achievements with his case was well known to many of his personal friends and acquaintances. If Ward made his views public, he would involve himself in a battle royal, much to his detriment. Consequently, nothing ever was made public about Ward's feelings and following this incident Ward's name was forever connected in the naming of the case.

PHOTOGRAPHIC CHEMISTRY

Among his many other interests was chemistry. By May 1839 Maconochie was able to show photogenic drawings, negatives and positives, of contact prints of botanical specimens to his friends Sir Walter Calverley Trevelyan (1797-1879), an English naturalist and also a fellow of the Royal Society of Edinburgh), and his wife, Lady Pauline Trevelyan. Writing to Sir Walter on January 7, 1843, Maconochie advised that he had "made great strides in the Photographic art" the previous summer, always striving to shorten the exposure time to better capture action. Working in the weak Glasgow sunlight of the dead of winter, he eventually managed to reduce the exposure times for his calotype negatives to as little as seventeen seconds.

Figure 7: Sir Walter Calverley Trevelyan (1797-1879), an English naturalist and also a fellow of the Royal Society of Edinburgh).

Maconochie attended the first meeting of the Photographic Society in London in 1853, showing instantaneous photographs taken on glass. No one knew him, but as the *British Journal of Photography* recalled some years later, the images "were at once recognised as wonderful; and it seemed as if the producer of them had dropped from the clouds he so faithfully depicted." The following is from the *British Journal of Photography*, July 15, 1861:

One of the first to show pictures so rapidly taken as to give an image of objects in motion was, I think, Professor Maconachie, then of Glasgow. He showed some pictures at the first meeting of the London Photographic Society. They were at once recognised as wonderful; and it seemed as if the producer of them had dropped from the clouds he so faithfully depicted. When the meeting was over, nobody knew who he was or where he could he found. Somebody said they thought he was a Scotchman—probably hazarding that opinion in consequence of one of the pictures shown being a view at Granton, near Edinburgh. By-and-by the Scotch gentleman took a more definite shape in the Society's Journal, in a letter to the Secretary (Mr. R. Fenton). Mr. Wellwood Maconachie detailed in this letter the preparations he used in taking the pictures which had commanded so much approbation. He recommended a stable normal collodion, iodised in the usual way, to which he added iodide of iron when about to operate. That was the peculiarity in his process. Iodide of iron had been used before in photography, and it was known to give great sensibility. Since then no one who has written on the means of producing pictures rapidly has proposed the addition of any new or before-unused substance in the collodion.

Figure 8: Roger Fenton (1819-1869), a British photographer noted as one of the first war photographers.

Maconochie began a correspondence with Roger Fenton (1819-1869), a British photographer noted as one of the first war photographers, in which he analyzed the properties of collodion and suggested ways to make it more stable. He was particularly excited by the shortened exposures he was able to achieve. Obviously impressed, Fenton published extracts of Maconochie's letters in the *Journal of the Photographic Society*, which led the firm of W. E. & F. Newton to write to the journal in August 1853 about a "Method of Deepening Negatives," which had been communicated to them by the professor **"some time since."** By allowing the correction of problems caused by too short an exposure, Maconochie's method helped make it possible to obtain instantaneous photographs, and it seems unlikely that he ever returned to the slower paper negative. A remarkable man was this 3rd Lord Meadowbank!

PART II: THE EVOLUTION OF THE WARDIAN SHIPPING CASE

There are two types of Wardian cases, each developed to solve different problems. The oldest involved transporting live plants on ships and the newest with protecting household plants from the noxious fumes of the air in polluted cities such as

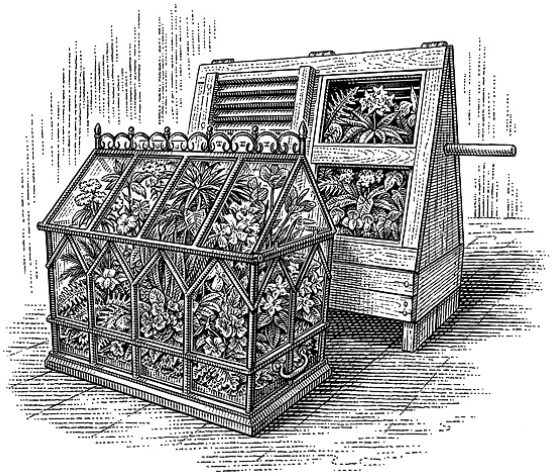


Figure 9: The two types of Wardian cases. Front, Indoor case; Back, Shipping case.

mid-nineteenth century London. Since the Wardian cases used in the Nineteenth century for growing plants indoors are well known to aquarists, I will concentrate on the types used to transport plants on the old sailing ships of the Eighteenth and Nineteenth centuries. The Wardian case is part of a long history of using boxes to move live plants that could be transported as seed. However, at times it was simply better to send seedlings as they could be quickly planted out on a plantation.

THE JOHN ELLIS CASE

John Ellis (circa 1710-1776) was a linen merchant and naturalist who studied coral and also imported seeds and plants. He corresponded with other naturalists and was a member of the royal societies of both London and Uppsala. Ellis worked as an agent in west Florida and Dominica and had the opportunity to collect specimens such as Venus flytrap, which he named *Dionaea muscipula.* He sent a description of Venus flytrap in a letter to "Sir Charles Linnaeus," dated 23 September , with an illustration and a specimen, and began: "My dear Friend, I know that every discovery in nature is a treat to you; but in this you will have a feast." His letter to Linnaeus about this newly found species was also published in Uppsala and Erlangen.

In a book published in 1770, he discussed techniques for transporting plants and "included a catalogue of exotic plants that might be successfully and usefully grown in the American colonies." His use of the term "West-Indies" in his book refers to a region of the North Atlantic Ocean in the Caribbean that included the island countries and surrounding waters of three major archipelagos: the Greater Antilles, the Lesser Antilles and the Lucayan Archipelago (Bahamas). The following is an excerpt (and see Figure 10):

To this I must add a method that promises success for bringing over plants from the West-Indies, and the southern parts of North-America, particularly West-Florida, the voyage from hence being longer than from the West-Indies, and more attention is required to keep the plants in health, than from any other parts of our North-American settlements: but as there is a good deal of difference in the climates of these places, it will be necessary to observe that plants from the West-Indies should be put on board in the latter-end of Spring so as to arrive here in warm weather, otherwise they will be destroyed by the cold of this latitude; and the ever-greens, which are the most curious from West-Florida, must be sent in the winter months while their juices are inactive, so as to arrive here before the heats come on. If the plants sent from these countries were planted in pots or boxes, and kept there a year, they might be brought over with very little hazard; or even if they were first transplanted from the woods into a garden, till they had formed roots, they might be sent with much more safety.

The size of the boxes that will be most convenient for stowing them on board merchantships, where there is very little room to spare, should be three feet long, fifteen inches broad, and from eighteen inches to two feet deep, according to the size of the young trees; but the smallest will be most likely to succeed, provided they are well rooted. There must be a narrow ledge nailed all round the inside of the box, within six inches of the bottom, to fasten laths or packthread to form a kind of latticework by which the plants may be the better

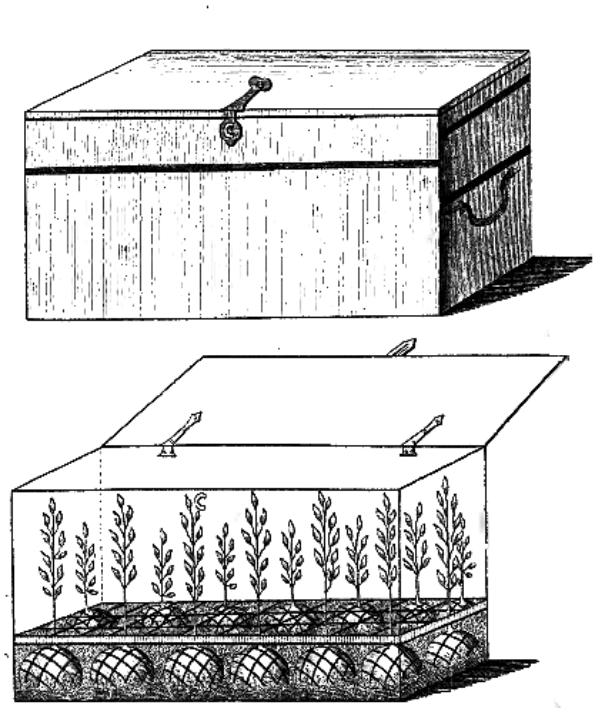


Figure 10: John Ellis' shipping case.

secured in their places. If the plants are packed up just before the ship sails, it will be so much the better.

When they are dug up, care must be taken to preserve as much earth as can be about their roots, and if it should fall off it must be supplied with more earth so as to form a ball about the roots of each plant, which must be surrounded with wet moss, and carefully tied about with packthread to keep the earth about the roots moist: perhaps it may be necessary to enclose the moss with some paper or broad leaves (as the palmetto) that the packthread may bind the moss the closer. Loamy earth will continue moist the longest. There must be three inches deep of wet moss put into the bottom of the box, and the young trees placed in rows upright close to each other, stuffing wet moss in the vacancies between them and on the surface; over this, palmetto leaves, if to be had, should be put to keep in the moisture, and over them the laths are to be fastened cross and cross to the ledges or pack-thread to be laced to and fro, to keep the whole steady and tight.

The lid of the box should be either nailed down close, or may have hinges and a padlock to secure it from being opened, as may be found necessary, with proper directions marked on it to keep the lid uppermost. There must be two handles fixed, one at each end, by which means there will be less danger of disturbing the plants. Near the upper part of the ends of the box, there must be several holes bored to give air: or in making the box there may be a narrow vacancy left between the boards of one-third of an inch wide, near the top, to let out the foul air (this is the method shown by the dark bands on the front and sides in Figure 10**); and perhaps it may be necessary to nail along the upper edge of these openings list, or slips of sail-cloth, to hang over them, to secure the plants from any spray of the sea; and at the same time it will not prevent the air from passing through. Boxes with plants packed in this manner, must be placed where there is free air, that is, out of the way of the foul air of the ship's hold.**

THE JOHN COAKLEY LETTSOM CASE

John Coakley Lettsom (1744-1815) was an English physician and philanthropist. He was born on Little Jost Van Dyke in the British Virgin Islands, into one of the early Quaker settlements in the territory. A Fellow of the Royal Society and the Linnaean Society, and a close friend of Benjamin Franklin, he used his private fortune and considerable medical income to support philanthropic ventures as well as a museum, library, and botanical garden on his estate of Grove Hill in Camberwell. In the diversity of his interests, as physician, philanthropist, botanist, mineralogist and collector, he had few equals.

In 1783, Lettsom published his *Hortus Uptonensis* in which appeared his "Directions for bringing over seeds and plants from distant countries." Although most of Lettsom's directions are identical to Ellis's, Lettsom does add some innovations (Figure 12). Lettsom's plant transportation box is slightly larger than Ellis's and includes hoops over the top of the box so that canvas can be draped over the

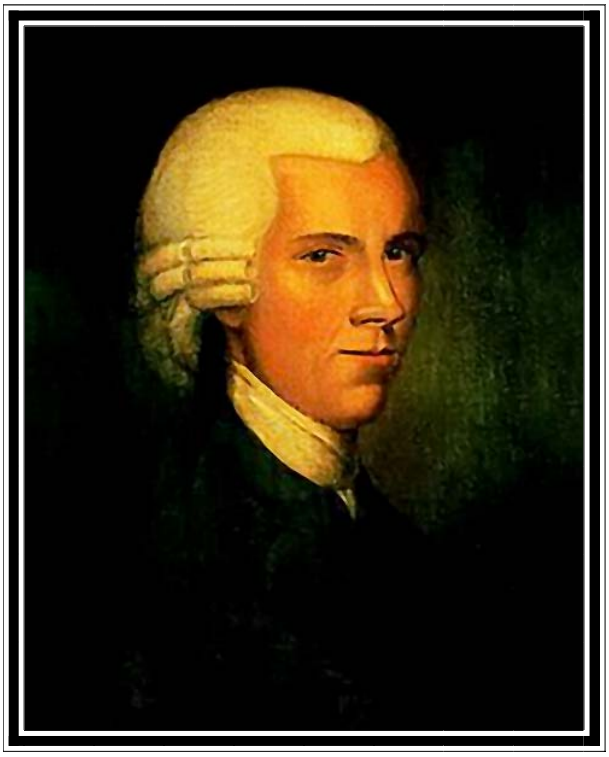


Figure 11:
John Coakley Lettsome (1744–1815).

plants on windy days when there is too much salt spray in the air. Both Lettsom and Ellis encourage trial and error to arrive at the right procedures for planting and growing vegetation aboard ships. Plants often arrived in England dead or in poor condition. During the eighteenth century, Kew gardens had special hothouse areas reserved for nursing sickly plants back to health after long sea voyages.

THE MAURITIUS CASE

John Lindley **(**1799-1865) was an English botanist, gardener and orchidologist. Lindley was appointed assistant secretary to the Royal Horticultural Society (the Horticultural Society of London became the Royal Horticultural Society at a later date) and its new garden at Chiswick in 1822, where he supervised the collection of plants. In 1829 Lindley was appointed to the chair of botany at University College, London, which he retained until 1860. He also lectured on botany from 1831 at the Royal Institution, including delivering the 1833 Royal Institution Christmas Lecture, and from 1836 at the Chelsea Physic Garden, starting the society's flower show in the late 1830s. John Claudius Loudon sought Lindley's collaboration on his Encyclopedia of Plants, which covered nearly fifteen thousand species of flowering plants and ferns. It was a massive undertaking and Lindley was responsible for most of it.

In a 1824 article written by Lindley in the *Transactions of the Horticultural Society of London* titled "Instructions for Packing living Plants in Foreign

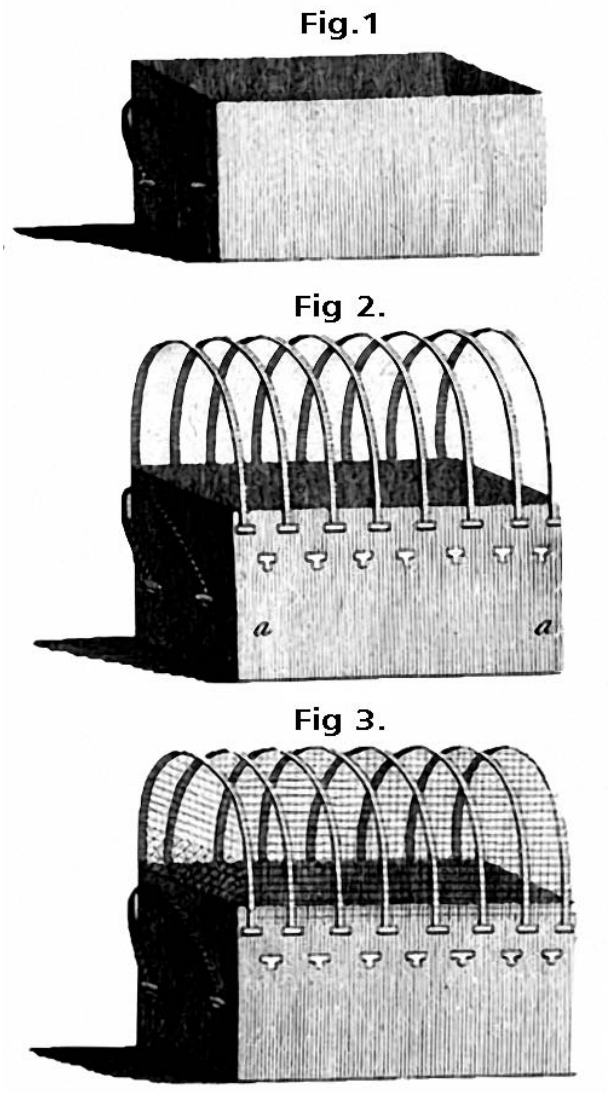


Figure 12: The Lettsom case. Top, The form of the box; Middle, the same with hoops and loops, a a, for securing the canvas; bottom, The same netted.

Countries, especially within the Tropics; and Directions for their Treatment during the Voyage to Europe," Lindley wrote:

Among the cases received by the Society this year from its numerous contributors, were four transmitted by his Excellency Sir Robert Farquhar, from the Mauritius (now an island country located 1,200 miles off the southeast coast of Africa)**. They were a kind of portable green-house, constructed in a very superior manner to any I have seen elsewhere. It is therefore presumed that an accurate plan and description of them, with such slight alterations as have appeared to be requisite, cannot be otherwise than acceptable. The plants they contained arrived in this country in much better condition than any received by the Society in the same year.**

The following is the description of the cases used, the references being to the figures in Figure14:

They were made of stout inch board well fastened together. Their height was three feet, length four feet, breadth one foot eight inches (Fig. 1). Twenty inches from the bottom they sloped off like a penthouse till the top was not more than two inches and a half wide. The sloping part on each side was closed by a shutter (Fig. 1. a. a.) formed of wooden bars two inches wide and two inches asunder, connected by a cross-rail at their ends. To the inside of these, panes of stout coarse glass were fixed by means of narrow slips of tin fastened to the centre of the bars where necessary, and well puttied in. (Fig. 3. a. a.) The shutters were moveable by means of hinges on their lower side, and in fine weather were kept open by hooks (Fig. 2. a. a.) fixed within three or four inches of the top into each side of the end of the boxes, and fitting into a staple in the corresponding edge of the shutter ; they were long enough to sustain the shutter, when open, in a perpendicular position (Fig. 2. b.) The shutters fell down so as to close the boxes completely in rough weather, and were kept together by two hooks fixed in the upper edge of one shutter, and catching into a corresponding staple in the opposite shutter. (Fig. 4.) A piece of tarpawling (Fig. 1. b. b.) was nailed to the top of the boxes, and in rough weather was unrolled and fell down over the sides, so as to protect them from the sea spray. In fine weather, when the shutter was opened, it was rolled up again, and tied together with two pieces of cord so as not to interfere with the shutters opening and closing. The trees were planted in square wooden boxes, just large enough to contain a single plant, and perforated with holes in their sides and bottom. (Fig. 5. a. a.).

I would recommend that square wooden boxes be used for the plants instead of earthenware pots, not only because the former are less liable to be broken, but also because they are lighter. When the period for embarking them arrives, they should be placed in wooden cases, the tops of which must be capable of being opened, and should slope both ways like the roof of a double green-house. These cases

Figure 13: John Lindley (1799-1865).

must be furnished with a tarpawling, fixed along their tops, and sufficiently large, when unrolled, to cover them completely, so as to protect the plants from being damaged by the salt water dashing over them in rough weather.

It cannot be expected that heavy cases should meet with very gentle treatment on shipboard, and it is certain they will be handled in the roughest manner by watermen, carters, and custom-house officers, after they have arrived in port. The materials, therefore, of which they are made, ought be of a very strong description, and the joints of the lower part either secured by iron bands, or well dove-tailed together ; but as the former method is attended with less trouble, and is equally secure, it will probably be the more generally adopted. Instances are not uncommon of fine collections being delivered from the custom-house with the sides of the cases beaten in, and the plants and pots broken in pieces.

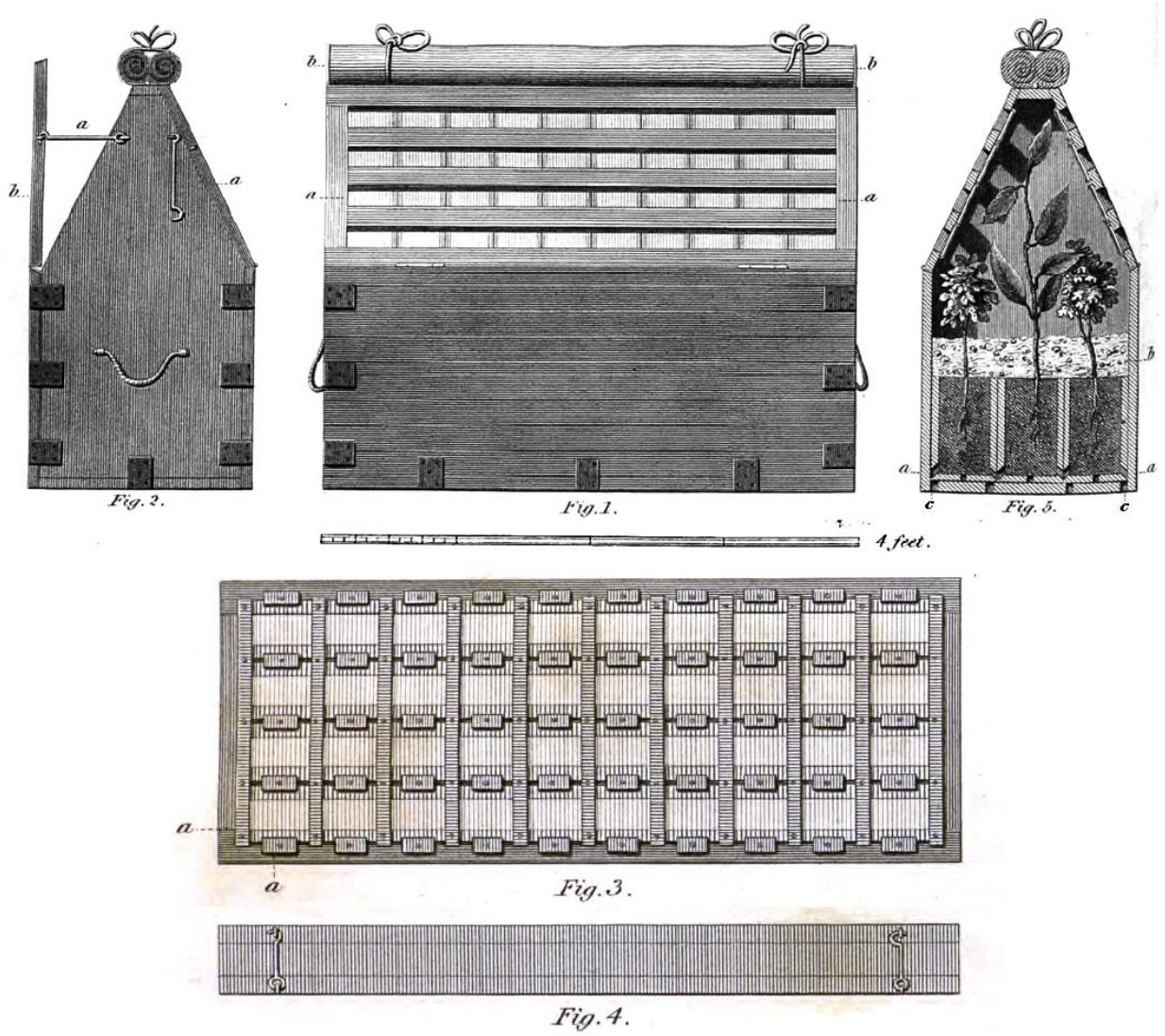


FIGURE 14: Fig. 1. Side view of the Mauritius case, with the shutter (*a a*) closed, and the tarpauling (*b b*) rolled up, and fastened with cords. Fig. 2. End view of the case, with one of the shutters (*b*) opened. Fig. 3. Inside of a shutter, showing how the tins (*a a*) for fixing the glass are placed. Fig. 4. The top, showing in what way the shutters when closed were fastened. Fig. 5. Section of a case. c*. c.* holes for draining, *b.* the moss above the pots.

The person in charge of the cases on board should have directions never to exclude them from air and light in fine weather, unless to protect them from the cold, as the vessel makes the land, and after she is in port, or during high winds, or especially when the seamen are washing the decks; but in foul weather to close the lids down and to unroll the tarpawling over the latter, so as to exclude the sea spray effectually. If, notwithstanding these precautions, saline particles should become encrusted upon the leaves and stems of the plants, it is necessary that the former should be removed as soon and as carefully as possible, with fresh water, and a sponge; otherwise the salt soon kills them. The quantity of water the plants receive must be determined by what can be spared; so that no other direction for its application can be given, than to keep the mould just moist. The requisite supply of water must also depend much upon the way in which the cases are drained. The best manner in which this can be effected is by causing holes about half an inch in diameter to be bored through the bottom of the cases and pots. Much mischief being occasionally done to collections by monkeys and parroquets on board the vessels, it is highly necessary that means should be taken to guard against their attacks.

Collections are not unfrequently injured after they arrive in this country, by the pots being shaken so violently as to be deprived of a large portion of their mould (in this context mould is loose soil, especially when rich in organic matter)**. Nothing can well be more destructive of vegetable life than this, which should be prevented by the pots being made square so as to fit accurately into the bottom of the outer case. There then could be no difficulty in keeping them steady; and if they were fastened down by cross pieces of wood, they would be secured still more completely. In addition, the surface of the mould ought to be covered deeply with coarse moss, or other similar substance (not grass,) which might be secured by packthread passed frequently across the box from its sides, or by slender laths, which would be less likely to become rotten than packthread. By this means evaporation of the watery particles which are necessary to the existence of the plants, proceeds much less rapidly than when the mould is exposed; and the latter has an additional security against being shaken out of the pots.**

THE ANDRÉ THOÜIN CASE

André Thoüin (1746-1824) was a French botanist born in Paris. He studied botany under Bernard de Jussieu, and in 1793 attained the chair of horticulture at the *Muséum National d'Histoire Naturelle* in Paris. He was a good friend of U.S. President Thomas Jefferson, and the godfather of Jean Baptiste Lamarck's son Andre. In the Atlas in his 1827 book, "Cours de Cultur de Naturalisation des Végétaux" (A Cultural Course in the Naturalization of Plants) Thoüin shows a plant case that is quite similar to that depicted by Lindley (Figure 16).

Figure 15: André Thoüin (1746-1824)

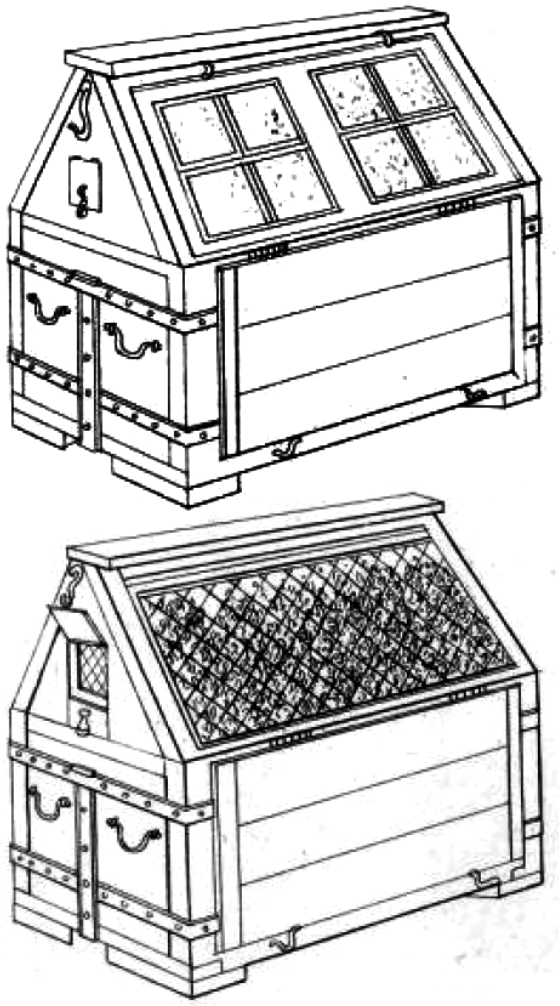


Figure 16: The André Thoüin Case.

A year after Lindley's article, John Loudon published the drawings and specifications for the case in his *Encyclopaedia of Agriculture* (1825). Although it is not known who invented this gable roof design (it may have been the Superintendent of the Botanical Gardens in Mauritius), its popularization was certainly due to both Lindley and Loudon and most likely the inspiration for Ward's cases for shipping plants by boat (and also for Thoüin's case).

NATHANIEL WALLICH'S PRE-WARDIAN CASE ADVICE

Nathaniel Wallich was born in Copenhagen in 1786 and died in London in 1854. From 1817 he took a permanent post as Superintendent of the Calcutta Botanic Garden, and travelled widely in the Indian subcontinent. Wallich published two major works on the plants of the region, however, his greatest contribution to botany was the fostering and assistance he offered to the many plant hunters who stopped in Calcutta on their way to the Himalayas. Wallich had one of the best records for keeping plant material alive for shipping prior to the development of the Wardian Case. A year before Ward started his experiments in sending plants overseas aboard ship, Wallich published a paper in *Transactions of the Horticultural Society of London* titled "Upon the Preparation and Management of Plants during a Voyage from India." The following describes the type of plant cases he recommended:

It has been the custom to make the chests very large, and to crowd into such chests as many plants as they will hold; this practice has had, amongst others, this bad effect, that Captains however well-disposed at first to pay the plants every attention, have soon found the cases troublesome, unwieldy, and unsightly. No case should be more than three feet long, eighteen inches in width, and sixteen in depth below the roof; I have taken these dimensions from a due consideration of the places where plants are generally stowed on board ship, viz. on the poop, or in front of the cuddy. The depth of the roof should be sixteen inches more, so that the shutters, when opened, will be the same depth as the sides of the boxes. The breadth of the upper rail should be five inches, which will admit of a piece of *painted* canvas sufficiently large to cover the whole sides, to be rolled upon it, and fixed to each side.

I would here observe that I would on no account use the common tarred canvas, which is a very imperfect defence against rain and sea spray, and in the next place, that whenever a number of chests are to be placed in a row close to each other, it would be preferable to use one piece of canvas instead of many. Some attention should also be paid to the neatness of the appearance of the cases, as Captains are

very unwilling to allow the deck to be occupied by unsightly objects; they should be well clamped together with iron and painted. On no account should holes be bored in the ends of passing rope handles through; the latter are perfectly useless. The roofs should be glazed either with stout glass or with the Chinese oyster shell; or with plates of thick talc.

Each plant should have a separate square pot made of wood, of such a size that eight should be contained in each case; they should not fit too tightly together, but should be so contrived that any one may be lifted out without disturbing the remainder. This renders it easy to replace deaths if the ships touch at any port on their voyage. The pots should have three or four holes bored in their bottoms : but there should be no holes in the bottom of the chest; for it is at such apertures that rats on shipboard always commence their depredations, and there is no advantage whatever in the holes.

Between the bottom of the pots and the bottom of the case, should be a layer three inches deep of broken glass and pebbles ; the former renders it impossible for vermin to establish themselves in the cases. The cases should be raised two inches from the deck by little feet.

Figure 17: Nathaniel Wallich (1786-1854).

In the treatment on board, too much attention cannot be given to the necessity of exposing the plants to the open air at all times when the weather will admit of it. As a general rule, it may be said that the boxes should be kept shut as long as the sun is above the horizon, and opened during the night, whenever the weather appears steadily fine. In cases where the chests are placed under the awning, the former precaution would be less necessary, and a due consideration of the changeableness of weather at sea, will of course ensure particular attention to the closing the roofs, if bad weather should come on. Whenever a shower falls the plants should be fully exposed to it, taking care at the same time that too much moisture be not admitted.

With regard to watering, it is desirable that the Captain should provide for each plant one pint per diem; because, although in rainy weather no water is required, yet if the weather is very hot, a larger allowance than this may be necessary. The water should be given in such a manner that the leaves and branches may be refreshed, besides the root; part should therefore be sprinkled over them, the rest poured on the earth. Generally, half a pint of water should be sprinkled over the plants before you shut them up in the morning, and the same quantity when the cases are opened in the evening ; a greater quantity will however of course be given in hot dry weather than when the sky is overcast and the air moist. It has happened in the large collection brought home by myself, as well as in another which came subsequently in the same ship, that such has been the vigour with which plants thus treated grew, that it was frequently necessary to have recourse to the knife in order to check their luxuriance.

THE NATHANIEL WARD CASE

In 1836 in a letter from Nathaniel Ward to William Hooker on the subject of his improved method of

transporting living plants in the *Companion to the Botanical Magazine*, Ward had this to say:

I come now to the most important application of the above facts: that of the conveyance of plants upon long voyages. Reflecting upon the causes of the failure attending such conveyance, arising chiefly from deficiency or redundancy of water, from the spray of the sea, or from the want of light in protecting them from the spray, it was, of course, evident that my new method offered a ready means of obviating all these difficulties, and in the beginning of June, 1833, I filled two cases with Ferns, Grasses, &c., and sent them to Sydney under the care of my zealous friend, Captain Mallard, copies of whose letters I have enclosed.

The cases were refilled at Sydney, in the month of February, 1834, the thermometer then being between 90° and 100°. In their passage to England, they encountered very varying temperatures. The thermometer fell to 20° in rounding Cape Horn, and the decks were covered a foot deep with snow. In crossing the line the thermometer rose to 120°, and fell to 40° on their arrival in the British channel, in the beginning of November, eight months after they were enclosed. These plants were not once watered during their voyage, received no protection by day or by night, but were yet taken out at Loddiges' in the most healthy and vigorous condition. The plants chiefly consisted of Ferns, among them *Gleichenia microphylla* never before introduced alive, and the *Hymenophylium Tunbridgense*. Several plants of *Callicoma serrata* had come up from seed during the voyage, and were in a very healthy state. As this experiment was made chiefly with Ferns, I will briefly give you an account of one other experiment, in which plants of a higher order of development were the subject of trial. Ibrahim Pacha being desirous to obtain useful and ornamental plants for his garden near Cairo, and at Damascus, commissioned his agents in this country to send them. I was requested by his agents to select them, and they were sent out in August, 1834, in the Nile Steamer, to Alexandria. They were about two months on their passage, and I have enclosed a copy of the letter from Mr. Traill, his gardener, giving an account of their condition when he received them; and have likewise sent you a list of the plants, which were contained in the Egyptian cases. I have, as yet, received no account of the Syrian plants. Various other trials have been made to other parts of the world, as Calcutta, Para, &c. &c., and with the same success.

I feel well assured that this method of importing plants would likewise be extremely useful in the introduction of many of the lower but most interesting tribes of animals, which have never yet been seen alive in this country.

It appears that it was almost an obsession with Ward that his cases be tightly sealed and, once on board, not to be opened on any account. Ward cites a letter from Captain Mallard where he states that

Figure 18: A Wardian case, circa 1870. The hinges are not original; hence this is not a true Wardian case.

These plants were not once watered during their voyage, received no protection by day or by night. In this article Ward was referring to a letter from Mallard dated January 18, 1834 referring to the return trip from Australia but Ward fails to mention that in Mallard's prior letter dated November 23, 1833 - the outgoing part of the trip - that Mallard stated: **During the very hot weather near the equator, I gave them once a light sprinkling of water, and that is all they have received during the passage.** This means, of course, that the case was opened. As Ward stated in response to a question:

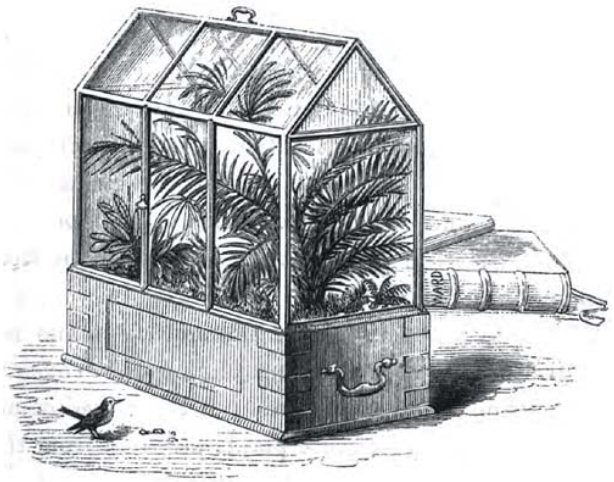
I may remark, that there is one point, upon which misconception exists very generally, even among well informed men. Because my cases are made quite tight, it is imagined, that the plants contained in them receive no change of air. Now, it must be obvious to everyone who reflects for an instant on the subject, that owing to the expansibility of the air by heat, there must, with every change of temperature, be a corresponding change in the volume of air contained within the cases. Without such a variation, the plants would, in all probability, soon perish.

This, however, was a grave error and ultimately led to various modifications of Ward's case, suggesting that Lindley's case, although not a true "Wardian case," was a better one. In any case, Ward's friend George Loddiges (1786–1846; his family managed one of the most notable of the eighteenth and nineteenth century plant nurseries that traded in and introduced exotic plants, trees, shrubs, ferns, palms and orchids into European gardens), who had accompanied him aboard Mallard's ship to witness the first successful transplant from Australia, was more ambitious. He put into circulation over five hundred cases to all parts of the globe. It is the ingenuity and wide usage of Loddiges nurseries that established the Wardian case as the most compelling tool to use for transporting live plants. Nathaniel Wallich was so impressed with the case that he received that he packed that same case and sent it on to the director of the *Jardin des Plantes*, Charles François Brisseau de Mirbel. The director at France's premiere garden was equally impressed and passed on knowledge of the case to the famous Cel family who imported exotics to Paris. Mirbel returned Wallich's case to India, and the Cel's, grateful for the knowledge also sent a newly constructed case of plants to Wallich.

In all his writings, Ward was somewhat vague about the construction details of his cases. He never showed any illustrations of his device except for a drawing in his 1852 edition of his "On the Growth of Plants in Closely-Glazed Cases" with the caption, "On The Conveyance of Plants and Seeds on Ship-Board" (Figure 19). I don't know what Ward had in mind with this illustration as it is clearly one of his cases designed to be used indoors and was made of glass set in a thin metal frame. I doubt that it could have remained intact before the ship even left harbor.

The following is my translation of a portion of a report that Mirbel and four of his associates published in l'Académie des Sciences in 1837 that provided more information in this regard:

Another device, invented for the transportation of plants by Dr. Nath. Ward, of London,



ON THE CONVEYANCE OF PLANTS AND SEEDS ON SHIP-BOARD.

Figure 19: From the 1852 edition of "On the Growth of Plants in Closely-Glazed Cases."

offers still more chances of success than that of Luschnath; but it fills its destination only on the condition that, during the crossing, it will remain exposed to the action of the light and will not experience any serious damage. This apparatus, which we shall call "a traveling greenhouse," consists of an elongated box, surmounted by a glass roof, formed by two frames adjusted so as to make an acute angle. The two small sides of the box, exceeding its base by two or three centimeters, serve as a support for the whole apparatus; and, rising at an acute angle above the opening of the box, close the two sides of the roof. One of the frames is stationary; the other, restrained by a few screws, is placed or removed at will, but the box must be closed for as long as the journey lasts: otherwise the perfect closing of all the parts is difficult. Wooden sleepers, four to five centimeters wide, at a distance of seven to eight centimeters from each other, fit with the lower and upper part of each frame, and serve at once to give it solidity and to support the glasses, which are small, very thick, covered like the tiles of a roof, and puttied in all their joints.

The authors point out that if the frame came off or had to be removed, it would be very difficult to reinstall it. In a moist environment, such as the oceans, wood absorbs moisture and if the box and the frame swelled differently by even a very small amount, the closing of the case would not be easy.

THE WILLIAM BULL CASE

Over the years the Wardian case had many designs and many different constructions. Figure ?? shows a botanist unpacking a Wardian case at the Royal Botanic Gardens, Kew, around 1890. Notice the large hole drilled into the top of the case just below the tip of the triangle that permitted air to enter and leave the case. In other words, the original Wardian cases used by Kew Gardens were now no longer cases as Ward envisaged.

William Bull (1828-1902) was a botanist and owner of a famous exotic nursery, established in 1861 and in existence up to 1917 on Kings Road, Chelsea. In 1887, Bull received the Victoria Medal of Honour for his achievements in importing new varieties and species of plants. Shortly after Ward's death in 1868, he was granted a patent for "An Improved Case for the Conveyance of plants" (December of 1870). In his introduction to his patent, Bull wrote:

It is well known that when plants have to be transported for long distances, and have consequently to remain packed for a considerable length of time, they require to be packed in cases with glass covers so that the requisite amount of may be enabled to reach them. They also require to be more or less moist to withstand a journey of three or four months (more or less) in a closed case, and it is moreover necessary to protect them from the action of sea air and salt water during transit. Heretofore great loss has been sustained in the transmission of valuable plants owing to the direct action of the rays of the sun upon the glass covers of the cases containing the plants, the result of which has been the creation of what

Figure 20: William Bull (1828-1902).

may be termed a " steaming" heat within the case, so that the plants have been literally boiled. Great damage results also from the breaking of the glass on board vessels, which at present frequently happens, thus exposing the plants to the action of the sea air. Various devices have been resorted to for the purpose of obviating these serious evils, such as the nailing across the case strips of wood, bamboo canes, canvass and other plans, but all the means hitherto used, so far as I know, have more or less failed to accomplish the object in view, as they either make the interior of the case too dark, or do not prevent the sun's rays from penetrating directly into the case.

Referring now to Figure 21, the following are the details of the patent:

Now in order to remedy the evils above referred to, and also to protect the plants from injury by the dripping on to them of the condensed vapor from the glass, I cover the glass with a frame or frames formed with louvre pieces *a,* so arranged as to permit the necessary light to enter the ease, but to protect the glass from the direct rays of the sun, and from breakage; and in order to protect the plants from the dripping of condensed vapor, I arrange the glass covers and interior of the ease, as shown in the Drawings, so that the condensed vapor shall pass down the surface of the glass into small channels or chambers *b,* provided within the case to receive it, which chambers *b* are filled with sphagnum moss or charcoal to absorb the moisture.

I furthermore guard the plants against injury from sea water entering the case during the washing of the decks, by constructing the case with projecting parts or legs c in such manner that its bottom shall be raised some distance from the surface of the deck, and thus allow any water to flow underneath without soaking it up. I provide for the escape of foul and overheated air from the interior of the ease by placing at each end thereof, or at one end only, a ventilator of the kind shown at Figs. 3 and 4. A small chamber *d* is formed in the upper part of the end of the ease; this chamber communicates through opening's e with the interior of the case, and through openings *f* with the external atmosphere. The openings *e* and *f*, which I prefer to make about one inch in diameter, are covered by screens *g,* made of the finest wire netting procurable, and outside of this netting by a

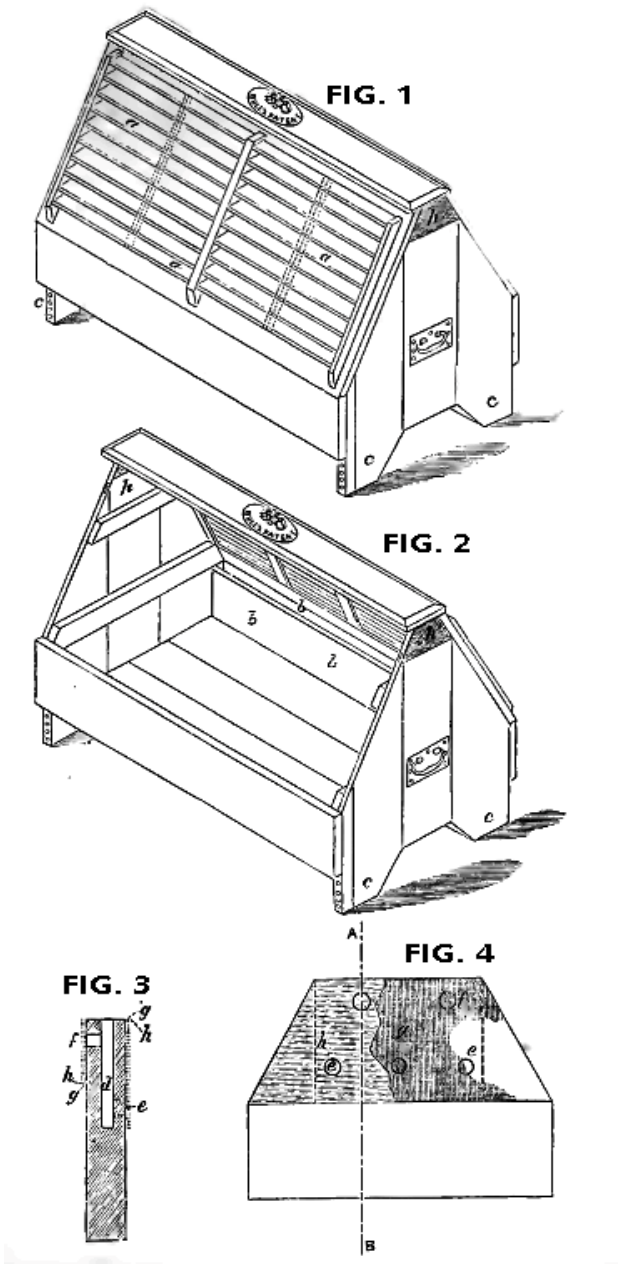


Figure 21:
The drawings from Bull's patent of 1870.

farther covering of finely perforated zine plate *h*, through both of which coverings the air is as it were "wire-drawn" in its passage into and out of the ease. The number of openings *e* and *f* may be varied to suit the requirements of the climate through which plants have to be conveyed, and the length of the voyage or journey, increasing the number of holes *e* and *f* according to the length of the journey, and the nature of the plants, as will be well understood by horticulturists.

This invention is the result of great observation and experience, for as a large importer and exporter of new and rare plants I was induced to turn my attention to devising some practical means for obviating the serious evils already referred to in consequence of having suffered great losses for several years in importing plants, many of which were not only now to this country but to science.

CONCLUSION

Users, whether they were organizations, institutions and nurseries, varied the design according to their needs, the type of plants being sent and the destination. These were not just centralized botanical gardens designing cases, but nurseries and plant collectors making them. Indeed some of the leading innovations came from commercial nurseries. Often it was the needs of the plants and the practicalities of shipping that determined the design of the cases.

The Wardian case is a persuasive and wide reaching example of how a simple technology for moving plants had a major impact on the ecosystems we know and value today. It was a prime mover for botanical enterprises for over a century. But by the 1940s it was largely phased out, with the last journeys carrying ornamental plants occurring in the 1960s. The case was superseded by the use of polyethylene bags and temperature-controlled air transport.

The Wardian case was extensively used by many different groups of people from across the globe to move many different plants; from scientists to gardeners, from ferns to bananas, from Australia to Boston, the case was put to good use. Collectively in the nineteenth and early twentieth century, the use of Wardian cases facilitated a major plant migration across the globe. These plant distribution networks, established with the introduction of the Wardian case, are still in use today.

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LA CENERENTOLA: JEANNE VILLEPREUX-POWER

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, February 16, 2019)

Jeanne Villepreux was born during the period of the French Revolution in Juillac on September 25, 1794. The consequences of the Reign of Terror did not reach her because she grew up in a village deep in the countryside. It is located in the Corrèze department in Nouvelle-Aquitaine in southern France (see Figure 1) and at that time, its population was estimated to be about 2,000 (it has lost almost of this since then, its current population being about 1,100). Her father was Pierre Villepreux, also born in Juillac, and her mother was Jeanne Nicot, born in Limoges, about 37 miles north as the crow flies (see Figure 1). In the late 1700s the porcelain industry in Lomages started to develop, favored by the presence of kaolinite which was discovered near Limoges in 1768, and many of the inhabitants became employed in the new industry.

Jeanne (who was called Lili at home, most likely to distinguish her from her mother; she was also for the same reason called Jeannette) was the oldest of two sisters (Marie and Gabrielle) and one brother (Joseph) but after her mother died at the

Figure 1: Map of France showing Juillac.

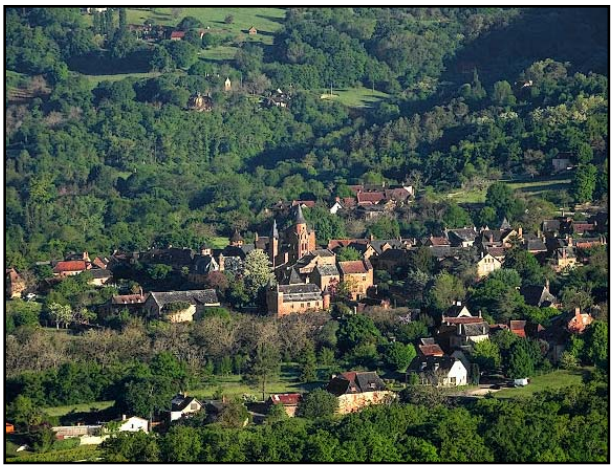

Figure 2: Aerial view of Juillac.

age of 31 in 1805 when Jeanne was only eleven years old, her father remarried two years later - a necessity since there were four children to take care of - and so Jeanne later added three half-brothers and one half-sister to her list of siblings.

Jeanne spent her childhood and adolescence in Juillac. In this small town, then the capital of the canton in the Corrèze department in Limousin, her father held various trades (at that time he worked as a saltpeter miner), while her mother was one of the few Juillac women who could read and write. She taught Jeanne but the other younger children would not be as lucky as their mother

Figure 3: The town of Juillac.

Figure 4: Jeanne Villepreux-Power (1794-1871), photographed in 1861.

died before they were old enough to be taught. The Villepreux were not rich, but they were not poor either since they lived in a house they owned in the Place de l'Eglise as well owning a plot of land.

JEANNE TRAVELS TO PARIS

The death of her mother in 1805 and the second marriage of her father two years later, with the birth of other siblings, marks the adolescence of Jeanne. In 1812, when she was seventeen and a half years old, she left Juillac to go to work in in Paris. She left for the capital, a journal of about 350 miles on foot, accompanied by her cousin who was taking a herd of cows to a slaughter-house in Paris and who also functioned as a guardian for the underage Villepreux. However, along the way her cousin assaulted her and she was forced to take refuge in the police station in Orléans, where she waited for new documents in order to be able to travel to Paris. The workplace she had been promised in Paris had already been taken upon her late arrival, but she nevertheless had the opportunity to work as an assistant to a society seamstress, proving her skills to such an extent that she was entrusted with embroidering the wedding dress in 1816 of Princess Maria Carolina of Bourbon for her marriage to Charles Ferdinand, Duke of Berry and nephew of the French king Louis XVIII.

According to family legend, James Power was impressed by the beauty of the embroidery of the princess's wedding dress and wanted to know the embroiderer. If true, wedding dress with her embroidery would have signaled the first fateful meeting between Jeanne Villepreux and James Power.

INTRODUCTION TO JAMES POWER

At the end of the eighteenth century, Morris Lucas Power and his wife Anne Cuffe, an Irish family of noble origins, had moved from their native Ireland to one of the smallest islands in the Antilles, Dominica, which had been sold by France to

Figure 5: The wedding dress of Princess Maria Carolina that Jeanne did the lace for in 1816.

Great Britain at the end of the Seven Years' War (1756-1763). The reasons that led them to move to Dominca are not known. Perhaps the financial problems and/or the difficult political and economic problems in Ireland at the time was the basis for their decision to move to a safer and less precarious place. Once established in the Antilles, the Powers probably reached that serenity they sought and was here that James Power was born on February 28, 1791.

In Roseau, the Dominican capital where he spent his early youth, James was immersed in the typical mixture of different cultures, languages and populations in the island, then inhabited by Europeans, Amerindians and Creoles. During this time he learned several languages, such as English, French and Spanish.

After the sudden death of his father and the subsequent marriage of his mother in the early nineteenth century, the young James Power decided to leave the Antilles to try and create a future elsewhere by traveling the reverse course to that of his father who, in his time, had left from Ireland to the Antilles. James' first goal probably was England, but this was only a step towards what would become his definitive residence, Sicily, one of the few European areas that was not occupied by Napoleon but for at least a decade was under the English protection.

In particular, in the decade from 1806 to 1815 Sicily was protected by 20,000 British soldiers sent to defend it from a dreaded Napoleonic invasion and to try to win back the kingdom of the Bourbon allies, Naples, occupied by the French. In the period of the Napoleonic wars this Mediterranean island had represented, together with Malta, an essential military base for Great Britain and also an important alternative market for many English merchants penalized by the negative effects of the "Continental Block" with which Napoleon had closed the continental European markets to British trade in 1806. In the "English decade," 1806-1815, along with the Royal Navy and British Army military, there had arrived numerous merchants who, rejected by European ports because of the Continental Bloc, were looking for new markets. In that decade, Sicily and Great Britain, allied in the fight against Napoleon, had developed a substantial interchange based on British exports of industrial products and on Sicilian exports of raw materials and production agricultural (oil, citrus, raw silk, sulfur etc.).

Figure 6: Dominica.

This trade had been initiated and managed by the large merchant community that had settled during the English decade. Before 1806, the English presence was limited to half a dozen merchants residing in Messina and Palermo, while between 1806 and 1815, forty commercial houses were established in Messina and about twenty in Palermo. The number of English merchants was

Figure 7: Location of Messina.

destined to increase in the following decades. After 1815, the new prospects for peace had led new English compatriots to come to Sicily to start new businesses and new expanded networks of exchanges already established during the age of Napoleon. Thus, to the merchants who had arrived in the English decade were added those who had arrived from England in the following years.

From the available sources it is not known if James Power arrived in Messina during the English decade (perhaps in the employ of other English merchants or as the owner of one of his own companies) or immediately after the Restoration by the Congress of Vienna in 1814-1815 that established the political order in Italy that lasted until unification between 1859 and 1870. In any case, here he was soon engaged in a flourishing commercial activity and considered as one of the most important English merchants of the city. His activities, documented for over twenty years starting from 1818, involved not only the commercial sector, but also the financial sector and the entrepreneurial ones. Power was also part of the maritime movement of the Porto di Messina, along with other English merchants resident in Sicily and involved in international trade, through the routes that in the port of Messina connected the different areas of Sicilian and Calabrian production with ports and foreign markets.

In addition to his commercial activities, from the first years of his residence in Messina Power also made financial investments. In 1819 he participated in the establishment of the marine insurance company *Banco di Assicurazioni* as one of its 27 shareholders. The successes of his varied commercial activities permitted him to invest part of his earnings in the subscription of shares as well as in other financial transactions. James Power's investments in the financial sector did not limit themselves to insurance; as shown in a document dated 1823, they also included the purchase of public debt securities of the Kingdom of the Two Sicilies. This was a kingdom in southern Italy from 1816 until 1861, created after the Congress of Vienna of 1814 by uniting the Kingdom of Sicily and the Kingdom of Naples, which had been ruled by Joseph Bonaparte during the reign of Napoleon.

In the mid-1820s (as early as 1825-26), Power was active in the Messina trade under the name "James Power & C." together with a partner (not known).

Figure 8: The old port of Messina, 1786.

English and Sicilian sources included the "James Power & C." among about thirty foreign companies operating in the city (the English ones totaled more than twenty, while the German, French, Belgian and U.S. ones were altogether less than a dozen.

In general, in those years in Messina the commercial activity of James Power, like that of many other foreign merchants, was part of a dynamic circuit based on the export of local products for markets more distant and on the importation of foreign productions that were then redistributed in the neighboring markets. This import trade, in fact, was broken down into that for consumption and circulation by land, and for consumption and circulation by sea for island domains and continental countries.

Even British sources attest to the commercial relations that James Power maintained with foreign markets and specify some details on the goods that were the subject of his trade. From a memorial of May 20, 1825, which concerned problems related to the export of oil from Sicily, it is clear that James Power, like other traders long active in the general trade, was very well integrated into the intense activity of foreign exchange, and especially with England. Within this system he, like so many other English merchants, did not deal only with the business of export of Sicilian products, but also of the import trade of English goods at a time when the trade movement between Britain and the Regno delle Due Sicilie showed a trend of gradual growth until 1840 and a phase of rapid expansion in the following decades (the Kingdom of the Two Sicilies was the largest of the states of Italy before the Italian unification; it was formed as a union of the Kingdom of Sicily and the Kingdom of Naples, which collectively had long been called the "Two Sicilies"). In 1827, for example, among the goods that James Power imported from England, were "18 barrels of manufactured colors" and "a box of hard soap bars" that had been sent from England on the brigantine, *Preceptor del Captain James Leigh*, to be delivered, along with other products of English industries, to the numerous foreign merchants of Messina.

His business did not always have its favorable sides, as can be seen from some controversies that ended in unfavorable rulings of the Court of Commerce of Messina. In 1820, for example, in one dispute over the payment of a bill, Power was ordered to pay it as a part of a debt. There were also problems with customs, rather frequently as a result of the intricacy of the regulations and for the general customs legislation that had changed the old equilibrium, not only between the island and the continent, but with foreign trade in the early period of the Restoration. In 1825, together with other foreign merchants, James was engaged in a judicial dispute for a payment requested by the Director of Duties for the shipment of oil abroad. Also the following year he was engaged, with his colleagues, in another controversy with the customs officials of Messina.

Figure 9: Messina on the waterfront.

Meanwhile, beginning in the late 1820s with the entry into the company of James Robinson Unett, a resident of Liverpool, "Power & C. changed its name and officially became "Power & Unett." Power was active in Messina not only in maritime trade, but he also started a significant new business activity. Starting in the mid-1830s, Power & Unett began to produce sulfuric acid, tartaric acid and cream of tartar

with new technology and asked the Bourbon government to grant them a "Privativa," i.e. an exclusive patent to manufacture those products using steam pipes. With the decree of August 25, 1838, Ferdinando II di Bourbon granted the Privativa for 5 years to the Power & Unett company for the production of tartaric acid and iron sulphate with the innovative use of steam tubes instead of the ancient way of applying direct fire.

The factory had done well and was active at least until the beginning of 1838, so much so that it was reported in his "Economic Memory" (1838) by Alessio Scigliani for the innovations introduced in the production of sulfuric acid:

In the factory of Power and Unett in Messina sulfuric acid was made to perfection, and compared to that of any other country concentrated in high grades with a new method without the aid of glass retorts, damaging the acid from the lead chamber and without the gases causing damage to the lemon trees, olive trees, etc., in which the said local is surrounded,. In the matter of the cream of tartar, that of M. Power, manufacturer of this material in Messina, was highly economical. He made sure that the red scum made at least a quarter to a fifth of the brown tartar cream, while the red tartar did not make more than a third. Furthermore there was a great deal of difference between their prices, since the former is sold from 10 tarì to 14 tarì per 100 kilograms and the red tartar is worth from 3.10 to 3.20 per ounce [30 tarì was equivalent to $2.38 in 1838 currency]. He got it right from the first, especially since it was difficult to transport as well expensive in the matter of fuels. Much economy in fuels was obtained by exploiting the so-called scurcidda [i.e., the internal rind of corks] that the tanners use, the tiny fragments of fossil and vegetable coals, and the residue of the wine lees after having pulled the cream.

CENERENTOLA

Cenerentola is the Italian name for Cinderella and this name certainly applied in the real world to Jeanne Villepreux, a simple girl - but a highly intelligent one - who married a very wealthy man. Jeanne left France to move to Messina, where in 1818 at the age of 24 she married James Power (three years older than she) and where she discovered for the first time the sea, a discovery that would forever mark her life. Equipped with a great spirit of observation, intuition and scientific curiosity, Jeanne had probably practiced these natural talents in her childhood in the countryside of Juillac or in the mountains of Corrèze, but it certainly matured in her almost 25 years of residence along the banks of the Strait of Messina.

The long period spent in Messina can be divided into two phases. In the years between 1818 and 1830 Jeanne was a lady of the city bourgeoisie and, as a wife of a wealthy merchant, could attend local salons and participate in the life of society, but instead preferred to cultivate her growing sci-

Figure 10: James proposes to Jeanne.

entific interests, reading texts of natural history, self-taught studying the various aspects of natural science and getting in touch with the scientific community of Messina. For Jeanne these were the years of her theoretical preparation, which would be followed by a long period of hands-on experience and research in the field of marine biology.

The years between 1830 and 1842 were the years of scientific experiments, systematic observations, inventions and early publications. It is in 1832 that Jeanne invents and builds her "gabbiolina alla Power" ("cages à la Power") and begins to report to the *Accademia Gioenia di Catania* (Gioenia Academy of Catania) the first results of her research on *Argonauta argo*, which would be published in the Acts of the Academy over the succeeding years. This second intense period culminates in 1839 with the publication of her *Itinerario della Sicilia* (Itinerary of Sicily) and, three years later, of her *Guida per la Sicilia* (Guide for Sicily), two books of wide-spread dissemination on the natural resources of the island as well as farewells before her definitive departure from the island of Messina.

JEANNE DISCOVERS THE SEA

In 1818, James and Jeanne Power begin their lives in Messina, residing in Strada Ferdinanda 96 (behind the Palazzata that runs along the port) and, a few years later, in the nearby Strada Austria, where James carried out his commercial activity. As her husband was more and more established in the maritime trade that revolved around the free port, Jeanne discovered the sea that surrounds the city and began, self-taught, to know, observe, analyze and catalog the natural resources of the waters of the Strait.

Jeanne thus came into contact with the leading scientific figures of Messina , such as the ichthyologist Anastasio Cocco and his brother Luigi, who also hosted the Powers in a country house in the Gravitelli district. Moreover, Jeanne was also in contact with experts and collectors of objects of natural history, such as Luigi Benoit, who had a Sicilian ornithological collection and a numerous collection of shells, Giuseppe Grosso Cacopardo, who owned an extensive collection of shells and Mariano Cesareo, who had a large collection of Sicilian seashells. Among her friendships and acquaintances there were also collectors who sold objects of natural history, like Pietro Campanella, who traded in minerals, fossils and living shells, and Mario Olivo, a young man who was paid for collecting objects of natural history, and above all the priest, Father Mario De Francesco, who accompanied her several times in her travels in Sicily and who was a skillful collector of objects of natural history, and particularly of fossil, terrestrial and fluvial shells, the collections of which he sold at very moderate prices.

In the 1830s, Jeanne's contacts were not limited to Messina, but also included scholars and collectors living in other cities of the island. In Catania, the privileged contacts she valued above all were those of the members of the Gioenia Academy of

Figure 11: Messina before the earthquake of 1783.

Figure 12: Carmelo Maravigna (1782-1851)

Natural Sciences (*l'Accademia Gioenia di Catania*, named after the catanese naturalist Giuseppe Gioeni d'Angiò). Among these, in addition to the canonical Giuseppe Alessi, to whom she had close ties of friendship, there was the celebrated Professor Carmelo Maravigna, who taught Philosophical Chemistry, Pharmaceutical and Applied Chemistry at the University of Catania. In his house there was a particularly rich Cabinet (a piece of furniture used for displaying items) with many finds of various branches of the natural sciences. There was also the famous and much renowned in Europe Professor Carlo Gemmellaro, who owned a Sicilian geological collection, and living shells and fossils in addition to a collection of insects collected and sorted by his worthy son, Mario Gemmellaro. In her *Guide for Sicily*, among the experts and collectors of the city of Etna Jeanne also recalled Doctor Mariano Zuccarello Patti for an extensive collection of living shells and crustaceans from the seas of Sicily and a collection of insects, among which included many beetles; the Doctor Andrea Aradas for a rich collection of marine shells of Sicily, fluvial and terrestrial, living and fossil; and the young Giovanni Piazza Ciantar for a collection of Sicilian shells and other objects of natural history. In Siracusa, among her friends Jeanne include Bishop Mario Landolina Nava, known to both citizens and foreigners for his virtues, who owned a collection of organic fossils, including shells and bones of elephants, hippopotamus etc., while Dr. Alessandro Rizza kept a collection of birds, shells and crustaceans.

Among the private collections observable in Palermo Jeanne pointed out, was a special collection of volcanic products, petrifications and shells of the prince of Trabia and an extensive collection of shellfish and nudibranchs, living and fossil, of the Baron Andrea Bivona, son of the illustrious

Figure 13: Carlo Gemmellaro (1787-1866)

Antonio Bivona Berardi; a rich collection of living shells and fossils from Sicily, and in particular from Altavilla by Domenico Testa; and a collection of living shells and fossils from Sicily by Dr. Pietro Calcara. In Termini, she mentioned the Cabinet of the Gargotta Lordswhich was worthy of being observed for its paintings, cameos, medals, works in terra cotta, shells both live and as fossils, minerals, volcanic production and so on, and in Cefalù the rich Cabinet of objects of natural history of Barone Enrico Pirajno di Mandralisca, who "uses it with great success for increasing our progress in this science."

Besides occasionally or systematically sharing many scientific interests with these and other scholars, collectors and expert collectors of objects of natural history in Messina, Jeanne daily shared much of her time with fishermen who, thanks to their activity, provided her raw material for her research. For readers of her *Guide for Sicily*, Jeanne described the method of fishing for marine animals in the Messina Sea and others that she had adopted in previous years and recommended to scholars who visited Sicily for scientific purposes:

Figure 14: Barone Enrico Pirajno di Mandralisca (1809-1864).

To get good specimens of marine animals you have to look for them in autumn and winter, their own seasons. In these times I would take myself on a boat with fishermen, giving them a little money or something to eat, the latter being more appreciated than money.

Whenever the fishermen withdrew the nets or other fishing equipment from the bottom of the sea, Jeanne would spill all the catch into the boat and then choose the specimens to study, putting them in a barrel of sea water open at the top to be able to observe the contents. On returning from these trips, Jeanne often ran into other boats along the coast between the tip of the Lighthouse and the city ("on the shores of Faro or de 'Ganzirri, or of Peace, places close to each other to the other") and, "using urban ways with those barcajuoli, one can see the fruit offered and admire their fragrance and buy something with little money."

With this method, which she recommended for naturalists and lovers of the natural sciences, Jeanne obtained a unique collection of beautiful specimens without having to spend a lot of time and money. Moreover, with this system a haul not only brought up shells and crustaceans, but in the middle it often had sea stars, sea urchins, comb jellies, jellyfish, univalve mollusks, echinoderms, nudibranchs, marine flatworms, cuttlefish, octopus, sea horses and a variety of *Laplysia* and other marine plants that were difficult to procure intact by other means.

She also bought rare fish directly from the fishermen, which she put in a barrel to avoid jeopardizing the scales with the impact of other objects. Among the scales of the larger fish she was able to find small crustaceans like the chiton (marine mollusks) and *Pinnella filosa* (a copepod, parasitic on large pelagic fishes) on the swordfish, the *Mediterranean Echeneis* (a remora that hitches a ride on certain fish) on the gills of *Tetrapturus belon* (Mediterranean spearfish) and the *Palcobdella* (a species of leech) on some venomous

stonefish. Finally, Jeanne learned that the minute and delicate objects, such as hyalea (mollusks), janthina (sea snails) and small nude mollusks, should be carefully placed in "a crystal vase filled with sea water with a cork stopper" to be inserted "inside a little bonnet with a straw so that it will not break."

THE PAPER NAUTILIS

The cephalopod mollusk was known from ancient times as the Nautilus. In an epic quest, Jason and the Argonauts, a band of heroes aboard the Argo, sailed the seas searching for the Golden Fleece that would grant Jason the authority of kingship. In 1758, it was renamed *Argonauta argo by Linnaeus.* The argonaut octopus, of the family Argonautidae, belongs to a group of pale pink-spotted octopuses. These octopuses are known for traversing the open ocean by way of a delicate, curved, creamy white vessel - an external casing often referred to as a "shell" - that gave them their common nickname, the "paper nautilus." These creatures baffled naturalists and philosophers for two millennia, even fooling Aristotle who believed that they used their large pair of webbed dorsal arms as "a sail" to catch the briny breeze and float across the ocean's surface like paper boats. These myths carried weight for centuries, even among naturalists in the 19th century.

Figure15: *Argonauta argo,* also known as a Greater Argonaut.

Figure 16: Aristotle's idea of the Astronaut sailing.

This octopus was a problem because the descriptions were a little funny with the scientists describing it often with old, antique descriptions - sketching it as a sailing octopus. "It uses [the thin webs], when a breeze is blowing, for a sail, and lets down some of its feelers alongside as rudder-oars," Aristotle wrote of the paper nautilus.

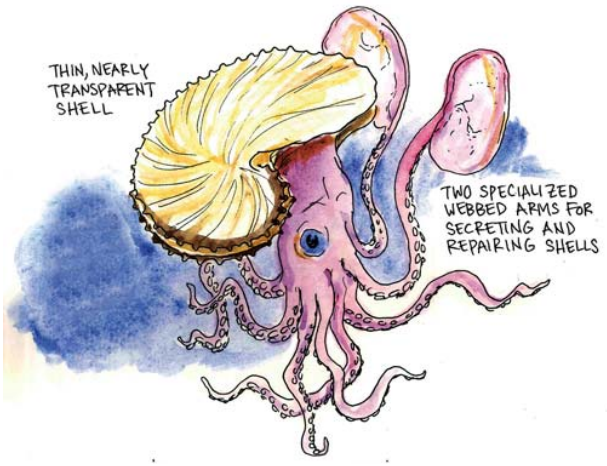

Figure 17: The specialized webbed arms were uses for secreting and repairing shells, not for sailing!

The four known living species of paper nautilus reside in tropical, subtropical, and temperate waters around the world. They feed on small crustaceans, mollusks, and jellyfish, using poison to immobilize their prey. Although they are rarely seen by humans in the wild, their "shells" have been collected in large numbers on beaches across the globe, sticking up from the sand like

Figure 18: Female *Argonauta argo* with its eggs bulging out of its damaged shell.

little cream-colored cornucopias. The abundance of shells washed up on shores after storms have led some to speculate that the argonauts may actually be quite common in the ocean.

But the "shell" of a paper nautilus isn't a shell at all. And confusingly, the paper nautilus is only distantly related to the chambered nautilus, the only living cephalopod with a true external shell. Instead, the female paper nautilus carries a calcite egg case that protects and holds its eggs, because unlike bottom living octopuses, they dwell in the open ocean.

The female argonauts must have a way of brooding eggs in a structure that isn't a cave or a den, and they could be carrying a hefty load of precious cargo. Females can produce up to a million eggs in a lifetime, with individuals in some species found holding over 170,000 eggs at a time. The shell allows her to protect those eggs as they develop until they hatch. In addition to holding eggs, the case also helps the females stay buoyant in the open ocean. The argonaut "gulps" and traps air in the egg case, allowing it to float, not on the surface as folklore depicted, but in the water column at neutral buoyancy. It's more like Alexander the Great's bathysphere than Aristotle's sailing boat.

This thin, nearly translucent egg case plays an essential role in a female argonaut's life cycle. But one big mystery divided scientists for centuries: Where did the shell come from? In the 1800s, most scientists believed that the shell was made by another animal - that argonauts lived in them the same way that a hermit crab will go find a snail shell or a mollusk shell to live in,. Once the octopus grew too large for the shell, it would abandon the shelter and either search, steal or kill the original inhabitant for a larger shell.

JEANNE BECOMES FASCINATED WITH THE ARGONAUT

Argonauta argo, which abounds in the waters of the port of Messina, attracted Jeanne's attention. Living in the ideal place and in favorable conditions ("I had found it so far within reach of being able to make a series of observations on it, that others could never possibly have, due to the lack of those opportunities, and of those means sufficiency I saw myself provided"), Jeanne felt almost obligated to do careful research on those points that concerned the physiological conditions of the cephalopod.

Thus began for a number of years an uninterrupted series of investigations and after repeated and new attempts, combining and renewing the experiments, she finally managed to obtain "results that lead to very useful knowledge, both to elucidate of doubts about the first development of his eggs, both in order to make known many new facts that its customs." Jeanne arrived at these results introducing the method of direct observation, since the lack of actual experiments had up to then resulted in a determined controversy among marine biologists ("Such was the state of things re *Argonauta* when I realized that the lack of experiments was the only cause of such disputes, and that every-

thing had to be made clear with careful scrutiny in such a remarkable subject").

The objective of her research was to demonstrate not only that it was the mollusk that built its shell ("Determined to undertake this task I looked to my eyes the purpose of my observations, that is to assure myself that the blacksmith of the *Argonauta* shell was the cephalopod that inhabited it"), but also to ascertain the structure of the mollusk, examine its relationship with its arms and follow its evolutionary development ("In that case, knowing the structure of this mollusk should be the first of my research; the relationship of the mollusk with its arms was the second, accompanying it on its development of the egg until its entire growth was the third. But how could one make a difficult series of observations to achieve these goals?"

JEANNE'S "CAGES"

For about a decade she closely studied these "suspicious" yet "graceful" creatures. She became intimately acquainted with them, examining, experimenting and describing everything from their feeding behaviors, movements, growth, and development. Unlike her predecessors, she did not turn to dead specimens preserved in jars or shells washed up on the shore. She was determined to find a way to bring live specimens to the laboratory.

If one believes that one will make interesting discoveries on marine animals with aquaria located in rooms, gardens or in cities far from the sea, one is mistaken: one will not make any that are serious. For the anatomical part of their structure it is possible, since a few days are enough: it is not the same for the physiological part. To study the use of each organ, the phenomena that vary according to the circumstances, the places and the times, their fertilizations, constructions, reproductions, their mores and their food among other things, it certainly takes a longer period of time; it is necessary, as it were, to accompany them in all their operations, and for that reason to keep them prisoners, but in their element and in spacious cages or aquaria for small individuals. They would not live enough time in water composed in imitation of sea water, or in the sea water concentrated in aquaria located as I said above for such a series of studies. And what about the food of each species; how does one located far from the sea obtain it? I experienced this when I invented aquaria in 1832, and although I studied marine animals in sea water maintained at the desired degree of heat and I provided food that suited each species, the results were not completely successful; then I resorted to the sea. I invented cages.

According to Professeur Carmelo Maravigna, writing in the *Journal de l'Académie de Cioenia, à Catane* for December 1834 (Margollé, 1864):

Madame Power has three kinds of these devices: the first is made of glass and arranged for the conservation and study of live mollusks in a Cabinet; the second is also in glass but is provided with an external frame, which is a bit higher, that makes it possible to submerge it in the sea and to bring it up for observation; finally there is a third model, suitable for mollusks of the largest size, which can be im-

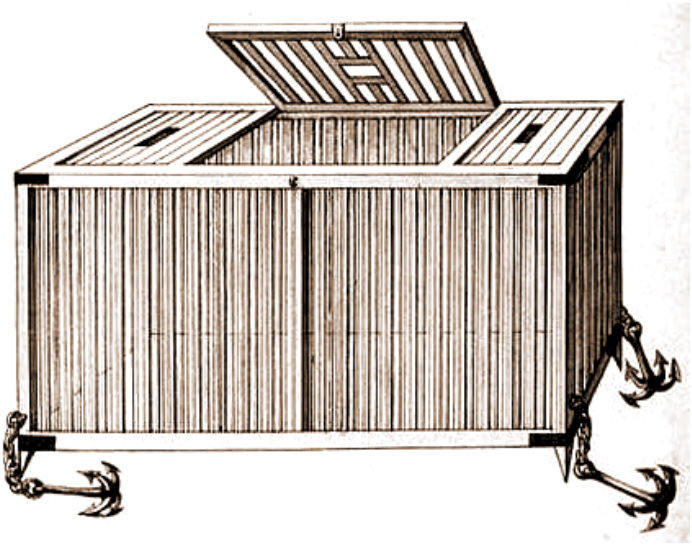

Figure 19: The third type of Jeanne's "cages."

mersed in the shallows of the sea with anchors, the upper part being sufficiently out of the water so that one can study the mollusks therein.

Except for her third type, which she described and pictured in great detail in her 1860 report (see below), we know nothing about the dimensions, shapes or construction of the first type of her cages (a glass one for use in her study of the type that we would call an aquarium today) but we do know that it had an efficient water circulation system that was based on rubber hoses pumping salt water in and out from the nearby sea. We also know very little about the construction of the second except that it involved an aquarium as well. Regarding the third type, in 1856 she described it in detail in her book, (*Observations Physiques Suis le Poulpe de L'argonauta argo, Commencées en 1832 et Terminées en 1843*.):

These cages [see Figure 19] **were 4 meters (13 feet) in length, 2 meters (6.5 feet) in height and 1 meter 40 centimeters (4.5 feet) wide. I left a space between the bars of wood so that the sea water could circulate freely without the mollusk escaping from the cage. An angle iron at each corner held the cage together. A door opened above the cage and two small openings in the door had been formed on the right and on the left. From there I could observe my animals without being seen. At each bottom angle I also had fixed an anchor to keep it firmly in the sea. I introduced into the interior of this cage seaweed, marine plants, small portions of rocks, small pebbles, millipora, venús, tritons and other shellfish mollusks.**

This was the cage she used for her studies on *Argonauta argo*. The name "cage," which she used for all of her containers, immersed or not, was very apt, however, for this one since it was definitely not an aquarium.

The following excerpt written by Richard Owen and titled "Origin of the Aquarium," is from *Cosmos*, Vol. 11, July-December 1857:

Twenty-seven years ago in 1832, Mrs. Power had come to settle on the coast of Sicily and became enthralled with observing the development and behavior of mollusks and other marine animals. It was there that shortly after her arrival she had built two aquariums: one for mollusks without shells, the other for the shell mollusks. At the bottom of these tanks was deposited sand taken from the sea, fragments of rocks to which grasses and marine plants still adhered, and branches of red coral - pink, black, etc. She also populated them with millépores, mollusks, asteri, various species of crustacea, and some small fish; and above all, the main object of her studies, her treasured *Argonauta argus*, whose mysteries she wanted to penetrate. Mrs. Power's home and her aquariums were located on the seashore; she could therefore often renew the water within which her little world lived, and she had not, therefore, had to be preoccupied with the tricky question of their cleaning, the only addition - important, it is true, though secondary - made to modern aquariums.

The *Journal du Cabinet Litteraire* de l'*Academia de Catania* issue of December 1834, *Faro* of May 1836, the *Magazine of Natural History* of February 1838 and the English *Athenaeum* of February 16, 1839, contain if not the description of the basins of Mrs. Power at least the accounts of her observations upon which the famous professors, messieurs Maravigna, Gemellaro, de Giacomo, the illustrious Owen and Charlesworht, made favorable reports. It is therefore certain that it is to our kind and learned countrywoman that the glory of the aquarium was restored. But at the same time she had a happier idea: that of marine cages, called in Italy gabbiolina alla Power - in England, Power Cages - established by her in the lazaretto of Messina on a

very accessible shallow area, with special authorization by the Neapolitan government, and remarkable by its purity in the highest degree and extraordinary transparency of its waters. The cage was circumscribed by bars, spaced enough apart so that the water and the small animals could move around in them without difficulty but narrow enough to restrain the creatures that had been imprisoned there in order to extract their secrets from them.

Rocks were first introduced, with the algae, corals and shells that adhered to them, then argonauts, asteri, sea urchins, fish, etc. Occupying the center portion of the cage, the animals continued their development much better than in the narrow aquariums. Madame Power, their guardian and "mother," twice daily brought them the food appropriate to their needs. A sort of platform or pulpit, raised 50 centimeters [about 20 inches] above the water level, dominated the cage. The cage was covered by a hatch which was raised at will and in which two openings were arranged on the right or on the left, which allowed her to see without being seen. It was there Madame Powers sat for long hours, observing and writing in her journal her observations, noting with great care what she saw forming or performing before her his eyes.

There she saw the argonaut's octopus build or repair her shell; the nodiferous triton, which had been guillotined, to take a new head; it was there that she initiated herself to the entirely unknown habits of *cerithium, coenus, murex, fusus, bulla, pinna, asteria, octopus vulgaris*, and *powerii*, and a large number of other marine animals. Each of our readers will be able to see, in the library of the *Jardin des Plantes*, in the interesting pamphlet entitled *Physical observations on the octopus of argonauta argo*, the descriptions and the drawings of the beautiful cages that we could only sketch.

Let's say a few words about a third portable aquarium designed by Madame Power that served her well in her studies of small mollusks. She took a cylinder of clay and split it along its length so as to transform it into two semi-cylindrical vases open at their extremities. She took a board a little wider and longer than the semi-cylindrical vase and immersed it in the sea long enough for it to be to covered with moss, algae and small shells. It was attached by circular metal strips to the board, its rectangular base open at the bottom and the convex part closed at the top. The middle strip bore a ring, and a rope passed through it served to carry and suspend the little apparatus in the sea or in the cage where small animals were introduced

Figure 20: The Cittadella, the remains of the old fort nearby to where Jeanne lived.

and studied. The openings of the ends of the small cylinder were closed by a framework that was sufficiently open to admit water without allowing the prisoners to escape.

We know from this account that the second type mentioned by Maravigna, "…of glass, for small mollusks, protected by an external cage of bars …," was abandoned by Jeanne and replaced by the fourth one described above by Owen as a "… third portable aquarium..." A glass aquarium would have to be small and would be more difficult to immerse. Jeanne also bemoaned the fact that it was too narrow for her purposes.

In 1836 she wrote in the *Atti dell' Accademia Gioenia di Scienze Naturali*:

For this object I thought of cages which were constructed under my direction; they were 8 palms long, and 4 palms wide with a convenient interval between the bars [she used about 1/3 inch], which allowed the water to enter freely when placed in the sea, whilst the escape of the animal was prevented. I placed the cages in a shallow bottom in the sea near our Cittadella [a fort in Messina] in a spot where I could examine them without disturbance.

With regard to the palm, it was a unit of length dating back to ancient Egypt, originally based on the width of the human palm and then variously standardized; in Sicily at the time it was roughly about 9.5 inches (Palaiseau, 1816). Thus her "8 palms long, and 4 palms wide" was equivalent to 6.3 feet long, and 3.2 feet wide. These dimensions were used in her reports written in Italian and in English. However, in her reports written in French, the dimensions were given in meters equivalent to 13 feet in length, 6.5 feet in height and 4.5 feet wide. This discrepancy suggests that either there were two identical cages differing only in size or else Jeanne made a mistake in the unit conversions. The first is the simplest explanation but a cage 13 feet long does seem overly large for the Argonauts and would be more difficult to handle. However, since she had a minimal (or no) formal education, the second is also plausible, but how then could this happen with James helping her and even translating her Italian papers into English? I leave the explanation to readers of this essay.

USING HER CAGES

In 1832, Jeanne first began to use her cages. In the cages that were immersed into the sea near the Cittadella on the peninsula of S. Raineri that encloses the port of Messina, as well as in those that were kept at home, Jeanne housed and bred the mollusks for her experiments ("There I introduced a quantity of living Argonauts, taking care to prepare them every two or three days for the necessary food with naked and hard shellfish, with the headless conchifera, venus [a bivalve], etc. and what I collected with a rake (oysters)."

In September of 1833, Jeanne conducted multiple experiments before coming up with the idea to

Figure 21: Giuseppe Saverio Poli (1746-1825).

break the shell and observe the octopuses' behavior. She punctured pieces of the shell of an individual and placed fragments from other Argonaut shells into the cage. She watched for three to six hour increments, patience wearing thin, until right before her eyes she saw one Argonaut repair its shell with the special membranes on its front two arms - the ones rumored to be used as sail. It was proof that the paper nautilus did create the egg case itself. She noted how the membranes on the two dorsal arms, which secrete the calcite, moved over the opaque case with gentle craftsmanship. "Nobody before me… has seen how the *Argonauta* appears with its membranes extended on its shell," she wrote. Close studies on the tissue of the thin, membranous webs have shown that they have calcium inclusions that are not found anywhere else on the female Argonauts.

Until the late 18th century, the study of mollusks was based largely on shells. Very little research or published information existed about molluskan anatomy and soft tissues. Giuseppe Saverio Poli (1746-1825), recognized by many as the Father of Malacology, changed this with his monumental publication, "Testacea utriusque Siciliae eorumque historia et anatome" (1791-1827). Returning to Jeanne's comments,

Encouraged by the distinguished Carmelo Maravigna, the most learned Canonico Alessi and other friends, to present to this illustrious Academy [i.e., l'Accademia Gioenia di Catania, named after the catanese naturalist Giuseppe Gioeni d'Angiò] the shell of the Argonauta that I patiently observed to learn the way the animal used to build it, I was made to deduce in a different way to what the famous Poli had done that the Conchiglia belongs to the octopus without any doubt. It will be seen the animal repaired the faults that I made in the Conchiglia, which has two different aspects, the whitest part of the two shells is the most distant of the exhalation and the new formation, and the shell marked N.2 shows the way I worked. It is therefore it pleases me to present this observation of mine to the Academy as a sign of respect in which I hold it. At the present time I am dealing with arranging some objects of Natural History to make a gift to it.

So wrote Jeanne in 1835 to the General Secretary of the Gioenia Academy of Catania, to whom she had already the previous year sent the results of her early research on the *Argonauta argo*, research that was presented ("read") in the session of December 1834 by Prof. Carmelo Maravigna. In November 1835 Maravigna recalled the contacts between Jeanne and the Gioenia Academy:

Of these observations and experiences Madame Power wrote an account of some early research that she asked me to present to Gioenia and in fact it took place in the ordinary session of September 1835. [...] This account was read in the session that month and likewise (I think) included in the Atti Gioenti [Acts of Gioenia] of November 26, 1835, when the members were read this second

Figure 22: ***Argonauta argos*****.**

compendiosa and valuable research [the research tended to prove that the octopus that resides in Argonauta is the true shellfish of the Conchiglia, and also its builder] and Jeanne was "Unanimously proclaimed" a Corresponding Member of the Accademia Gioenia di Catania.

Note that in 1835, women were not members of scientific societies so this was quite an honor for her.

In 1836, in a report that summarized her experiments began many years prior and which was read in the Academy session of November 26, Jeanne presented the picture of the state of zoological knowledge on the *Argonaut Argo* based on her research and, importantly, she explained the method she followed in her experiments and the physiological consequences that derived from them. Jeanne traced the extraordinary experiences that allowed her to shed light, through observation and experimentation, on the mollusk that continued to make naturalists disagree, divided between supporters of her constructive theory versus the parasitic nature hypothesis ("It has been the subject of great controversy for the naturalists to determine with confidence, whether the octopus of the Argonauta was the blacksmith of the shell or if the situation was similar to that of the hermit crab moving in after the true inhabitant was chased away, devoured, or naturally died").

Jeanne's research on *Argonauta argo* continued to be encouraged and supported by her naturalist friends:

The distinguished Prof. Carmelo Maravigna, Prof. Anastasio Cocco, and Prof. Carlo Gemmellaro, encouraged me to push ahead with my research, and having been honored by this illustrious academy of the title of corresponding correspondent, I have been more and more encouraged that my research would be useful. Professor Carmelo Maravigna expressed his admiration to Jeanne: I was amazed by her sagacity and patience, and of the unexpected results of her new observations and discoveries [...] but these virtues bore fruit to other discoveries, and who knows how many others there will be.

In the following months Jeanne expanded her field of research and prepared two more accounts, which she presented to the Gioenia Academy one on the reproduction of the testaceous shells and another on the fossils she found in the area of Capo Milazzo. As Maravigna wrote in 1837:

Madame Power does not content herself with having demonstrated with ingenious experiments and observations that the Mollusk that ordinarily one finds nested in the Argonauta Argo shell is the true blacksmith, not satisfied with the honors received for the reproductions obtained from the limbs cut off from the mollusk of the triton nodiferum, the murex trunculus, and other similar mollusks, in this beautiful labor she offers us a catalog of the fossils she found at Capo di Milazzo. It was a very precious travail because it was our first introduction to some of the fossils belonging to our island.

SO WHERE'S THE MALE?

Even today there is much that we do not know about the Argonaut, and its mating habits are no exception. Argonauts exhibit extreme sexual dimorphism in size and lifespan. Females grow up to 4 inches and make shells up to 12 inches, while males rarely surpass ¾ of an inch. The males only mate once in their short lifetime, whereas the females are capable of having offspring many times over the course of their lives. In addition, the females have been known since ancient times, while the males were only described in the late 1800s. What we do know is that when the male and female hook up, the male leaves something behind, other than sperm, of course. Specifically, it's a specially adapted arm called a hectocotylus, A hectocotylus (plural: hectocotyli) is one of the arms of male cephalopods that is specialized to

store and transfer spermatophores to the female. For fertilization, the arm is inserted into the female's mantle cavity and then becomes detached from the male (see Figure 23).

The hectocotyl arm was first described in Aristotle's biological works. Although Aristotle knew of its use in mating, he was doubtful that a tentacle could deliver sperm. The name hectocotylus was devised by Georges Cuvier (1769-1832), who first found one embedded in the mantle of a female Argonaut. Supposing it to be a parasitic worm, in 1829 Cuvier gave it the binomial name, *Hectocotyle octopodis*. While Villepreux-Power was never able to directly study male Argonauts, she observed hectocotyli during her experiments. She believed that these wriggling appendages were part of the Argonaut reproductive process, but she was rebuffed by the (mostly male) naturalists of her day who, following Cuvier, held that they were parasitic worms.

JEANNE FINALLY RECEIVES SOME POPULAR RECOGNITION

Meanwhile, Jeanne's research on *Argonauta argo* began to be mentioned in Europe by other scholars in their reports. Between 1836 and 1837, some Sicilian periodicals of wider dissemination published her results, such as *Il Faro* (Messina) and the *Passatempo per le Dame* (Palermo).These observations of the "illustrious naturalist" were also published in the twelfth issue of the newspaper *Gioenio di Catania*, where an account was given by Prof. Carmelo Maravigna **"as her achievements, known by a few scholars of the island, and much less among women, deserved a brief mention in this newspaper to make it better known; that in the end, beyond the satisfaction of the spirit, which remains satisfied after the discovery of a truth, no other reward is obtained from us with so many painful trials, than a bit of praise."**

Meanwhile, after the third account of her observations on the octopus of the Argonaut written by "our colleague Madame Power" that was presented at the Gioenia Academy on December 22, 1836 by Prof. Carlo Gemmellaro, the following year Jeanne sent the results of her observations, together with some specimens of mollusks, to the *Zoological Society of London*, but her conclusions did not convince some marine biologists, such as Henri-Marie Ducrotay de Blainville (1777-1850), a French zoologist and anatomist [He was the taxonomic authority of numerous zoological species, extinct and extant, including the eponymous Blainville's beaked whale, *Mesoplodon densirostria* and in 1822 coined the term "paleontology"] who supported the thesis of parasitism of *Argonauta argo* and who was not very convinced either by the experiments made later by the famous French malacologist, Sander Rang (1793-1844) in the port of Algiers, that also confirmed those of Jeanne.

Regarding Rang, Jeanne related it in detail in her book of 1856 and taken again in that of 1860:

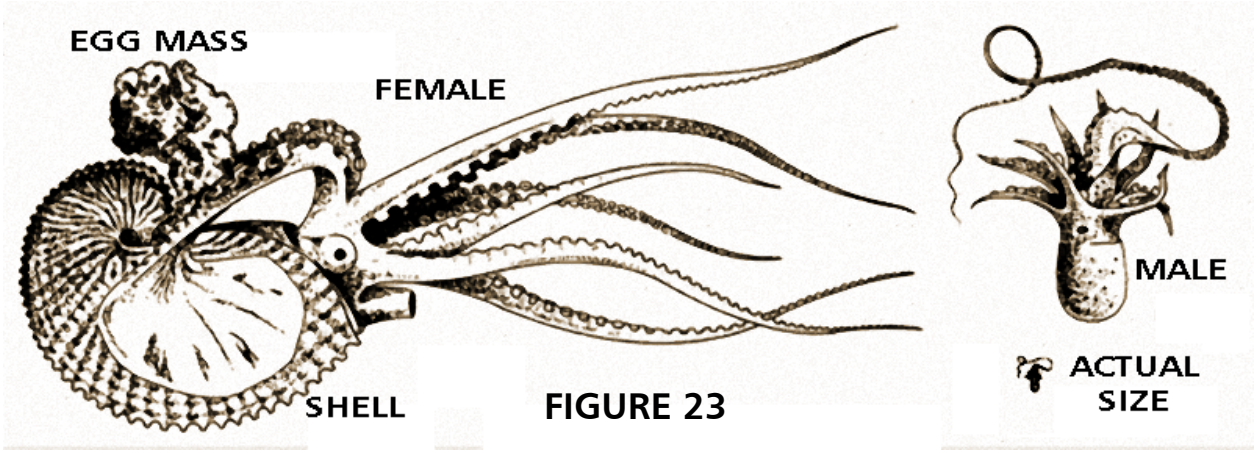

FIGURE 23

Figure 24:
Henri-Marie Ducrotay de Blainville
(1777-1850).

Monsieur le Chevalier Alban de Gasquet, captain of a frigate, having been at Messina at the beginning of 1835, came to see me several times, accompanied by the officers of his frigate. Having informed him of my discoveries concerning the Argonauta, he found them very interesting, and told me that I should send them to the Institute of Paris; that he had a friend, M. Rang, an officer in the Royal Marine Corps, who would be happy to present them on my behalf to the Institute. I gave him a copy in Italian, written in my own hand, accompanied by a letter addressed to M. Rang, leaving Mr. Rang and M. de Gasquet ignorant of the contents of the said memorial. was read in 1834 at the Gioenia Academy of Catania, as can be seen from the newspapers cited below.

Shortly after, I received notice from M. de Gasquet that my memoir and my letter had been personally delivered to M. Rang. Having received no answer from M. Rang, although a long time had elapsed, I wrote him again; he kept a stubborn silence. Finding myself in London in April 1837, I learned that Mr. Rang, abusing the confidence I had in him, and taking advantage of my observations, had written a note on the Argonauta Argo dated 1837, that is to say, three years after my publications in Catania, and two years after my sending him my memoir.

M. Rang claims to have discovered in 1837 the use of the octopus membranes of the Argonauta Argo, a discovery I had already made in 1833 and which had been read in 1834 at the Gioenia Academy of Catania, and on which the professor C. Maravigna had made a report inserted in the Journal of the Literary Cabinet of the Gioenia Academy of Catania, in December 1834. Another report was again made in the same journal by professors Ch. Gemmeliaro and di Giacomo.

It is clear that Mr. Rang did not know the use of the aforesaid membranes, since he does not say that they are used for the manufacture and repair of the shell. He claims that the membrane serves only to maintain the shell so that it does not escape the octopus, while it serves, as I say in my memoir, in the manufacture and repair of the broken shell. The octopus swims with the membranous arms within the shell or on the shell, according to its whim. It swims, the end of the membranes applied on the turns of the shell, and when the sea is calm and a light wind swells them, we see sailing his small boat.

I will not have fun criticizing M. Rang's commentary; I think, moreover, that this would be a perfectly useless task for all the studies of M. Rang do not even have the shadow of probability; and though he had in his hands, as he says himself, the previous observations which I had made, he has not succeeded in giving to the public studies that deserves the slightest merit; however, I will allow myself a few observations on the serious mistakes that exist in his commentary.

Back in 1837 , Jeanne was not shy in commenting upon Rang's work and we see here a different side of her (Power, 1937):

Not only are his observations erroneous, but his drawings are incorrect, and the manner in which they are presented demonstrates perfectly that M. Rang did not study with the thoroughness and perseverance that is necessary to arrive at an exact knowledge of the mores and habits of this animal, but that is what M. Rang wants us to believe. He did not succeed in his observations, and to arrive at such a result, it was not necessary to take a patronizing tone, for although my studies were anterior, they are serious, exact, and animal, as I present it, has the merit of the natural. I reproduce it as I have seen it, as it exists, and as any observer will see it. [...] Finally, M. Rang has greatly expanded on this subject; he talked a lot without saying anything precisely.

The "Battle of the Argonaut" had now begun and would continue between de Blainville in Paris and Owen in London, where Jeanne's theses would eventually prevail over those of parasitism.

RICHARD OWEN

Since Richard Owen was an important figure in Jeanne's scientific life, it is important to introduce him here in some detail.

Sir Richard Owen (1804-1892) was a British anatomist and paleontologist who is remembered for his contributions to the study of fossil animals, especially dinosaurs. He was the first to recognize them as different from today's reptiles; in 1842 he classified them in a group he called Dinosauria. Owen was also noted for his strong opposition to the views of Charles Darwin.

Owen was educated at Lancaster Grammar School and was apprenticed in 1820 to a group of Lancaster surgeons. In 1824 he went to Edinburgh to continue medical training, but in 1825 he transferred to St. Bartholomew's Hospital in London. He was admitted to the Royal College of Surgeons of England, where he was engaged as curator of the Hun-

Figure 25: Paul Charles Léonard Alexandre Rang des Adrets, in publications called Sander Rang, (1793-1844) with his wife, Margueritt.

terian Collections (made by John Hunter, the renowned anatomist) and set up in medical practice. In 1830 he met Georges Cuvier, a celebrated French paleontologist, and the following year visited him in Paris, where he studied specimens in the National Museum of Natural History.

Elected a Fellow of the Royal Society in 1834, in 1836 Owen became Hunterian professor at the Royal College of Surgeons and in 1837 its professor of anatomy and physiology, as well as Fullerian professor of comparative anatomy and physiology at the Royal Institution. Leaving medical practice and devoting himself to research, he was appointed superintendent of the natural history departments of the British Museum in 1856. From then until his retirement in 1884 he was largely occupied with the development of the British Museum (Natural History) in South Kensington, London. On retirement he was created a knight of the Order of the Bath.

Among Owen's earliest publications were the "Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy Contained in the Museum of the Royal College of Surgeons in London" (1833), which enabled him to acquire a considerable knowledge of comparative anatomy. His Memoir on the Pearly Nautilus (1832) was a classic, and he became a highly respected anatomist.

By 1859, the year of the publication of Charles Darwin's *Origin of Species*, however, Owen's judgment was muddied by his sense that his own preeminence in biology was about to be lost, and he set about to discredit Darwin, who had been a good friend and colleague for 20 years. Owen wrote a very long anonymous review of the book (*The Edinburgh Review*, 1860), on which Darwin commented:

It is extremely malignant, clever, and I fear will be very damaging…It requires much study to appreciate all the bitter spite of many of the remarks against me…He misquotes some passages, altering words within inverted commas…

As Darwin's thesis began to become more accepted in the scientific community, Owen shifted his position somewhat; although he denied Darwinian doctrine, he admitted the accuracy of its basis, claiming to have been the first to have pointed out the truth of the principle on which it was founded.

Unfortunately, Owen developed a reputation for controversy, was accused of stealing other scientists' specimens and undermining people by writing anonymous reviews of their work while supporting them in public. Owen's contemporary and rival Gideon Mantell whose attempts to reconstruct the structure and life of *Iguanodon* began the scientific study of dinosaurs, claimed it was "a pity a man so talented should be so dastardly and envious."

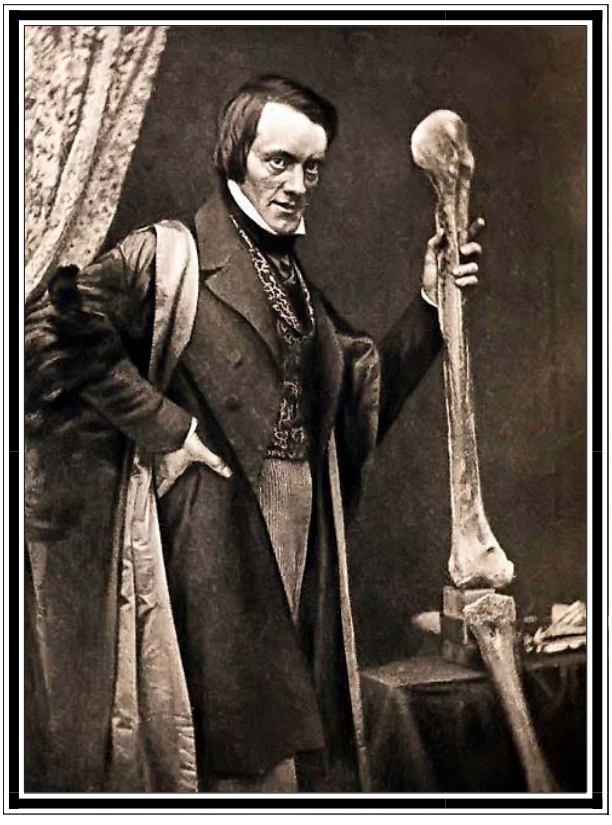

Figure 26: Richard Owen (1804-1892) holding a Moa bone.

MISFORTUNE STRIKES THE POWERS

In 1838, at the time of the publication of the royal decree of Privativa, the "Power & Unett" company was dissolved by mutual agreement between the two partners, the factory already having suspended its activity. On August 31, 1837 Power had communicated to the Court of Commerce the decision, taken jointly with his partner James Robinson Unett, to dissolve the business and to withdraw from Sicily. All the reasons for this decision are not known but on February 22, 1838 Jeannette informed prof. Antonio Di Giacomo, General Secretary of the Gioenia Academy, that she had just returned to Messina with her husband who, on the advice of London doctors, must spend a period of convalescence, after a "serious illness" contracted by her husband, for the healing of which no remedy was found by the London doctors.

In autumn of 1838, the Powers departed from Messina to move to England, leaving behind several objects listed in a notation on September 28, 1837 and kept in 16 closed and nailed cases to be sent to London. At the end of November, James Power asked the Matthey & Oates shipping firm of Messina to send to him in London "all the effects left by Mrs. Power in the hands of Mr. Matthey." At the beginning of the following year, 16 boxes containing books, table cloths, stuff, fossil shells, three pieces of marble, a monetary and an ancient column of agate were loaded on the brig Bramley, but they would never arrive in London. The brig sank at the bottom of the sea of Brittany along with most of the collections that Jeanne had with so much effort extracted from the sea of Sicily. Her Cabinet of natural sciences "by choice and rarity of species" was considered by experts "among the richest and most singular in Europe." The loss was enormous.

Thus, alternating returns to Sicily with departures to England, Jeanne in the spring of 1838 made one of her trips to the island where she wrote her *Itinerario della Sicilia* (Itinerary of Sicily) and then the *Guida per la Sicilia* (Guide for Sicily)." On May 17, having just returned to Messina ("very troubled by the Itinerario della Sicilia book, advised Prof. Di Giacomo that she will leave for England "no later than early August." Meanwhile, between spring and summer, her studies and research resume in Messina ("I'm working, and I'm almost at the end of three other accounts touching upon natural history"). And, being "in urgent need to consult for further travails" the memory on *Argonauta argo* presented by her two years earlier and published in the *Atti Accademia Gioenia*, on July 26 asks the general secretary to send her a copy of the volume containing her accounts of which she has no copy or to return the original manuscripts for a "short time."

A LONDON TRIP

In the early months of 1839 Jeanne was definitely in London and resided in Great Ormond Street. Here on January 26 she received a visit from Richard Owen who could now directly see with his own eyes her collections of fossils, shells and mollusks,

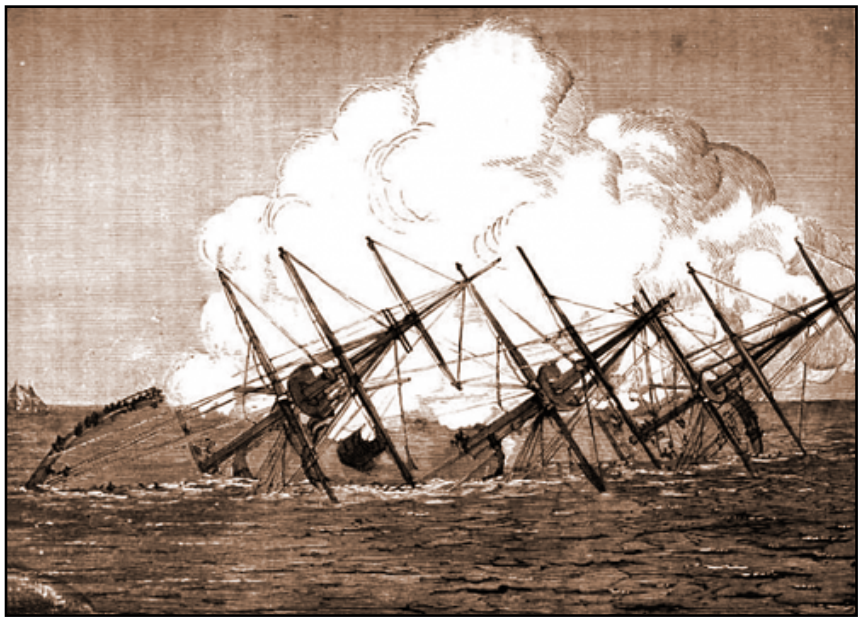

Figure 27: Most of Jeanne's collections sank with the brig Bramley in 1838.

but also and above all the specimens of *Argonauta argo* with the shell specially broken by Jeanne for her experiments, visible in three different stages of reconstruction. Owen's wife describes in her diary in 1839 their meeting with Jeanne:

January 26th. Richard and I to Great Ormond Street, where Madame Power showed us her boxes of fossils shells &c., and some mollusca in bottles and, above all, the argonaut shells with the fractures made by her in her experiments, beautifully filled up and mended: three specimens in different stages of reconstruction, the first filled up with a substance like the lining membrane of a boiled egg. This was done in about ten minutes after the piece was cut by Madame Power; the more perfect restorations had the corrugations formed to match the rest.

On February 2, Owen returned to Jeanne's house, taking away three containers of Argonauts.

February 2nd. Richard to Madame Power's and brought away three bottles full of argonauts. A beautiful collection! One of them has the sail spread back over the shell, the suckers on the points. Madame Power says that if we count the suckers they will be found to correspond with the number of points. This, with other circumstances, makes the question, I think, not whether the poulpe belongs to the shell, but how it has come to pass that, after so many have debated on the subject, Madame P. has been the first to discover these things.

On February 12 1839, during a session of the *Zoological Society of London*, prof. Richard Owen presented Jeanne's observations and research on *Argonauta argo*, of which she also showed some specimens she brought from Sicily. That meeting of the Zoological Society marked the highest recognition of the scientific world towards the theses of Jeanne that Blainville still challenged. And on March 22, 1839, with a letter sent from London to the members of the Gioenia Academy in Catania, she informs them of the success of her London mission. The success was underlined not only by the "unanimous" applause of all persuaded" members of her thesis, "namely that the octopus of *Argonauta* was the true fabricator of the shell and who has the power to redo missing parts," but also from the proposal made by various members to accept Jeanne as a Corresponding Member, to publish a memoir on the reproduction of marine specimens in the *Magazine of Natural History*, as well as the appreciation of "many of prominent scientists in different branches of Natural History who visit her and encourage her to continue her studies on the testacei and molluscs."

In 1839, while Jeanne was abroad, her *Itinerario della Sicilia* was printed in Messina, covering all branches of natural history and several of its historical sites. *The Passatempo per la Dame* deemed that it would not only be a guide to foreign naturalists, saving them both time and money, but also very useful in the education of youth.

Figure 28: Jeanne's Guide to Sicily.

BACK IN MESSINA

At the end of 1839 Jeanne was in Messina and completed a further series of experiments on *Argonauta argo* that January 30, 1840 was described in a letter to Richard Owen ("Experiments and Observations on *Argonauta argo* made during the months of October, November and December, 1839"). In addition to the letter and the specimens of mollusks, she also sent another more detailed account ("Continuation of Observations on the Polypus of *Argonauta* argo, in 1839") with three drawings of *Argonauta argo* in different phases. On 4 April 1840 she also sent to the General Secretary of the *Gioenia Academy of Catania* an account that was the continuation of the previous observations on *Argonauta argo*. To the new account Jeanne could not, however, attach specimens of the mollusk referred to in the text because they had already been sent to Professor Owen on January 30 with the letter concerning the observations so that he could refute in the *Zoological Society of London* the still contrary opinion of Blainville. Although Jeanne's observations had the same effect as when Sander Rang repeated them in Algiers on behalf of Blainville himself, the latter continued to hold the opposite opinion but was well refuted by Owen in the Atheneum with arguments that shocked the Blainville, who was unable to refute them. Meanwhile, in 1840 the material dedicated to *Argonauta argo* in the *Penny Cyclopaedia* was based almost exclusively on passages of Jeanne's texts, which were printed in full. It also contained detailed descriptions of both the invention of her cages, her methods, research and. Also in the spring of 1840, after completing the continuation of her *Argonauta argo* observations, Jeanne had other research in progress, the results of which she intended to send to the Gioenia Academy.

In this same year she proposed to reprint, in a much improved, correct and enhanced edition, her Itinerary for Sicily printed the previous year that contained some "defects" both because of haste and because, in her absence, "people unaware of Natural History [...] added, changed and interpreted her text incorrectly. At that time, while Jeanne was in Messina, her husband was in England and on April 25, 1840, James Power wrote to Richard Owen from London to announce not only the arrival of a letter from his wife for him from Sicily with some specimens *Argonauta argo f*or the *Zoological Society,* but also the publication of an article by Blainville that seems to have finally been convinced of Jeanne's theses.

THE YEARS 1841-1842

Of the following period little is known, but in the first days of 1841 Jeanne was in Messina and in the country house that was home to the Bolognese Domenico Galvani (Jeanne remembered him for his generosity and kindness) where she examined a conch shell found in the outskirts of the city. This period seems, however, to be characterized by personal or perhaps health problems. On January 29, 1841 at one o'clock in the morning in her home and in a hurry, "Lady Donna Giovanna Villepreux-Power, daughter of Don Pietro, wife of Mr. Don Giacomo Power, born in Juilac and domiciled in this City of Messina, in the village of Portalegni in the Gravidelle district, in the presence of the notary Perciabosco and four others witnessed her public testament to leave all her goods to her husband."

In the summer of 1842, the observations Jeanne made at the end of 1839 were printed in Palermo and then sent to Owen and to the Gioenia Acade-

Figure 29: Although did not discover the male *Argonauta argos*, Jeanne did discover the hectocotyl arm and concluded that it was part of the reproductive process and not a parasite.

my. Also in 1842 Jeanne published her *Guide for Sicily* in Naples where, in addition to the more traditional information and statistics useful for foreign travelers, it also offered a Natural History column and catalogs describing subjects of interest in Conchiology, Tetology, Ornithology, Botany, etc. found in Sicily. This Guide, which can be considered her last "gift" to the island where she had produced her extraordinary scientific findings, also marked Jeanne's departure from Sicily. She had arrived in 1818 as a "Cinderella" and now was a scientist known in European scientific circles, as well as Sicily.

THE YEARS 1844-1867

After leaving Sicily and after a stay in London, Jeanne and her husband settled in Paris where James, after recovering from his mysterious illness, became the first representative for France of the *Société du Télégraphe Sous Marin sous la Manche entre la France et l'Angleterre* (Underwater Channel Telegraph Society between France and England); the first submarine cable will come into operation on September 25 1851. Afterwards he was Secretary of the *Compagnie du télégraphe électrique méditerranéen* (Mediterranean Electric Telegraph Company), which in 1856 attempted unsuccessfully to link France and Algeria.

For Jeanne the departure from Messina marked the end of her experiments and her researches: "My untimely departure from Messina forced me to suspend the work that I was fond of." In the 1850s and 1860s and far from the sea, she published in Paris her previous research, which she dedicated to Owen, re-proposing his "Observations physiques sur le poulpe de l'Argonauta Argo," began in 1832 and ending in 1843, and collecting his "Observations et expériences physiques sur la Bulla Lignaria, the Astérias, the Octopus vulgaris et la Pinna nobilis," together with her essays on the marine specimens, Crustacé Poweri, on martens and on turtles in addition to those on *Argonauta argo* and a plan to study marine animals. Even after her departure from Messina, Jeanne wanted to continue to publish her studies, but the loss of her notes in the move from Sicily made this project unattainable: "After publicizing accounts on *Argonauta argo* and other marine animals, I was willing to continue my publications; unfortunately, in the confusion of packaging, when I left Messina my manuscripts went astray but it is only today that I managed to find them and extract the following observations." Thus, as Claude Arnal wrote, "Established in Paris, the naturalist no longer seemed to have had any particular scientific activities, except the publication of her works prior to 1856-60." In later years, however, her scientific interests seem to have changed, but not dormant. Jeanne shifted her scientific observations from the sea to the sky and in 1867 she published her observations on meteorites.

EULOGY

Jeanne Villepreux-Power was a member of many learned societies in Sicily and Europe: two in England, one in Belgium, four in France and eight in Sicily. These integrations were not insignificant as they were not allowed in major institutions like the Academy of Sciences or the Royal Society. They remained rare, as in the case of La Société Polymathique du Morbihan, where only Villepreux-Power and the poetess Elisa Mercoeur (elected correspondent in 1827) appeared in the

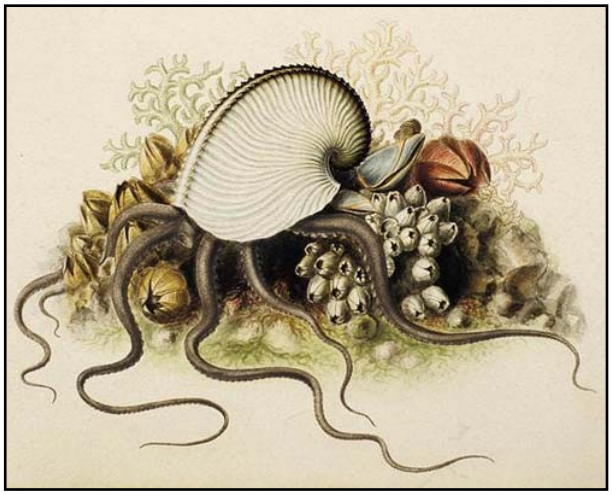

Figure 30: Jeanne was also an excellent illustrator. This is the only surviving example of her work.

list of members. She was accepted at La Société des sciences médicales et naturelles de Bruxelles, composed only of male doctors. Her status as a foreigner certainly facilitated these elections but they were always special and therefore never really legal; she was always a corresponding or honorary member and never a titular one. Jeanne Villepreux-Power was not an influential personality in the scientific institutions of her time, and if she belonged to some leading societies in London and Catania, the rules that relegated women scientists to the periphery of academies, societies and educational institutions were not completely overturned here.

Moreover, such a career was certainly not built without specific difficulties. She sometimes justifies herself in not devoting herself solely to domestic activities. In 1837 she writes:

Having for several years devoting myself to the natural sciences the hours that remained to me free of my domestic affairs (few are indeed the moments of study that people of my status and my sex can enjoy), while I was preparing a few marine objects for my little cabinet, the octopus of the Argonaute fixed my attention more than anything else [...].

1883, Matilda Joslyn Gage, analyzing the inventions made by women, those of Ipazia, Maria Agnesi, and Caroline Herschel, addressed the name of Jeanne Power as

[…One of the most eminent naturalists of the century. It was used by her in making curious scientific discoveries. The value of the aquarium to marine zoölogy is incalculable. Not only can rare species from the Indian, Artic, and Pacific oceans be brought into close comparison, but the subject of embryology can be studied, and the great Darwinian problems of evolution and permanence of type are likely to be solved by its instrumentality.]

Yet, despite the official acknowledgments and prestigious appreciations by some scholars for her research in many other areas of the natural sciences (from oceanography to astronomy, from zoology to botany, etc.), Jeanne Villepreux-Power has been almost forgotten both in the last period of her life and especially after her death. A long veil of silence and oblivion would fall for almost a century and a half upon this "Cinderella" who turned into a "femme savante" in the world of natural sciences that strongly leaned to the male, and who became a pioneer of marine biology and often the first woman to be admitted as a member of academies and other scientific institutions.

In Paris the Powers lived for about 25 years and it was during this period that, while James established himself in new activities, Jeanne disappeared as a scientist, observer attentive to natural phenomena and queen of oceanography: in her place another Jeanne took over, whose main role, if not unique, was now that of wife, a woman en-

Figure 31: *Jeanne Villepreux Power* by Anne-Lan. She and the artist were born in the same Department of Corrèze, France.

gaged in managing the affairs of the house and taking care of daily interests and abandoning her studies and research. Jeanne died at the age of 76, on January 25, 1871 in her native Juillac where she had taken refuge when the Frankish Prussian war had made life difficult in Paris. A year later, on January 9, 1872, James died in Paris in the house of Rue de l'Université 58 where he had spent together with his wife the last years of their long life together. It was an extraordinary couple who had lived in symbiosis since that distant day of 1818 in which their marriage was celebrated.

Thanks to this symbiosis in the 25 years of residence in Messina, Jeanne Villepreux became a true scientist thanks to her personal talents and thanks also to moral support material of her husband. To his wife, James certainly gave support from the human point of view at a time when women were limited and left on the margins of scientific studies. To have alongside her a husband who allowed her to follow her inclinations and passions undoubtedly allowed Jeanne to devote herself without problems to her research. To his wife, who had no personal income of any kind, James guaranteed financial support for her research and for her travels in a period when traveling was exceedingly expensive. Since Jeanne's research required some engineering training, James was the first one she turned to for help. Besides his expertise in commerce and finance, he had designed, had built and operated a sulfuric acid factory where glass containers were in everyday use. Furthermore, he collaborated in the publication of his wife's research by translating some of her scientific papers into English, as Jeanne herself remembered in gratitude.

In 1837, in an article published in the *Passatempo per le Dame* (*Pastime for Women*), in addition to indicating Jeanne as "an example that can serve as a model for all mothers of family," Alessio Scigliani also emphasized the extraordinary talents of her husband James, calling him "a man who was of a very sweet character and of the most amiable manners who should be honored as his embellished fame was united with the great merit of having seconded the genius of his wife for the natural sciences."

As Claude Arnal, the French authority on Jeanne Villepreux-Power wrote recently,

[…it would be unjust to close the eulogy of this exceptional woman without remembering that all this would have been impossible without the companion of his life, this Englishman, he also exceptional, who had the great merit of understanding his genius wife for the natural sciences and to love her enough to bear the consequences. Thanks, James!"

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Jeanne Villepreux-Power and the Myth of the Invention of the Aquarium

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, February 16, 2019)

Jeanne Villepreux-Power was on born on Sept. 25, 1794 in the small town of Juillac in Central France. She is best known for her research on the paper nautilus, *Argonauta argo*, a cephalopod that resembles members of the genus *Octopus* in most respects.

Jeanne Villepreux-Power's mother was a dressmaker who knew how to read and write and who taught her daughter. Jeanne moved to Paris at age 17 and served as an assistant to a society dressmaker. In 1816 she crafted a wedding gown for Princess Caroline, the eldest daughter of Francis I of the Two Sicilies, for her marriage to Charles-Ferdinand de Bourbon, the nephew of Louis XVIII of France. This work brought her fame and the attention of the successful merchant, James Power, whom she married in 1818 in Messina, Sicily. The couple remained in Sicily for about 25 years, and during that time Jeanne taught herself natural history and described the flora and fauna of the island.

Between 1832 and 1843 Jeanne closely studied the paper nautilus, *Argonauta argo*. In 1832 she began to use what she called "cages" to aid her observations and experiments on the species. Using these devices she became the first to discover that *Argonauta argo* produces its own shell rather than obtaining the shell from another organism, which was a prominent competing belief at the time. She also made other discoveries involving *Argonauta argo and also other mollusks.*

In 1839 Jeanne published *Observations et expériences physiques sur plusieurs animaux marins et terrestres* ("Physical Observations and Experiments on Several Marine and Terrestrial Animals"), which recorded her work with *Argonauta argo* and other animals. In 1842 she published *Guida per la Sicilia* ("Guide to Sicily"), a comprehensive survey of the island's environment. The following year she and her husband moved from Sicily to new residences in London and Paris. During the transit a major part of her collections, records and other scientific materials was lost after the ship that carried those items sank. Although she continued to write after 1843, she discontinued her research.

Jeanne Villepreux-Power belonged to more than a dozen academies, including the *London Zoological Society* and the *Atti dell'Accademia Gioenia di Scienze Naturali* in Catania (Sicily), something unheard of at that time for a woman. In 1858 the British anatomist and paleontologist Richard Owen referred to Villepreux-Power as the "Mother of Aquariophily" and in 1997 a large crater on the surface of Venus was named for her.

DID JEANNE VILLEPREUX-POWER INVENT THE AQUARIUM?

Jeanne Villepreux-Power was a remarkable woman. In *The Penny Cyclopaedia* of 1840, the following appeared after the description of her research work on *Argonauta argo*:

Now, though there may appear in the account of these experiments evidence of their having been drawn up by one not deeply versed in zoology, there is an air of truth and sincerity about them that makes them to us as valuable at least as any that could have been the result of the inquiries of a more learned observer.

With little or no formal education, she bested Giuseppe Saverio Poli, considered the "Father of Malacology"; she bested Henri de Blainville, an authoritative, well-known figure in the field; and

she bested Baron Cuvier, the famous French ichthyologist. As a result of this, she revolutionized the study of marine biology, a fantastic accomplishment for any one with so little formal education and by a woman in an age where men did not take women seriously.

However, over the years we have read countless times on the internet that Jeanne Villepreux-Power was the inventor of the aquarium. Ironically, she is known more for this myth than for her real and more important accomplishments. That she was the inventor of the aquarium simply is not true.

In 1858 Richard Owen (a British anatomist and paleontologist who is remembered for his contributions to the study of fossil animals, especially dinosaurs) briefly described three cages she employed as attested to by her good friend Prof. Carmelo Maravigna in the *Giornale del Gabinetto Letterario dell'Accademia Gioenia di Catania* of December 1834. Owen had also previously described a fourth one, the second one above having been replaced by it (Owen, 1857).

Jeanne, therefore, had four types of cages: Two were made of glass (the first of which was used at home; the second was used for smaller mollusks and was in a frame so that it could be immersed in water) and the third (Figure 1) was a cage made out of wood designed to be immersed in water. The fourth, invented to replace the second which proved unsuccessful, was a cage made of clay for smaller mollusks and also designed to be immersed in water.

The wooden cage was the one she used for her work on *Argontauta argos* and was the one that made her reputation in the scientific community. It, however, was not an aquarium since by definition aquariums are made to hold water and this one was made to be immersed. If it had been water-tight there would have been the very devil in getting it submerged, it would not have allowed sea water to pass through it (this was important since Jeanne's success was achieved by studying *Argonauta argos* in their natural habitat - the sea - something the previous marine biologists - all men, by the way - had not done) and it would have been heavy and difficult to handle. The volume of this cage was 117 cubic feet, equivalent to almost 878 gallons of water, and if it had held water it would have made it the world's largest aquarium ever existing before modern times!

Nothing is known about the two glass aquariums, neither their shapes nor their dimensions, or whether they were identical, except for Jeanne's comment that the glass aquarium that was in a frame was "too narrow." (The Argonauts preferred to occupy the center of the aquarium; if it was too narrow, there would be insufficient room for them there and they would migrate nearer to the sides where they would be much more difficult to observe and study.)

Now we might conjecture about these glass aquariums but they would only be suppositions, not facts. We might for instance, postulate that they were flat-sided since the whole point to them was to be able to see and observe the mollusks clearly. We might postulate that Jeanne bought or was given them, or had designed and had them

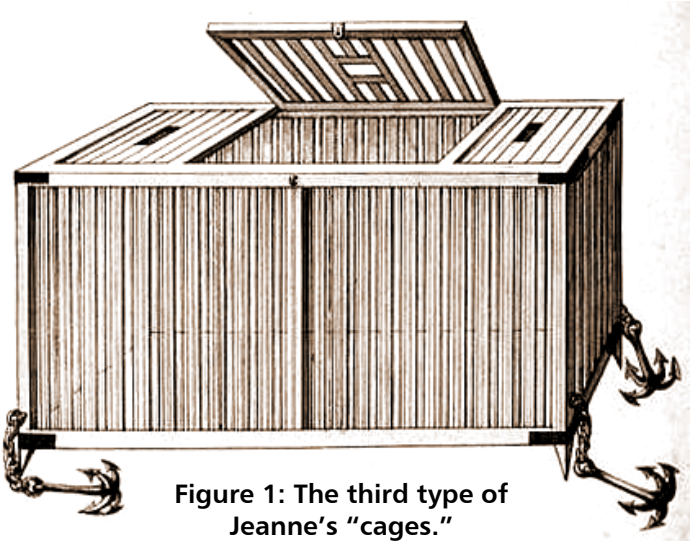

Figure 1: The third type of Jeanne's "cages."

made. If bought or given, then she could not have invented them. If she had designed and had them made then indeed she would had invented the aquarium. However, in Jeanne's days, containers made of glass designed to hold liquids were made by the press and blow method. This involved two molds made of wood and involved five steps:

1. A gob of molten glass was dropped into a blank mold;
2. A plunger then pressed down, forming the blank shape;
3. The blank shape was transferred to the blow mold;
4. The final shape was blown; and
5. The edges were finished off (see Figure 2).

This was a very expensive process for a custom-sized aquarium and some knowledge of the glass thickness required would have been needed if the aquarium was to be large enough to house 10-inch Argonauts. However, recalling Jeanne's remark that the immersible glass aquarium was "too narrow," if this were the case then she could simply have redesigned the aquarium and had another, wider one made. Since this was not done, it suggests that her tanks were purchased and that nothing suitable was available.

One other possibility is that she invented framed glass aquariums, but if they were framed and sealed, Maravigna would certainly have commented on this unique (and it had to be unique since it would be new) construction rather than just describing them as being "glass."

In any event, all this is conjecture and no proof that she invented the glass aquarium. What she did do, however, was to invent the submersible wood cage that was the keystone to her success and fame. So, where did this myth come from?

In one sense it started with Jeanne herself when she noted years later that in many newspapers that there was a great deal of interest in "aquariums and cages." She wrote to Richard Owen in August 21, 1857, reminding him that she had invented several in 1832 and 1834 that she had placed in her house for the studies of *Argonauta* and other marine animals, and also other cages she had placed in the sea, as well as a glass aquarium for smaller individuals. She stated that since it was she who "first had the idea to study marine animals in aquaria or cages," she wanted to keep her rights as inventor and requested Owen's help in this matter. Owen's entry in the Eighth Edition (1858) of the *Encyclopaedia Britannica* exalting her accomplishments and his naming her in the same year as "The Mother of Aquariology" (which he never defined) apparently was sufficient to put her mind to rest as she never raised the issue again.

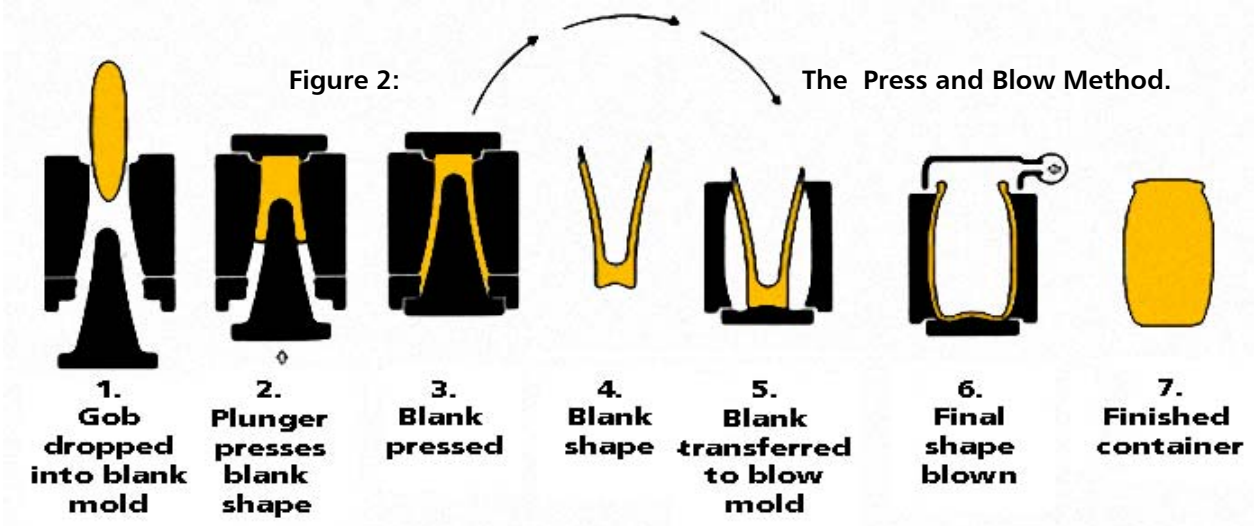

Figure 2: The Press and Blow Method.

However, the fault really lies with Owen who in his *Encyclopaedia* entry mistakenly referred to all three receptacles described by Maravigna as aquaria, rather than including only the first two glass types.

Attributing to Jeanne Villepreux-Power in the myriad of articles appearing on the Internet as the invention of the aquarium has prompted mistaken comparisons with my own essay, "Who Invented the Aquarium?" (Klee, 2012). Jeanne's aquariums were quite different from what she was observing in the newspapers of her day and quite different from those that I was addressing in my essay. The following excerpt is from "Links In The Chain; Or, Popular Chapters On The Curiosities Of Animal Life" (Kearley, 1862) and describes the basis for the definition of aquarium that was the subject of my article:

The chemical principles involved in this ingenious and beautiful contrivance are now too well known to require any lengthened explanation. It is a matter of familiar knowledge, that in the process of respiration, animals consume the oxygen or life-sustaining principle of the atmosphere, and give back in return a quantity of carbonic-acid gas, which is as deleterious to animal life as the oxygen is healthful and invigorating. It thus happens that when animals are confined by themselves in a limited quantity of air, this double process of deterioration speedily renders the fluid absolutely poisonous and destructive of life. But in respect to plants, a precisely opposite state of things obtains. By a process somewhat analogous to the respiration of animals, though not to be confounded with it, the vegetable world is continually appropriating the carbonic acid of the atmosphere, and giving back oxygen. In their relation to the atmosphere, therefore, the two great divisions of the organic world beautifully balance one another - each taking and appropriating to its own use what would he injurious to the other, and each giving hack that which the necessities of the other require.

In respect to the free atmosphere this mutually counteractive influence of the animal and vegetable kingdoms has long been familiar; we owe the Aquarium to the discovery that it equally holds good with respect to the atmospheric air contained in water. The gentleman to whom the world is mainly indebted for this discovery and for its practical application to natural history purposes, is Mr. Warington, of Apothecaries' Hall, who may fairly claim to be the originator of the Aquarium.

The aquariums I was describing in this essay were important to hobbyists since they had long sought out a means to keep fishes without having to continually change their water. Sir John Dalyell's sister, for example, reported that he was most particular in giving his marine animals sea water always out of the sea when it was flowing. He changed the water every morning and often twice a day if he perceived the smallest fragment of dirt amongst it, wiping and washing the glasses very clean. He procured his sea water twice a week and sometimes three times; it was carried in an earthenware jar holding about three or four gallons of water and a person was specially employed for this purpose. Kearley continues, describing what happened after Warington and Gosse had published their findings.

The publication of Mr. Gosse's elegant volume, "The Aquarium," opened up a new source of interest in connection with the subject. It suggested the establishment of the "Parlour Aquarium," by means of which private persons might have in their own houses, and under their constant notice, similar collections of animals to those which attracted such attention in places of public resort. The idea was no sooner suggested than it was eagerly caught up, and forthwith the Aquarium was elevated to the first rank amongst the ornaments of the parlour and the drawing-room. The expense, however, was something considerable at first; and, for a while, it was only in those "desirable residences," as the auctioneers phrase it, the substantial mansions of the people well-to-do

in the world, that you had any chance of meeting with the Aquarium.

But an increase of dealers, and the competition between them, soon made matters different; so that before long the man who had only a few shillings to spare could yet have his collection of pet Anemones, and keep, if he would, a whole aquatic menagerie inside his parlour window. Nor did it matter in the least, apparently, where, or at what distance from the coast he might reside; for like those famous bedsteads one sees announced at the railway stations, the Aquarium, it seems, is expressly adapted to be "sent free by post," and might anywhere he had to order by simply addressing a letter to one of the London dealers. In London itself the passion for the Aquarium raged for a while at fever point. The new invention quickly dispossessed the shop windows of all the old-fashioned globes of gold fish, and created such obstructive crowds upon the footpaths, as to rail for a speedy interference of the police. In West-end squares, in trim suburban villas, in crowded city thoroughfares, in the demure houses of little, unfrequented back streets, and inside the fiat, sillless windows of poverty-stricken Spitalfields and Bethnal Green [both notable slums of London at the time], everywhere you saw the Aquarium in one form or another, and had abundant proof how ardently the cockney of every grade was attached to "the new fancy" which had come into fashion.

Thus the aquariums that Jeanne was seeing in the periodicals she was reading were not her aquariums; she knew nothing about the relationships between plants and animals. Indeed, some periodicals maintained that the cages made by Jeanne could not be called Aquaria, but only receptacles suspended in the waters of the bay. The following is from *The North American Review* for July 1858 and was written by Isabella James, one of our earliest American writers on the aquarium:

As is usually the case with all popular inventions, there are many claimants for the honor of having made the first aquarium. It is easy to see how scientific research into the mysteries of the ocean, replete with life, so little known and still less understood, should lead its votaries in different lands to form similar plans for rendering this microcosm accessible to their own and other eyes.

The cages made by Mrs. Power, a learned French lady residing in Messina in 1832, although she gave to some of them the name of Aquaria were merely receptacles suspended in the waters of the bay to enable her to watch the habits of marine animals. The plan of maintaining the balance of nature by means of plants was unknown to her. To Dr. Johnson, an English naturalist, it appears, should be assigned the first practical application of the well-known theory, that the gaseous exhalations of animal and vegetable life mutually support each other.

Figure 3: Young women around an aquarium, *Le Journal des Demoiselles*, p. 257, August 1864. This was the kind of aquarium Jeanne was viewing in the French periodicals of the time.

The following is from the *Hand-Book to the Marine Aquarium*, June 23, 1873, written by William Alford Lloyd:

In 1840 Madame Power kept marine animals alive in Messina, and when, in 1860, a public aquarium was set up in Paris for the first time, she being then a resident in Paris, it was stated that she had invented aquaria; but this lady, by her own showing, knew nothing of the employment of plants in the manner stated, though she might have used them so, unconsciously, and derived benefit from them.

Although there are some minor errors in both of these accounts, they agreed that Power's cages were not aquariums following the so-called balanced aquarium principles in the sense of Warington, Gosse, Lankester, Bowerbank, Mitchell, Ward and others of the time were not involved. [Note: Although Isabella James credits George Johnston with being first to successfully apply the balanced aquarium principle, in my essay "Who Invented the Aquarium?" (Klee, 2012), I awarded this title to him only for the category of "Marine Aquarium Sans Fishes."]

SO, WHO DID INVENT THE AQUARIUM?

First of all, *I will require that the invention of the aquarium and its development must proceed chronologically without interruption to arrive at how we use this word today* . This lets out the Egyptians and Romans, for example; although they certainly had aquariums, they were not responsible for the word nor did their aquariums have any relationship to the aquariums of today.

In my essay titled "A Few Words on the Origin of the Word Aquarium" (Klee, 2015) I noted that Cato, in 160 BC, was the first author of record to use the word aquarium. Examples from his book, *De Agri Cultura (*"On Agriculture") include the following: **situlum aquarium** ("water bucket"), **urceum aquarium** ("water vessel") and **bonumque aquarium** ("well-watered"). Note, however, that aquarium here meant water and not a container of water.

In Cicero's *Three Books of Offices and Other moral Works*, written in 44 BC, we find the following: Tum Canius inquit, quæ, Pythi, quid est hoc? Hic, ne, tantum piscium, ne tantum cymbarum? Et ille inquit, quid mirum? Quidquid piscium est Syacusis est hoc poco, **hic aquatio**…

"Then Canius says, 'What is this, pray, Pythias – so many fish – so many boats?' And he answers, 'What's the wonder? Whatever fish there are at Syracuse are taken at this place; **here is their watering-place**…'"

"Aquationis" is the genitive (possessive) form of a Latin word that was used by Julius Caesar, Palladius, Columella, Pliny and Cicero with regard to water that had several different meanings but Cicero uses the nominative form "aquatio" here to mean "watering-place; it was not used in the sense of a container to hold fish (or anything else for that matter). Thus at no time did the Romans use aquarium or its cousins in the sense of a container; rather, it was either meant as water or a place (but not a vessel) that held water.

ENTER CARL LINNAEUS

The fame of Carl Linnaeus (1707-1778) - ennobled Carl von Linné in 1757 - rests upon his reform of natural history. Among other things, by introducing binominal nomenclature in his *Systema naturae* (1735), finally adopted in *Species plantarum*

Figure 4: Watering place near Cervara, a municipality in the province of Rome in the Italian region Latium, located about 31 miles east of Rome.

(1753), he created order in a period when there was great confusion in naming animals and plants. His close friendship with Peter Artedi should also be mentioned. Artedi was a Swedish naturalist and is known as the "Father of Ichthyology." Intending to become a clergyman, he went to study theology in 1724 at Uppsala University, but he turned his attention to medicine and natural history, especially ichthyology, a science that he influenced greatly. In 1728 Carl Linnaeus arrived in Uppsala, and a lasting friendship was formed between the two. In 1732 both left Uppsala, Artedi for England and Linnaeus for Lapland; before parting they reciprocally bequeathed to each other their manuscripts and books in the event of death.

Carl showed a deep love of plants and a fascination with their names from a very early age. He disappointed his parents by showing neither aptitude nor desire for the priesthood, but his family was somewhat consoled when Linnaeus entered the University of Lund in 1727 to study medicine. A year later, he transferred to the University of Uppsala, the most prestigious university in Sweden. However, its medical facilities had been neglected and had fallen into disrepair. Most of Linnaeus's time at Uppsala was spent collecting and studying plants, his true love. At the time, training in botany was part of the medical curriculum since every doctor had to prepare and prescribe drugs derived from medicinal plants.

Despite being in hard financial straits, as previously mentioned Linnaeus mounted a botanical and ethnographical expedition to Lapland in 1732. Linnaeus developed an admiration for the Lapps - their way of life and, in particular, their clothing. He found their clothing to be more practical than tight-fitting Swedish clothing. It is reported that Linnaeus was so taken with Lapp clothing that, upon his return, he could be seen in Lapp costume around Uppsala and even courted his wife in this ensemble (Figure 5).

Linnaeus, who was a practicing physician, also wrote *Materia Medica* (1749), a useful reference book for doctors. It was full of aphorisms such as "all excess is harmful" and "eat to keep up your strength, not to stuff your belly." On the rules of diet, Linnaeus often made his students roar with laughter by his descriptions of the follies of fashion, using a joke and a light touch to teach a valuable lesson about the care and preservation of health. So wrote Sven Hedin, one of the many students who were impressed by Professor Linnaeus's ability to lecture.

Olof Rudbeck (1630 - 1702), a professor of medicine at Uppsala University in Sweden (he discovered the lymph system) and for several periods its Rector Magnificus, founded a botanical garden, then situated in the center of Uppsala, close to the

Figure 5: This is a portrait of Linnaeus in Lapp costume when he was about 30 years old.

Fyrisån river). In later years, Carl Linnaeus named an aquatic plant, *Rudbeckia,* after him. The garden was primarily used for teaching botany and pharmacy, and by the end of the century more than 1,800 species were grown there, many of them for the first time in Sweden. It was largely destroyed by a fire in 1702 and since the university could not afford to restore it, it was left unattended for a period of 40 years. Linnaeus became responsible for the garden in 1741 and had it rearranged according to his own ideas, documented in his *Hortus Upsaliensis* of 1748. Under his supervision, it turned into one of the foremost gardens of its time. Although Uppsala University commissioned the famous architect Carl Hårleman to design the garden, Linnaeus was responsible for the planting, including three ponds for plants typical of streams, lakes and marshes.

In his 1742 prologue to his *Hortus Upsaliensis*, Linnaeus defined the following terms under the heading of "Aquaria:" *Aquarium palustre, Aquarium fluviatile* and *Aquarium lacustre*, denoting respectively a marsh pond aquarium, river pond aquarium and lake pond aquarium (Figure 6). Since this is the earliest use of the word "aquarium" by gardeners, it is also the first time the plural of the word was used. Historically then the plural of aquarium should be aquaria, not aquariums.

In front of the lake pond, Linnaeus placed a statue of Venus, bought in 1758 from Piperska trädgården in Stockholm. It caused a scandal in Uppsala, as the Medicean Venus was completely naked. Here is how Linnaeus described the marsh pond aquarium:

Aquarium palustre ad latera truncos horizontales seu parietes habet, aquam a solo separantes, inter illos vero & ipsam humum repletum est spatium humo limosa e paludibus desumta, cui insertae plantae palustres.

The marsh aquarium has horizontal sides of tree trunks or walls that separate the water

AQUARIUM PALUSTRE ad latera truncos horizontales ſeu parietes habet, aquam a ſolo ſeparantes, inter illos vero & ipſam humum repletum eſt ſpatium humo limoſa e paludibus deſumta, cui inſertæ plantæ paluſtres. veluti:

Acorus,	*Iris*,	*Scheuchzeria*,
Aliſma,	*Juncus*,	*Sium*,
Butomus,	*Phellandrium*,	*Schœnus*,
Cyperus,	*Sparganium*,	*Siſymbrium*,
Erigeron,	*Scirpus*,	*Triglochin*, &c.
Eriophora,		

AQUARIUM FLUVIATILE fundo ſuo tenet plantas fluviatiles & lacuſtres; e. g. *Hottonia*, *Hippuris*, *Myriophyllum*, *Potamogetones*, *Sagittaria*, *Utricularia*, &c. margines vero hujus aquarii ſpecies *Caricum* 20 veſtiunt.

AQUARIUM LACUSTRE, ſtellata figura & artificio hortulani inſigne, non alias alit plantas, quam eas, quæ foliis natant: ut, *Nymphæa lutea*, *Nymphæa alba*, *Hydrocharis*.

Figure 6: From Carl Linnaeus' *Hortus Upsaliensis*, Prooemium, 1742.

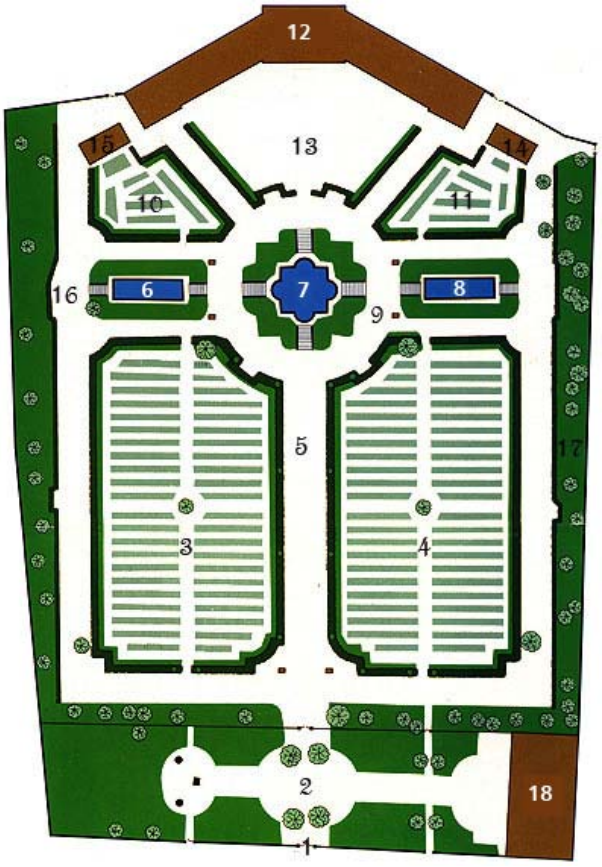

Figure 7: Sketch of the Linnaean Garden.
6 = The River Pond (Aquarium fluviatile)
7 = The Lake Pond (Aquarium lacustre)
8 = The Marsh Pond (Aquarium palustre)

Figure 8: The marsh pond aquarium (*Aquarium palustre*) in the Linnaeus Garden in Uppsala, Sweden.

Figure 9: The river pond aquarium (*Aquarium fluviatile*) in the Linnaeus Garden. It is the same length as the marsh pond aquarium shown above but it was photographed here at one end so its length appears shortened.

Figure 10: The lake pond aquarium (*Aquarium palustre*) in the Linnaeus Garden. The statue caused Linnaeus no end of trouble at the time.

from the surrounding soil; the ground between them is filled with soil from muddy swamps, into which is inserted marsh plants.

Clearly Linnaeus was describing the construction of an artificial container and was not using the word aquarium merely as a synonym for water. Linnaeus, of course, was not concerned with fish but with aquatic plants. From this point on, however, botanists and horticulturists used the term aquarium to mean any receptacle that held water and aquatic plants. One of the most outstanding was that built for the Marquis of Blanford in 1806 (Figure 11). The Marquis' aquarium represented the highest end of the spectrum of the gardener's aquarium, i.e., a pit containing water being its lowest and an intermediate aquarium being a pond. In John Loudon's *Encyclopædia of Gardening*, he

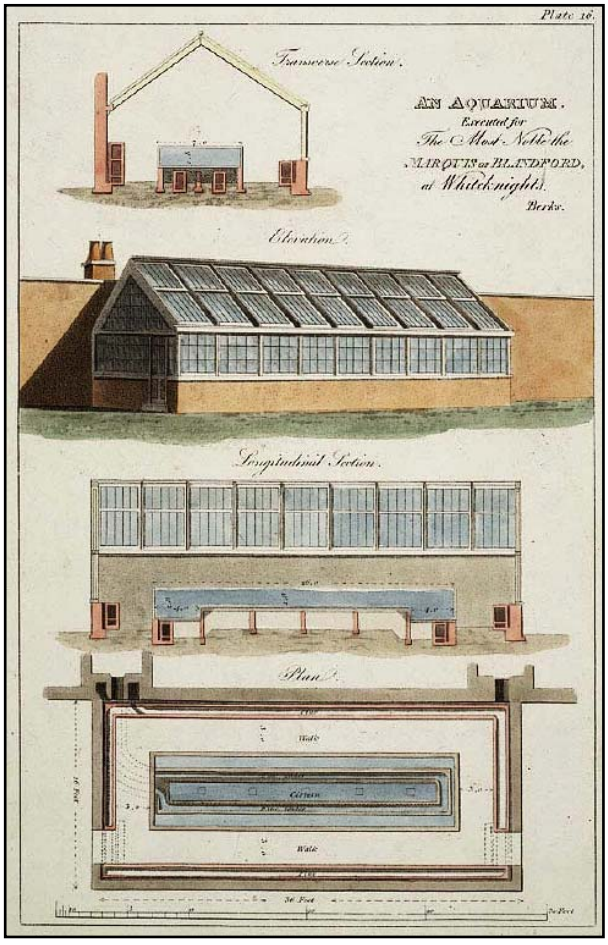

Figure 11: The Aquarium of the Marquis of Blanford, 1806.

showed several examples of the more ornate aquaria and suggested that fish might be added to them (Loudon, 1824):

It is almost needless to add, that exotic aquatic fowls and fishes might be kept in such an aquarium, and either of the sea or fresh water rivers, according as salt water or fresh was used.

Note that this was 13 years before Jeanne's first publication. The definition of aquarium now was expanded to mean any receptacle that held water, aquatic plants and/or aquatic animals. It was the term adopted by Warington and Gosse to replace the awkward term "Aquavivarium," and it also was the term used by the general public. Although Philip Gosse undeniably was responsible for the popularization of the term "Aquarium" in the fish hobby sense, he was not the first one to use it. Warington preceded him. Gosse himself did not claim priority in this matter, the following being his clear and elegant explanation of why he used the term:

A neat, easily pronounced and easily remembered, significant, and expressive term is so advantageous, that it is worth taking some trouble to select the best. For the subject of this volume some have chosen the word Vivarium, and I have myself occasionally used it. The only objection to it is that it lacks distinctness of signification. It literally means any enclosure in which living animals are kept; and the ancients used it to signify a park, a rabbit-warren, and a fishpond; indeed, I am not sure whether our word "warren," is not "Vivarium" Saxonised. Thus it is quite as applicable to the whole Zoological Garden as to any particular house, yard, or tank in it. To avoid this indefiniteness, others have used the term Aqua-vivarium. The objection to this is its awkward length and uncouthness, which render it unsuitable for a popular exhibition or domestic amenity. I have adopted the word Aquarium, as being free from the objections which lie against the other two, while it possesses the neatness of the former, and the definiteness of the latter.

He goes on to say (and herein lies the subject of this essay):

The term had already been in use among the botanists, to designate the tanks in which aquatic plants were reared; and the employment of the same term for our tanks is not forbidden by the character of the service to which they are put, since this is not an alteration, but only an extension. The growth of aquatic plants is still a most important and pleasing feature of our pursuit, and the addition of aquatic animals does not at all detract from the appropriateness of the appellation.

Although the aquarium all but disappeared for a while in the 1860s in Great Britain, the term "aquarium" has survived to this day. Therefore, emulating Richard Owen in coining names, I christen Carl Linnaeus,

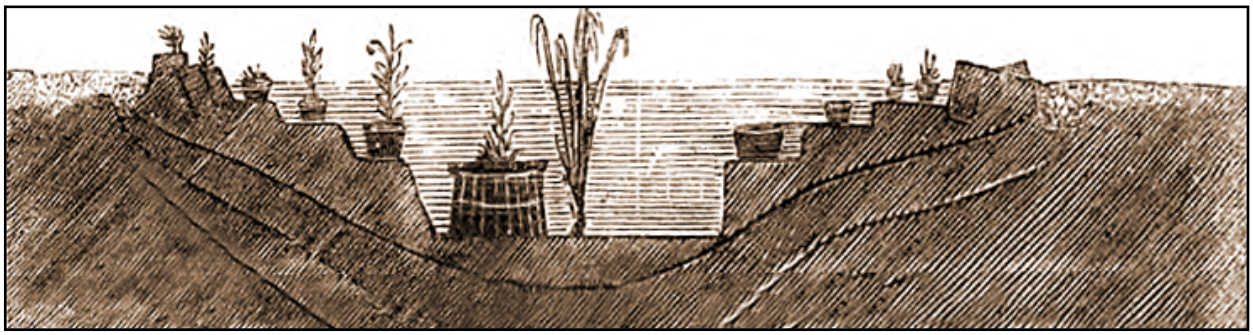

Figure 12: An aquarium from John Loudon's *Encyclopædia of Gardening* (Loudon, 1824).

CARL LINNEATUS
PATER AUTEM AQUARIUM or "FATHER OF THE AQUARIUM."

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THE LEISURE HOUR

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, April 13, 2019)

When writing about historical characters, authors often wish that they knew more about the personal side of the characters than just the bare facts expressed in the written sources available. Sometimes these written sources are themselves rife with misinterpretations, exaggerations and even downright lies. I will explore this idea using as examples the two most influential men associated with the invention of the aquarium, Robert Warington and Philip Henry Gosse. First, however, I will start by presenting some brief information about their education and achievements.

A.1 ROBERT WARINGTON

Warington entered an independent private day school for boys in 1818 and in 1822 was articled for five years to John Thomas Cooper, a lecturer in medical schools and a manufacturer of potassium, sodium, iodine, and other then-rare chemical substances. On the opening of the London University in 1828, later *University College, London*, he was chosen by Edward Turner, the Professor of Chemistry, as his assistant. In 1831 he was appointed chemist to the London brewers Truman, Hanbury & Buxton, becoming the first qualified chemist to work for a British brewery. From 1842 until shortly before his death in 1867 he was resident Director to the *Society of Apothecaries*. In 1831 he published his first research, on a native sulfide of bismuth. In 1839 he started a movement to found the *Chemical Society of London*, convening the first meeting in 1841 and serving as its first Secretary for ten years. In 1844 he began a series of investigations into the adulteration of tea, and gave evidence at the parliamentary inquiry in 1855. In 1845 he was one of the founders of the *Royal College of Chemistry*, later part of *Imperial College, London*. In 1846 he took part in the formation of the *Cavendish Society*, of which he was secretary for three years, and from then on had many engagements as a chemical expert in legal cases. In 1851 he revised the *Translation of the Pharmacopœia of the Royal College of Physicians* into English. He was also engaged in the construction of the *British Pharmacopoeia* from 1864, and was joint editor of the second edition in 1867. In 1854 he was appointed chemical referee by four of the London coal gas suppliers, and held this post for seven years. In 1864 he was elected a *Fellow of the Royal Society*, and the *Royal Society's* catalogue lists 47 papers written by him alone. Warington proved the principle of the balanced aquarium, i.e., the use of plants to provide oxygen and to remove harmful carbon dioxide both in fresh water and in salt water. He also was the first to use the word aquarium with regard to a container that was intended to hold fish.

Figure 1: Robert Warington (1807-1867)

A.2 PHILIP HENRY GOSSE

Gosse's formal education as a child was limited to five years of day-school followed by two years of grammar school and because his parents could not afford additional education, he left school at the age of 15. In essence, he was largely self-taught but he taught himself well. Gosse wrote a succession of 31 books and articles on various subjects, including natural history. He also wrote what were (in his own words) "pot-boilers" for religious publications. In 1857, he published his most controversial book, Omphalos, in which he challenged the validity of evolution and presented his case for what today is called creationism. His most significant scientific works, however, were in marine biology and taxonomy, notably Actinologia Britannica: A History of the British Sea-Anemones and Corals (1858-1860) and The Rotifera (with C. T. Hudson) on marine rotifers (1886, 1889).

In recognition of his scientific contributions, Gosse was elected an Associate of the *Linnaean Society* (1850) and a Fellow of *The Royal Society of London* (1856), which, because he had no university position or inherited wealth, gave him a standing he otherwise lacked. The criterion for the latter contained the words "Distinguished for his acquaintance with the science of Zoology, particularly Microscopic Zoology" and the further statement, "The inventor or improver of the Aquarium." It should be noted that he word "aquarium" can be taken in two ways: as the actual vessel that holds the water, also commonly known as the "tank," or as the system that consists of the vessel that holds the water and aquatic plants and/or animals. It is with reference to the first that the term "inventor" is used here. Gosse himself made the claim of inventor in his 1853 book, *A Naturalist's Rambles on the Devonshire Coast*:

But my attention has been directed to the realization of such a desideratum as I have before mentioned, a Marine Aquarium for the Parlour or Conservatory. An apparatus for this purpose has been for some time in the manufacturer's hands; and though there are some minor difficulties attendant on the mechanical part of the execution, they are not such as to throw any material doubt on my confident expectation, that in a short time an elegant vase stocked with algae and sea-anemones, and comprising within itself the elements of its constant self-purification, will be before the world.

However, if we are confined to the Nineteenth Century (which marks the birth of the aquarium hobby), this recognition should go to Warington; he had publication priority by at least a year (see Klee, 2012). If not confined by date, the honor actually should go to Linnaeus (see Klee, 2019).

Although he is often credited with creating and stocking the first public aquarium, i.e., the fish house at the London Zoo which opened in 1858, in actuality Warington designed the freshwater and Gosse the saltwater portion. Although the freshwater portion was a success, the saltwater exhibit was a disaster. His greatest legacy, how-

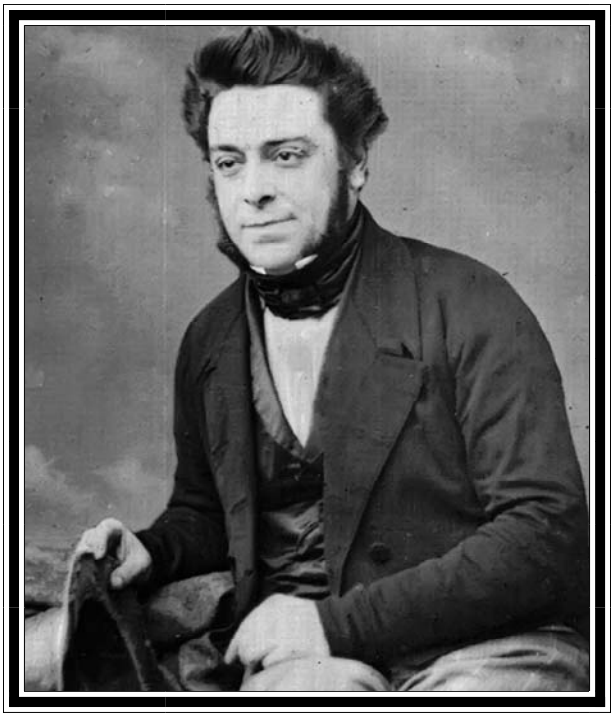

Figure 2: The first known photograph of Philip Henry Gosse, circa 1850.

ever, was as a popular writer of science for the general public.

Gosse was a painstaking, extraordinarily patient and endlessly enthusiastic observer, whose style and character endeared him to his readers. Charles Darwin admired his qualities and would ask him questions and use his observations on such things as whether male Crustaceans ever fight for the females, the pugnacity of the male humming-bird or the impregnation of orchids. But Darwin commented that, whereas in Alfred Wallace's book on the Amazon there are "hardly facts enough, in Gosse's books there is not reasoning enough to my taste." Facts were safe for Philip Henry Gosse. When he tried reasoning, as he would do in his book, *Omphalos*, it would be disastrous.

B.1: THE LIFE OF PHILIP HENRY GOSSE

After his father's death Edmund Gosse published a biography, *The Life of Philip Henry Gosse* (1890). This is the one aquarists should read if they wish to know more about the aquarium aspects of Philip Gosse's life. The reader should be aware, however, that Edmund's knowledge was often spotty, Henry James remarking that Edmund Gosse had "a genius for inaccuracy." For example, when discussing Warington in this book he wrote:

There was no sort of rivalry between these earnest and amiable investigators, but a little later on, when the aquarium had become a fashionable thing, Philip Gosse was accustomed to say that if it was needful to dispute about an invention which was virtually simultaneous, it might be said that Warington had invented the vivarium and he the marine aquarium.

This, of course, was not true as witness their controversy over artificial sea water in 1854 (see below).

B.2 GOSSE'S RELIGIOUS SIDE

Philip Gosse's code was the Bible and the Bible only, without any modern modification whatever, without allowance for any difference between the old world and the new, without any distinction of value in parts or without the smallest concession to the critical spirit upon any point. He had an absolute, uncompromising, unquestioning reliance on the Hebrew and Greek texts as inspired by the mouth of God and uncorrupted by the hand of man. As Gosse admitted, the Bible, however, is full of obscure sayings and needs an interpreter and he did not doubt his own competence to interpret. Admittedly, he had some reason to hold this view since his knowledge of the Bible can hardly have been excelled. Edmund observed that his verbal memory of the Authorized Version included the whole New Testament, all the Psalms, most of the Prophets and all the lyrical portions of the Historical Books. The condition of his memory fluctuated, of course, and was being daily refreshed at various points, but Edmund had

Figure 3: Philip Henry Gosse (1810-1888).

his own repeated assurance that, practically speaking, Philip Gosse knew the Bible by heart.

In a letter to his son, Gosse gives a key to the social isolation of his life. **I am impatient and intolerant of all resistance to what I see to be the will of God, and if that resistance is sustained, I have no choice but to turn away from him who resists.** Edward provides the following example:

His extraordinary severity towards those who occupy the extremes of Christian dogma, towards the Church of Rome and towards the Unitarians, was a result of this idiosyncrasy pushed to its extreme. In 1859, when he was lecturing in Birmingham, before the Midland Institute, he was invited to meet some of the principal personages of the town at dinner, and, in particular, a well-known gentleman, who is now dead. Philip Gosse accepted the invitation with pleasure; but shortly before the party met, the host received a note saying that it had just been mentioned to Mr. Gosse that Mr. — was a Socinian [a system of Christian doctrine named for Fausto Sozzini; it is most famous for its nontrinitarian Christology but contains a number of other unorthodox beliefs as well]**. Had Mr. Gosse been unaware of this, he should have desired to ask no questions, but the information having been volunteered, he had no alternative but with extreme regret and even distress to explain that he could not "sit at meat with one whom I know to deny the Divinity of the blessed Lord." To realize what this sacrifice to conscience involved, it must be recollected that my father was a man of elaborate and punctilious courtesy, and extremely timid. I could multiply examples, but it is needless to do so.**

Philip Gosse made it an invariable practice in advancing life to qualify every public expression of his views on natural phenomena by an attribution of the beautiful or wonderful condition to the wisdom of the Divine Creator. He had done so in his monograph on *The Clasping Organs ancillary to Generation in Certain Groups of the Lepidoptera*, appending to that memoir a paragraph embodying the pious reflections that his conscience dictated him to make.

Rightly or wrongly, these sentiments appeared to the Council of the Linnaean Society to be out of place in a very abstruse description of certain organs, which although are curious are neither beautiful nor calculated to inspire ideas of a particularly elevating nature. In sending to him the proof of his memoir, the Secretary was directed to ask him, in making some other trifling excisions, to be kind enough to put his pen through this little passage also. To the surprise of everyone concerned, he absolutely declined to do this. The Council was then placed in a most embarrassing position. A great deal of money had already been spent, and here was a paragraph that by the rules of the society forbid all contentious matter on the subject of religion, and which yet the author was prepared to

Figure 4: Philip Henry Gosse, age 5, painted by his father, Thomas Gosse, a portrait painter.

Figure 5: Philip Henry Gosse, age 17, also painted by his father, Thomas Gosse.

sacrifice the whole volume rather than agree to the request.

The knot was cleverly untied by Professor E. Ray Lankester, who suggested that it should be represented to Gosse that if in the future an atheist should wish to defend his atheism in the *Transactions* of the Society, the Council could scarcely forbid him to do so if it had yielded to a Christian writer the privilege of defending his faith in Christianity. Gosse saw the force of the argument, and gave way, though with great unwillingness.

B.2 HOW SHARPER THAN A SERPENT'S TOOTH IT IS TO HAVE A THANKLESS CHILD!

After the publication of *The Life of Philip Henry Gosse* it was suggested to Edmund that it contained "the germ of a great book" and so he revised his material and the first edition of *Father and Son* was published anonymously on October 25, 1907 by publisher William Heinemann. This seems to have been a clever marketing ploy to arouse curiosity, and Edmund's name was soon attached to subsequent editions. Edmund was also eager to test the water, to discover just how much he would be attacked for his lack of filial piety. The reviewer in the *Times Literary Supplement* wrote: **The author of this book has no doubt settled it with his conscience how far in the interests of popular edification or amusement it is legitimate to expose the weaknesses and inconsistencies of a good man who is also one's father**. In any event, the anonymous publication indicates some hesitation about owning up to the book, although oddly enough, opposite the title-page of this first impression is a photograph of Philip Henry Gosse holding an open book with Edmund on his knee. In fact, its authorship was something of an open secret in literary circles, and there are indications that

Figure 6: The photograph of Philip Gosse and his son, Edmund that appeared in the "anonymous" Father and Son in 1907.

from the first that Heinemann wanted the facts of Gosse's authorship to leak out.

Father and Son is part biography but even more an autobiography. Edmund Gosse left an epic portrait of his evangelical father as a God-haunted neurotic, declining to celebrate Christmas Day "The very word is Popish," Philip Gosse used to exclaim, "Christ's Mass!" pursing up his lips with the gesture of one who tastes assafoetida by accident. Then he would adduce the antiquity of the so-called feast, adapted from horrible heathen rites, and itself a soiled relic of the abominable Yule-Tide. This objection showed itself in amusing and bewildering ways. He regarded plum-pudding and roast turkey as innocent and acceptable, if the fatal word had not been pronounced in connection with them; but if once they were spoken of as "Christmas turkey," or a "Christmas pudding," they became abominable, "food offered to idols."

After Gosse had moved permanently from London to St Marychurch, Devon, Gosse refused to use the "St" and even gave his address as Torquay, the neighboring borough, so as not to have anything to do with the "so-called Church of England." In 1875 Edmund was to marry Ellen Epps, a young painter who was also the sister-in-law of Laura Alma-Tadema, an artist of high repute. In the summer of 1875 Alma-Tadema wrote to Philip Gosse to urge him and his wife to attend the wedding. However, Gosse could not face the actual Register Office wedding or the reception afterwards at Alma-Tadema's smart Townsend House in Regent's Park, crowded as they would inevitably be with so many who were "alien to Christ." If I said that Gosse's approach to religion was aberrant, it would be a compliment. However, it is easy to criticize deviate behavior.

The reaction of readers to Philip's personality and character, as represented in *Father and Son*, has included phrases such as "scientific crackpot," "bible-soaked romantic," "a stern and repressive father" and a "pulpit-thumping Puritan throwback to the seventeenth century." However, Ann Thwaite has rejected this portrait of Philip Henry Gosse, on the grounds that his own "writings reveal a genuinely sweet character." Ann Thwaite is a prize winning biographer and children's writer. Her book, *Edmund Gosse: A Literary Landscape* won the 1985 Duff Cooper Prize and was described by John Carey as "one of the finest literary biographies of our time." *Glimpses of the Wonderful*, a life of Edmund's father, Philip Henry Gosse, was picked out by D.J. Taylor in the *Independent* as one of the "Ten Best Biographies" ever.

Thwaite has established just how inaccurate Edmund's recollections of his childhood were. Although Edmund went out of his way to declare that the story of *Father and Son* was "scrupulously true," Thwaite cites a dozen occasions on which either Edmund's "memory betray[ed] him - he admitted it was "like a colander" - or he "changed things deliberately to make a better story." Thwaite argues that Edmund could only preserve his self-

Figure 7: Dr. Ann Thwaite, a Fellow of the Royal Society of Literature.

respect, in comparison to his father's superior abilities, by demolishing the latter's character.

However, it was impossible for evangelicals like Philip Gosse to accept that there were other views and, indeed, much of his life was spent convincing himself and others that he was right in his beliefs. Questioning would be akin to Satan talking and must be dismissed, locking Gosse into his narrowness. This single-mindedness, while being a marvelous support for evangelical Christians like Gosse, was oppressive to anyone who did not accept these views, and especially for those who were brought up with them. It is easy to see why Edmund Gosse felt the way he did and emphasize with him, despite having such a benevolent father, and so he eventually gave up talking to his father about their differences.

It is interesting to note that Gosse had the idea that Edmund might like an aquarium in his lodgings - the original one, "a historic relic" which "ought to be an heir loom in my family." He would make his son a present of it, send it up at his own expense, pay for sea-water and collect for him. "What do you say?" So in 1869 Edmund was able to keep most of his father's usual interrogation at bay by filling much of his letters with comments on the activity in the aquarium his father had supplied. He asked lots of questions so his father would have to fill his letters with equally uncontroversial subject matter. Things did not go smoothly in spite of all of Philip Gosse's expert advice. All the details were of "painful interest" to him. Edmund sent lists of the "thriving" and the "precarious. We begin to despair; our little community is dwindling more seriously." His father suggested that he should "aerate the water, pouring it from a jug held at a height. And do not leave this to be done by the ladies; but take *your* share of it, doing it every evening till the whole tank boils and froths."

C.1 GOSSE'S CHARACTER

The letters of Gosse's first wife, Emily Bowes, were full of love. This is an example, written on July 1, 1850 (the baby refers to their son, Edmund):

My love, How lonely you must feel tonight and how much I am sure you must wish me back. I am always thinking of you and dear baby and I long for tomorrow when I shall have a letter from you. Do not forget me for a moment and let me hear your assurance that you love me as I love you. I do not like to go to bed. I shall be so lonely. I miss having you to pray with me and to kiss me. I would write on but I am very tired. Kiss Baby for me and believe in the love of your own wife, Emily Gosse

After Emily's death he met and married his second wife, Eliza Brightwen, a kindly, tolerant Quaker who shared Gosse's intense interest in both natural history and the well-being of his son. Gosse's second marriage was as happy as his first. In 1862 he wrote that Eliza was "a true yoke-fellow, in love, in spirit and in service." Appendix I, written by Eliza and in Edmund's *The Life of Philip Henry Gosse*, also shows more of Philip Gosse's character:

Figure 8: Emily (nee Bowes) Gosse (1806-1857) at age 25, 12 years before she married Philip Henry Gosse.

Figure 9: Eliza Brightwen (1830-1906), Philip Gosse's second wife.

He never opened out to general visitors. He always spoke of himself as a shy man. Some might think him stern and unsocial; he was a recluse, and a thorough student in all his ways, and a true home bird. Often when, in after years, I remonstrated with him on his isolation, and urged him to go out more among his friends, he would say, My darling, "my mind to me a kingdom is," which might seem a trifle selfish, if selfishness could be considered at all a constituent in the heart of my beloved husband. He was of a remarkably even disposition. I never saw him give way to those frailties or minor faults that are so often exhibited in the lives of less exalted, or of uncontrolled characters. His life was given to studies of a grave and more or less religious nature, or else to closely thought-out scientific studies, especially those of natural objects. His mind being habitually occupied with this higher order of thoughts, he seemed to find it impossible to unbend to the lighter topics of everyday conversation. He was wont to excuse himself by saying, "I have no small talk."

Another time Kate (a servant) interrupted Gosse to tell him that the baby had walked all the way from the chair in the hall to the street door. Gosse picked up his rule, rushed into the hall, measured the distance and found it six feet and then, he wrote to Emily,

I induced him to try again and he several times made several steps, but he was excited and could not get on so well. Dear little fellow! It is so funny to see him. How he balances himself first and straddles wide, to get a good broad foundation, then he staggers two or three steps forward and plump! down on his little bottom. He is as good as he can possibly be and sends you, I doubt not, many kisses. At least I do for him … Believe me, as ever, *more than ever*, my darling Emily, Your own affectionate lover, P. H. Gosse.

Gosse's attitude towards animals was also instruc-

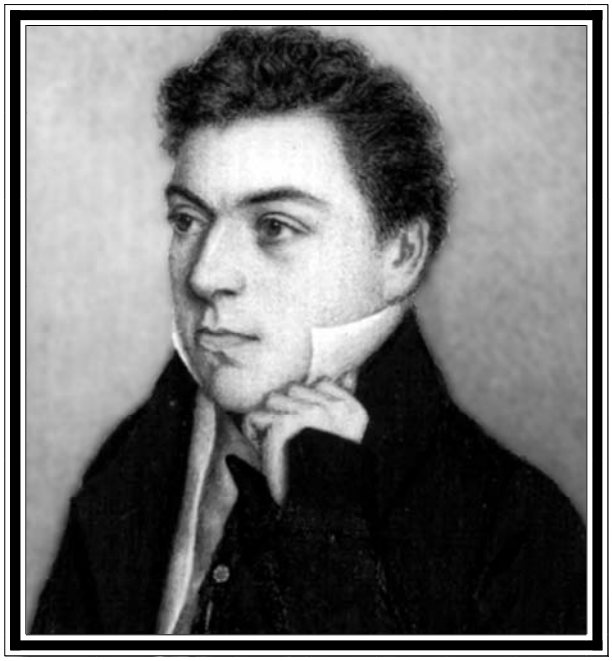

Figure 10: Philip Henry Gosse, age 20, painted by his brother William Gosse.

tive. He had a six year old cat called "Fairy," and he recorded April 18, 1877 as "a day full of sorrow" as she was having great difficulty in birthing her kittens, most of which were stillborn. When it seemed inevitable that she would not recover, he laid the mother cat gently and carefully on a soft bed of dry moss in her kennel. About 6 p.m. he saw, "with an intense sorrow" that his dear little cat was dead. Having restrained his emotion in front of his gardener who had buried the kittens, Gosse went inside the house and wept.

The sorrow which the death, so sudden and unexpected, of this little animal has produced in me is something that I could not have anticipated: it surprises me as I feel it; it is rather that which one feels for the loss of a loved human relative…

When Gosse was dressing, Fairy would remain in the room, very quiet and always watching for the chance of a little play with his watch-chain just before he put it in his pocket. Then she would go down to breakfast with them. Sometimes in the day she would, in her great affection, start licking Gosse as he sat reading. She might start on his fingers or sometimes my nose, eyes and cheeks, or she would make her way to the head of the sofa and, crouching there, would begin an earnest licking of the hair of my head as if I had been her kitten, the evident affection making the operation not unpleasant to me. No wonder he missed her, that source of such unquestioning love.

In 1832, when both he and his brother William were in Newfoundland, they learned that their sister, Elizabeth, was ill in Dorset, that her life was in danger and that she hoped to see her absent brothers once again before she died. Her brothers feared that that was about to happen and they both obtained permission to travel back to England on their own company's ships. Fortunately, after they arrived - a five week journey - she had recovered. Elizabeth Gosse remains a rather shadowy figure, but she was certainly important to her brothers. The year before, she had sent Philip a miniature portrait their father had painted to mark her eighteenth birthday. And on another occasion she sent him two bound volumes of *The Lady's Pocket Magazine*, because it contained an article, "Unwritten Philosophy," she thought would interest him. He kept those volumes all his life. Then there was a time when one of his fellow clerks had taken his sister's Elizabeth's name in vain with some lascivious jest, and Philip had struck him on the mouth with the back of his hand, the only time in all his reminiscences when he recorded his own violence.

C.2 GOSSE'S CHARACTER FLAWS

However, Gosse has some character flaws that Ann Thwaite glosses over so he does not go scot-free here. An example; Gosse wrote the following in a letter soon after his arrival in Alabama in1838:

In the fields of some large estates through which the road led, I saw, for the first time,

Figure 11: Edmund William Gosse, age 13 in 1862.

negro-slaves performing the labours of agriculture. They were ploughing between rows of cotton, which was just appearing above ground. The ploughs appeared to me to be rude and ineffective, the share doing little more than scratching the soil: each was drawn by a single mule.

It was revolting to me to observe women engaged in this laborious occupation, whose clothing - if the sordid rags which fluttered about them deserve the name - was barely sufficient for the claims of decency. Poor wretches! whose lot is harder than that of their brute companions in labour! for they have to perform an equal amount of toil, with the additional hardships of more whipping and less food.

The Emancipation Proclamation, issued January 1, 1863, effectively made the Civil War become a matter of slavery and ethics. This was important because the people of Great Britain had forbidden slavery in their lands and holdings in 1833. In order to avert open rebellion among the working class, Great Britain officially withdrew its support of neutrality that Queen Victoria had issued on May 13, 1861and condemned the Confederate States of America for their continued use and expansion of slavery. Gosse, however, hoped that the South would win its independence, arguing that it would weaken the United States who was in competition with Great Britain for trade and global influence. In effect, Gosse had considered this issue more important than slavery, suggesting that Gosse had more noble beliefs than was the case and was in effect a hypocrite in this instance.

On occasion, Philip Henry Gosse made imprudent decisions as shown by the following four examples.

C.3 THE LONDON ZOO

Gosse's main contribution to the aquarium at the London zoo in 1852-1853 was to provide marine plants and animals, including fish, for which he was to be paid. When he submitted his bill, David Mitchell, the Secretary of the *Zoological Society of London* (who owned the Zoo), presented it to the Society's Council who directed him to try and persuade Gosse to reduce it. Gosse, replied, however, that if he wasn't paid then all collections would stop. Gosse then requested that the matter go to independent arbitration. However, the arbiters soon found that the reason the Council had disputed the payment was that the Council had discovered that Gosse had also collected and sent specimens to the *Surrey Zoological Gardens* (a competitor) during his time in Weymouth collecting but charged the Zoological Society for this time. Understandably, the Council was only willing to remunerate Gosse for the animals he sent to the Zoo. The arbitrators found in favor of the Society, awarding Gosse only £150, which he quietly accepted.

C.4 ARTIFICIAL SEAWATER CONTROVERSY

The second example occurred in 1854. In his desire to be the first to write about artificial seawater, and especially in his desire to beat Warington to it, Gosse visited Warington in on two occasions at Apothecaries Hall, on January 16th and again on January 21st to discuss, among other things, the feasibility of using artificial seawater. However, in discussing the subject in his meetings with Warington, Gosse did not tell Warington about what he knew about the subject during these discussions. One can imagine Warington's surprise when he read Gosse's introduction to his paper the *Annals and Magazine of Natural History* for July1854:

Several scientific friends to whom I mentioned my thoughts, expressed their doubts of the possibility of the manufacture; and one or two went so far as to say that it had been tried, but that it had been found not to answer; that though it looked like sea-water, tasted, smelt, like the right thing, yet it would not support animal life. Still, I could not help saying, with the lawyers, 'If not, why not?' *Experientia docet* [Experience teaches**]. I determined to try the matter for myself.**

There is no doubt that this was included in the introduction to assure readers that he, Gosse, had no assistance from any of the scientific community. One can imagine Warington's surprise when he read Gosse's introduction. Accordingly, he replied in an article submitted on November 1, 1854:

In the *Annals and Magazine of Natural History* for July last, you published a short communication from Mr. Gosse, on the artificial formation of sea water, and having lately had my attention especially directed to this paper by a friend who wished to put the formula given into practice, I was surprised at the difference in the proportions of the ingredients as compared with what I had myself employed in the course of 1853, more particularly from the circumstance, that when Mr. Gosse called upon me in January last, and consulted me on the feasibility of the plan, I told him that there could be no difficulty in the matter, as I had made and had then in use several small quantities artificially produced, and that all that was required was that a good analysis should be taken as the basis for deducing the proportions, and at the same time referred him to the source from which I myself had worked, namely Dr. E. Schweitzer's analysis of the water of the English Channel taken off Brighton.

Gosse's reply submitted on December 20, 1854 was shorter:

If Mr. Warington supposes that I obtained from him one atom of information previously unknown to me, on the subject of making seawater from its constituent salts, he is most thoroughly mistaken. He is no less wrong in saying that I "consulted" him; since I merely mentioned what was on my mind in familiar conversation. With this, however, the public are of course not concerned, and I shall say no more on that head.

Not all believed him. The following appeared in the *Leisure Hour*, January 25, 1855:

It is now some months ago that Mr. Gosse, the gentleman on whom the care of the marine vivarium belonging to the Zoological Society devolves, and to whom the public are indebted for some most interesting works on natural philosophy, published a formula for the generation of sea-water artificially, and having supplied some marine pets with the liquid, found that they thrived in it well. The analysis of seawater chosen by Mr. Gosse was that made by Dr. Schweitzer, the formula of which it appears was suggested to that gentleman by Mr. Warington of Apothecaries Hall."

Thus, Gosse in effect shot himself in the foot and caused what he was worried about come to pass. His actions were decidedly unethical; Gosse and Warington were good friends at the time and good friends do no dissemble like Gosse did in this manner.

C.5 A MEMORIAL OF THE LAST DAYS OF EMILY GOSSE

The third example involved a memorial book dedicated to his first wife, Emily Bowes. Emily Gosse found a lump in her breast that was diagnosed as cancer in April 1856. She began alternative treatment by a quack doctor [Jesse Weldon Fell] on October 10, 1856 and decided to discontinue that treatment on December 17 after the cancer continued to spread, and eventually died from the illness in February 10, 1857. Gosse described the journey in graphic detail, quoting often from Emily's letters and journal, in an 1857 book titled *A Memorial of the Last Days on Earth of Emily Gosse, By Her Husband*. Gosse's extremely graphic account of his wife's death from breast cancer in the memorial he wrote of her is incredibly painful to read and was not well received by his friends and family. The following is an extract taken from Gosse's book:

The whole surface of the left breast, an area of four inches in diameter, was wetted with nitric acid, applied by means of a small bit of sponge tied to the end of a stick. The object of this application was to remove the skin. The smart was very trying, and continued for sev-

eral hours augmenting; the effect being to blister and destroy the whole skin, exactly as if a severe burn had taken place.

On the succeeding day, the doctor proceeded to incise the tumour, in order that it might be penetrated by the peculiar medicament which he used for its separation. With the scalpel he drew, on the surface of the now exposed flesh, a series of parallel scratches, about half an inch apart, reaching from the top to the bottom. When these were made, a plaister of a purple mucilaginous substance was spread over the whole. The next day, on renewing this plaister, the scalpel was passed again along the scratches, deepening them a very little; and a fresh plaister was applied. By the daily repetition of this operation, the scratches were in a few days deepened into long parallel cuts or scores, into which narrow strips of linen rag, covered with the purple mucilage, were pressed, instead of the common plaister. Every day these strips of rag were renewed, and the scores were made deeper and deeper.

The effect of this application was very distressing. In about an hour after its renewal every morning, the breast began to be the seat of an aching, piercing pain, under which my beloved sufferer was fain to wander up and down her narrow room, leaning now and then her head upon the mantel-piece or against the wall, unable from the agony to lie, sit, or stand. For several hours this continued, after which the intensity of the anguish commonly abated. Abatement of suffering, however, was the most she could look for; suffering never ceased from the beginning of the operation, till her spirit was freed from the worn-out body.

With regard to Emily Gosse's treatment, Dr. Thomas Spencer Wells had to say (Well, 1860):

I feel certain that any surgeon who reads this harrowing narrative of useless torture, and compares the history of this painful case with others in which he has removed large cancerous growths in a few seconds, without pain to the patient under the anaesthetic influence of chloroform, and has seen the clean cut wound he has made unite in a few days, will be shocked by the contrast.

The writing of this book was clearly another error in judgment by Philip Gosse.

C.6 OMPHALOS

The fourth example also came about in 1857. Despite authoring an impressive number of books and articles, Philip Henry Gosse is likely best remembered for his strangest, *Omphalos* (the Greek word for navel); his book addressed the question of whether Adam had one. Gosse published *Omphalos* a year before the announcement of Darwin and Wallace's theory of natural selection, and many scientists of the time shared Gosse's belief in the fixity of species. In his 1843 *An Introduction to Zoology*, for example, there is one passage that is worth quoting for its evidence of Gosse's abiding belief in the literal truth of verses 20 and 21 of the first chapter of Genesis. It is his own explanation

Figure 12: Emily Bowes Gosse photographed on her death-bed, aged 51. The photograph was touched up (and also colored) by William Gosse.

of the origin of species, a phrase not yet loaded with its Darwinian freight. Of the word "Species" he wrote that it was

a term used to signify those distinct forms which are believed to have proceeded direct from the creating hand of God ... Thus, the Horse and the Ass, the Tiger and the Leopard, the Goose and the Duck, though closely allied in form, are believed to have descended from no common parentage, however remote, but to have been primary forms of the original creation.

Geologic time, however, was another matter. Mountains of sedimentary rocks loaded with fossils argued strongly that humans were a recent arrival on an ancient planet. How to resolve this troubling evidence with a literal belief in Scripture? Gosse's book was an attempt to rescue Creation itself from the perceived threat of science denuded of Christian authority. Gosse fervently believed that God's word and works were in accord, but if there was any conflict between the two it was because naturalists had been looking at the world in the wrong way.

Gosse attempted to mend the increasing distance between a literal reading of Genesis and the facts of geology in a very peculiar way. If you found the skeleton of an extinct animal, Gosse proposed, you would naturally assume that the bones must have given form to an animal that lived at some distant period. But what if you were mistaken? What if, instead, the bones had been created already in place in the ground and had never been clothed in flesh and blood?

For Gosse fossils were just components of the earth that implied history without actually possessing it. God, in other words, had created the world "already in progress." The first plants and animals were all adults, ready to reproduce after their kind and bearing the marks of age that they would be expected to bear. This rule applied to the first humans, too; Adam and Eve had been created with navels even though they had never actually been connected via an umbilical cord to a mother during gestation. Gosse believed this explanation could reconcile the "lost worlds" of geologists to those who believed that the word came into existence in 4004 (Bishop Ussher's computation). Naturally he rejected any suggestion that life evolved. Gosse rounded off his book with perhaps the most extraordinary suggestion of all, that his theory should not affect geological research.

Gosse thought his explanation perfectly understandable but unfortunately for him, his defense of Genesis was met with scorn from both theologians and naturalists. His fellow Christians disliked the implication that God had deceived (some modern-day creationists, however, still invoke the argument that the Earth just looks really old, aided by fossils placed specifically to test our faith) and scientists thought his argument absurd. The public, on the other hand, took barely any notice at all. Gosse felt that he had developed a brilliant reconciliation between science and scripture, but in the end all he did was publicly embarrass himself. This is another case of poor judgment on the part of Philip Henry Gosse. Fortunately for him, although he was pilloried by theologians and scientists alike, the public took barely any notice at all and the sale of his books afterwards on marine biology were never affected.

C.7 MONEY AND THE HOBBY

Gosse's literary earnings are given in detail (Freeman and Wertheimer, 1980) and we learn that Gosse made over £2,000, roughly $236,000 in 2017 dollars - calculated from the site measuringworth.com and based upon the Consumer price index/Retail price indexes - from the five books he published in the mid-1850s. *The Aquarium* was more than a cultural sensation: it was also a financial success, with earnings of about £818 (roughly $96,700 in 2017 dollars). (However, although Gosse had £14,000 (roughly $1,930,000 in 2017 dollars) of investments on his death, it was mostly derived from an inheritance of his second wife, Eliza Brightwen.) Compared to Gosse, whose liv-

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44 Freedom
45 The Sermon on the Stile
46 What is Believing?
47 The Drunkard's Wife
48 The King's Daughter
49 Fire! Fire!
50 The Cure for Cholera
51 The Drowning Sailor
52 A Happy Family
53 Royal Compassion
54 The Bathing Woman and her Visitor
55 Mary Kelly's Letter
56 The Two Tenants
57 Love
58 "I've no time"
59 The Sceptical Traveller
60 The Prize Fighter

*** For the convenience of postal circulation, Nos. 1 to 20 of these Tracts may be had in the form of small books, very neatly printed on Tinted Paper. They are done up in a packet, price 6*d*. These must be ordered under the title of "GOSSE'S INTERESTING NARRATIVES."

"They were EXACTLY what suited us. I think them far superior to almost any I have seen: short, interesting, and to the point. Some have been circulated in Boulogne; some by our clergyman's lady, who sees so many English here; and others by our friends who meet on Tuesdays to pray for Tract-work in all its branches. Some have also been put into French, and published in various periodicals as articles. Brittany has had several in its Protestant paper, and Dr. Monod's 'Archives' have inserted one or two, abridged."

EXTRACT OF A LETTER FROM FRANCE.

LONDON: MORGAN & CHASE, 38, LUDGATE HILL.

AND MAY BE ORDERED OF ANY BOOKSELLER.

Figure 13: Some of the bible tracts authored by Philip and Emily Gosse.

ing depended a large part upon the books he wrote, Warington was a true aquarium hobbyist and made no money from his research or his writings.

High-quality illustrations, which were quite rare at the time, played an important role in the success of most of Gosse's books. He had inherited his father's artistic talents and is credited with providing the drawings for many of the beautiful lithographic plates that accompany his texts. It was, however, his first wife, Emily, who made the color images for the stunning plates found in *The Aquarium*.

By way of introduction, Emily Bowes was born in 1806 in London. Her parents, William and Hannah Bowes of Boston, Massachusetts, were on both sides of old New England families. She was a talented artist trained by popular landscape painter John Sell Cotman and in 1848 she became the first wife of Philip Henry Gosse. She was a woman of somewhat unusual acquirements, a fair knowledge of Greek and a good Hebrew scholar. Emily, besides publishing two small volumes of devotional verse and a prose work on education was, with her husband, the author of a series of extremely popular religious tracts (see Figure 13). In 1853, also in conjunction with her husband she published, without the name of either author, a volume of sketches in North Devon entitled "Seaside Pleasures." The final chapter, "The Valley of Rocks," is accredited as the prose of Emily who, as well as regularly submitting gospel tracts, was also planning the composition of a series of articles about the Christian care of poor children.

Accurate scientific illustration has often been the purview of women. Yet few Victorian women entered the ranks of scientific illustrators in order to gain recognition for their achievements. Most worked for love or money. Emily Gosse executed all of the underwater landscapes for *The Aquarium* (1854), a stunningly and colorfully illustrated book by her husband, Philip Gosse. This book bears the subtitled "Unveiling of the Wonders of the Deep Sea," a designation that clearly points to the importance of its illustrations. Philip Gosse is here unveiling and revealing nature in this case, the sea through his written text. But Emily Gosse's illustrations are both more dramatic and more accessible to the uninitiated than are Philip Gosse's accompanying words. She is the real unveiler for the public. Nevertheless, although the sale of books like *The Aquarium* was in large part dependent upon the quality of their pictures, she is entirely uncredited on its pages. Instead, her husband's name was inscribed below the images with the legend, "P.H. Gosse, Del." and the lithographer, Hanhart. The "Del." is an abbreviation for delineator, a person who makes a sketch or trace in outline indicating that Gosse supplied the outlines that Emily used to do the artwork on the color images. While it was the general convention at the time for pic-

Figure 14: "Plumrose Anemone," from *The Aquarium*, 1856, 2nd edition. Philip Gosse did the drawing and Emily Gosse did the color artwork.

ture credits in scientific publications to default to the text's author, one does wonder why Gosse failed to mention his wife's contribution at all in his preface, despite finding room to acknowledge the lithograph printers.

Much the same happened with his second wife, Eliza, who was an accomplished landscape painter who filled in landscapes for grouped illustrations of her husband's later works. In *A Year at the Shore* (1864) and *Actinologia Britannica* (1858-1860), for example, Eliza painted the submarine landscapes and Philip painted the creatures that swam, crawled or waved their tentacles in the foreground. One copy of Gosse's *A Year at the Shore*, however, is inscribed like this:

To my beloved wife, Eliza Gosse: whose loving sympathy and fellowship throughout the preparation of this book, it is affectionately presented. P.H. Gosse, January 1865.

D.1 A SLUR ON WARINGTON'S CHARACTER

By way of introduction, William H. Brock is Professor Emeritus of the History of Science and former Director of the Victorian Studies Centre at the University of Leicester. He is a past president of the *British Society for the History of Science* and past chairman of the *Society for the History of Al-*

Figure 15: sea anemones and corals from *Actinologia Britannica*, 1860. Philip Gosse did the drawing and Eliza Gosse did the color artwork.

THE LEISURE HOUR.

A FAMILY JOURNAL OF INSTRUCTION AND RECREATION.

No. 48. THURSDAY, NOVEMBER 25, 1852. Price 1d. Stamped 2d.

THE FUNERAL OF LORD NELSON.

At the present moment, while the recollection of the sublime and imposing pageant attendant upon the recent funeral obsequies of England's great chieftain, by which the nation has so spontaneously testified its gratitude and esteem for his brilliant deeds of arms and sage counsel in the senate, is yet vivid in all minds, it seems natural for us to revert to the burial of Nelson, which

Figure 16: The cover page of Warington's 1852 article on snails and the Stickleback.

chemy and Chemistry. He is considered to be among the most distinguished scholars in the history of chemistry and the history of physics.

In 1991 Brock published a paper titled "The Warington-Gosse aquarium controversy: two unrecorded letters." Oddly enough, the "two unrecorded letters" had nothing to do with the controversy between Warington and Gosse. The controversy recorded by Brock had to do with Gosse's paper referred to above that described his experiments with artificial sea water. Unfortunately, Block missed the whole point of the controversy, attributing it to Warington's pointing out the errors that Gosse made in his formula copied from Edward G. Schweitzer's paper of 1839, rather than focusing on the real controversy caused by Gosse's concealment from Warington of his knowledge of the paper and his own experiments with the Schweitzer analysis during two visits he made to Apothecaries' Hall to ascertain whether Warington was about to publish an article on the subject. Although the facts are clear, Brock concluded that the controversy was Warington's fault because "…he was jealous of Gosse's success in a field in which he had made the major scientific breakthrough," a conclusion for which there is no evidence whatsoever (for further details see my 2012 essay, "Who Invented the Aquarium?" and my 2016 essay, "The Warington-Gosse Controversy revisited"); the fault was clearly Gosse's.

D.2 ROBERT WARINGTON'S CHARACTER

Unlike Philip Henry Gosse, we know very little about Warington's character. What we do know is found in a paper that he intended to present before the Members of the Botany and Zoology Section of the *British Association for the Advancement of Science* at their September 1852 meeting in Belfast, but from sudden and unexpected business engagements he was prevented from attending. His time also was so much occupied as to prevent him copying them in a readable form before the Sections closed. He therefore submitted the final versions to both the *Annals and Magazine of Natural History* and to *Leisure Hour*, the latter being a family journal of instruction and recreation and having quite a different audience from the former. (The *Leisure Hour article* caught my interest and was the inspiration for this essay and hence its title.) The editor of *Leisure Hour* had no problem with this double appearance, commenting that "Independently of the pleasing interest of the facts communicated in the paper, we commend it to the notice of our readers, as pointing out a simple and innocent source of enjoyment to be derived from the observation of the habits of animal life." The title of the paper in the *Annals and Magazine of Natural History* version was "Observations on the Natural History of the Water-Snail and Fish kept in a confined and limited portion of Water."

This paper is of great historical interest, not with regard to its two subjects - water snails and the

stickleback - but rather with providing insights into Warington as the man. My comments on these insights are singled out from parts of the article.
1. The Religious Man. Warington writes:

My object in bringing the accompanying observations before the public is to endeavour to direct, more in detail than I have hitherto been able to do, the attention of naturalists, and those who take a delight and pleasure in the study of God's wonderful and glorious works…

On the matter of God, both Gosse and Warington agree. Both were religious men, Gosse more so. One oddity is that the versions of the paper sent to the *Magazine of Natural History* and to *Leisure Hour* were identical except for the *Magazine of Natural History* where the word :God's" was replaced by "Nature's." Either the editor made the change or Warington did but I suspect the latter, perhaps because he thought that the word God would offend some readers in this more scientific publication.

2. The Modest Man. Warington writes:

And when I state that these observations have been made by one most ignorant on the subject of natural history, and a perfect tyro in this field of research, as the details of this communication will fully demonstrate…

This most beautiful little creature has afforded a subject for much interesting observation for some time past, and I fear that what I have to offer will prove very much a repetition of what has already been published on the subject. As, however, the proceedings and observations of those who dare not rank themselves in the class of naturalists, sometimes from their want of knowledge, cause circumstances to arise which would not otherwise occur, so in the present case my failures through mv own ignorance may develop some new points in the economy of these small fry.

There are several other interesting particulars regarding the habits of the several fish, etc., which I have had the opportunity of experimenting with, and which may form the subject of some future memoranda. I would merely remark in conclusion, that I have, after many difficulties and failures, succeeded in keeping sea-water perfectly clear for upwards of six months, and that I have for the last five weeks had several sea anemones living in it which at present appear extremely healthy, and the water has not been disturbed for the last fourteen days.

Joseph Addison (1672-1719) was an English essayist, poet, playwright and politician. A friend of Jonathan Swift, his name is usually remembered alongside that of his long-standing friend Richard Steele, with whom he founded *The Spectator* magazine in 1711. I like the following quote by him that seems to fit Warington appropriately: **A just and reasonable modesty does not only recommend eloquence, but sets off every great talent which a man can be possessed of.**

2. The Hobbyist Man. Warington writes:

I mention also that they have been made at leisure intervals of very short duration, snatched as an amusement and as opportunities occurred from the weightier matters of professional business…

D.3 WARINGTON RECEIVES HIGH RECOGNITION

In 1857, Warington was invited to present a paper, "On the Aquarium," in the *Notices of the Proceedings at the Meetings of the Members of the Royal Institution of Great Britain*. This year was probably the zenith of the aquarium craze in Britain and the following introduction was made by the Duke of Northumberland, President, in the Chair:

The speaker opened the evening's demonstration, by stating that he had immediately responded to the invitation of the Managers of the Royal Institution to deliver this discourse,

Figure 17: Gosse's quoting from Warington's article on the stickleback indicated that they had reconciled.

on what they had been pleased to call his "own subject," from the feeling that as the originator of the aquarium, he was in duty bound to afford to all those who had taken up this "new pleasure" every assistance, from the results of his own experience that lay in his power in order to render the undertaking more easy and pleasurable; and for this purpose, he proposed to lay before his audience, as far as was practicable, a demonstration of the principles on which it was founded, particularly as very erroneous ideas had been promulgated on the subject, and instructions given in several most engaging publications, which might tend materially to mislead and disappoint those inclined to recreate themselves with this interesting subject.

This is high praise indeed and showed that the scientific community considered Warington to be the authority in the matter of the aquarium, not Gosse.

Warington's paper presented before the *Royal Institution of Great Britain* included aquarium history, principles of the aquarium, water, fresh and marine, vegetation, scavengers, light, heat, food and a few observations on the construction of a microscope for the purpose of employment in connection with the aquarium and the method in which an instrument could be used. It should be noted that when Warington was pressed to give to the world a little manual of instructions for amateurs, he always stated as a reason for non-compliance with the request, that the book market was overcrowded already with the worthless compilations of many scribblers on the subject. He was a really scientific man, and he did not wish to be associated with authors who wrote about things which they had never seen or done.

D.4 RECONCILIATION BETWEEN WARINGTON AND GOSSE

In his 1857 book, *Life in its Lower, Intermediate, and Higher Forms: or, Manifestations of the Divine Wisdom in the Natural History of Animals*, Gosse wrote:

Within a few months of the writing of these pages, a most interesting detail has been published by Mr Warington, of the nest-building instincts and tender care of the commonest of British fishes—the tiny Stickleback, that swarms in every pool.

This was followed by re-writes and excerpts from Warington's 1852 paper in the *Annals and Magazine of Natural History*, "Observations on the Natural History of the Water-Snail and Fish kept in a confined and limited portion of Water." By 1857, therefore, Gosse and Warington had settled their 1854 seawater dispute amiably; Gosse considered Warington be an expert observer of the breeding of this fish and Warington had no objection to Gosse using his material in his book.

E.1 FINAL NOTES

Both Gosse's and one of Warington's sons became even more famous than their fathers. Edmund

Figure 18: Edmund William Gosse (1849-1928), son of Philip Henry Gosse.

Gosse (1849-1928) achieved great renown as a literary critic and biographer. From September 1875, Gosse worked as a translator at the Board of Trade on account of his knowledge of French, German, Italian and, above all, the less well-known Scandinavian languages. He is often credited with bringing Ibsen to the public's attention in Britain. In 1904 Gosse was appointed Librarian of the House of Lords, a position which he held until forced to retire at 65 in September 1914. His presence in Parliament and familiarity with many of the leading figures of the day gave him an extraordinary informal influence. It was during Herbert Henry Asquith's reign as Prime Minister between 1908 -1916 that Gosse was at the height of his influence, being both one of Asquith's most trusted advisors and a member of the *Anglo-French Society*, the *Royal Literary Fund* and the *Royal Society of Literature*. From 1922 Gosse was also President of the *English Association*. Gosse and his wife socialized with Leslie Stephens, the Rider Haggards, Balfour before he became Prime Minister, Lloyd George, and, in later years, Sir Harold Nicolson. Edmund Gosse was knighted in 1925.

The name of Robert Warington Jr. (1838-1907) will ever be associated with one of the most important advances in the agricultural chemistry of the latter half of the nineteenth century, although his classical work on nitrification, which may be regarded as his life-work, bears but a small proportion to the total of that accomplished by him. After studying chemistry in his father's laboratory and attending lectures by Faraday, Brande and Hofmann, Robert Warington Jr. became in 1859 an assistant to Sir John Bennet Lawes at the Rothamsted Experimental Station. Warington was from 1862 to 1867 an assistant to the Professor of Chemistry at the *Royal Agricultural College*. Warington was given by Lawes the post of chemist to his manure and tartaric and citric acid works at Barking and Millwall. His engagement terminated in 1874, but he remained in the Millwall laboratory for two years longer, working on citric and tartaric acids, and ultimately publishing his results in a

Figure 19: Robert Warington, Jr. (1838-1907) , son of Robert Warington.

paper of 70 pages in the *Journal of the Chemical Society* (1875).

He was from 1876 to 1891 an investigator at Rothamsted Experimental Station, where he published many articles on soil nitrification. In 1891 Warington was appointed by the committee for the *Lawes Agricultural Trust* to give six lectures in the United States before the *Association of American Agricultural Colleges and Experimental Stations* at Washington, D.C. from August 12 to 18, 1891. The lectures dealt mainly with the subject of soil nitrification, based upon his own research at Rothamsted. He was appointed in 1894 as an examiner in agriculture for the science and art department of the University of Oxford and was for three years, from 1894 to 1897, the Sibthorpian professor of rural economy at the University of Oxford. He was elected in 1863 a Fellow of the *Chemical Society* and in 1886 a Fellow of the *Royal Society*. Warington's work, placed agricultural science on an altogether different basis from that which it previously occupied, and the institution which gave birth to it has served as the prototype for similar institutions throughout the whole civilized world.

Finally, both of Warington's papers, "Domestic Life of the Water Snail and the Stickleback" in *The Leisure Hour* and "On the Aquarium" in the *Notices of the Proceedings at the Meetings of the Members of the Royal Institution of Great Britain*, are well worth reading in their entirety.

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THE EARLY DAYS OF AQUARIUM CONSTRUCTION

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 13, 2019)

The word *"Tank"* in this essay is used to signify any angular, flat-sided vessel. A "*Slope-back Tank*" is one in which the back inclines at an angle of about 45 degrees to the base. A "*Rectangular Tank*" has all its *inside* angles as right angles. Vessels of a single piece made by a glass-blower and have their sides variously curved are termed "*Blown Aquariums*." An "*Aquarium*" is any of the above receptacles. I'll further stipulate that any aquarium must have at least one area of glass where the inhabitants can be viewed from the outside. Also, in parenthesis after mention of any British currency is its equivalent in today's dollars).

Over the years, any vessel that would hold water, from a pickle jar to a cistern, was converted into an aquarium. In the first part of the 1500's Guillaume Rondelet's wife had kept a fish alive in a glass of water for three years, although we know nothing about the vessel itself or the fish she kept in it. Samuel Pepys made the following entry in his diary on May 28, 1665: "Thence home and to see my Lady Pen, where my wife and I were shown a fine rarity: of fishes kept in a glass of water, that will live so forever; and finely marked they are, being foreign." The "Lady Pen," it should be noted, was Margaret (nee Van der Schure) Penn (1622-1682), the mother of the Quaker, William Penn of Pennsylvania. As in Madame Rondelet's case we know nothing about the vessel itself but it is highly likely that the fish it contained was a goldfish (see Klee, 2016).

The keeping of fishes as pets did not become a popular pastime until after the goldfish was widely introduced into England during the first half of the eighteenth century. At first they were maintained in ponds on the lands of the well to do. Sir John Hawkins, noted editor of Izaak Walton and Charles Cotton, wrote in 1760: "There has also been lately brought hither from China those beautiful creatures, Gold and Silver Fish. These fish are usually kept in ponds, basins and small reservoirs of water,

to which they are a delightful ornament; and I have known a few of them kept for years in a large glass vessel like a punch-bowl." In the second and third editions of *The Complete Angler* which Hawkins edited, dated 1766 and 1775 respectively, the above footnote was repeated, but in the fourth edition, printed in 1784, he saw fit to alter it, stating that "it is now a very common practice to keep them in a large glass vessel like a punch-bowl." The Reverend Gilbert White corroborates Hawkins in Letter LIV of *The Natural History of Selborne*, based on an entry from his journal dated October 27, 1782: "When I happen to visit a family where gold and silver fishes are kept in a glass bowl, I am always pleased with the occurrence, because it offers me an opportunity of observing the activities and propensities of those beings with whom we can be little acquainted in their natural state."

About the middle of the 1700s much attention was given to a minute fresh-water zoophyte, the *Hydra*, and it became almost as much a fashion to keep it alive in glass jars as it was a hundred years later to keep its larger marine relatives, the sea-anemones. Hydra were described in the Enemies of Fishes section of "Exotic Aquarium Fishes," written by William T. Innes (Innes, 1935). Almost 200 years earlier, in Henry Baker's book, "An Attempt towards a Natural History of the Polype" (Baker 1743), the hydra's mode of maintenance was described and figured (Figure 1). The water was changed regularly but Baker did observe minute plants in his aquaria that came with the hydras he collected. He may, therefore, had unwittingly employed this low form of vegetation as a purifying agent and if so, had therefore kept aquaria unaware he was employing the balanced aquarium principle.

In 1790, Sir John Graham Dalyell began to keep living marine animals for observation in his house in Edinburgh and continued this practice until his death in 1851. His vessels containing them were all made of the very finest, clearest glass, wide at the top and just the same width as at the bottom: they were invariably round and all sizes, some short, some long, some wider, some not so wide. He changed the sea-water two or three times a week and though some of the animals lived for eight or ten years, one particular anemone nicknamed "Granny" survived from the time of its collection in 1828 until 1887, out-living Sir John and several others to whom it was passed on.

In 1834 Jeanne Villepreux-Power had two glass vessels for her marine research on mollusks, the first of which was used at home and the second was in a frame so that it could be immersed in water and used for smaller mollusks. Nothing is

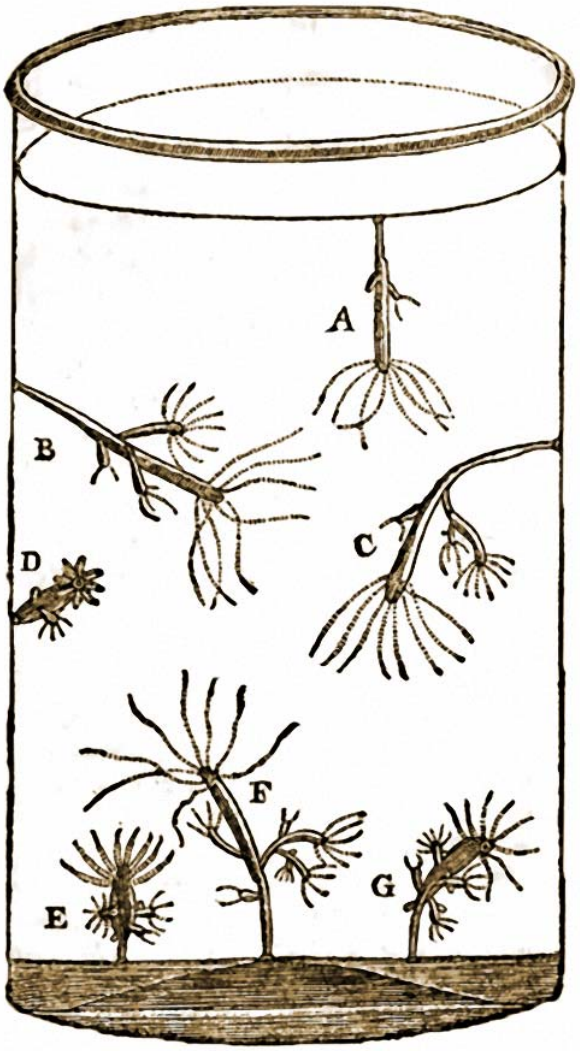


FIGURE 1: The Hydra Aquarium from Henry Baker's book, "An Attempt towards a Natural History of the Polype."

known about these two glass aquariums, neither their shapes nor their dimensions or whether they were identical, except for her comment that the glass aquarium that was in a frame was "too narrow" for the purpose.

Clearly the foregoing historical information does not really shed any light on the history of aquarium construction. However, starting with Robert Warington's paper, "Notice of Observations on the adjustment of the relationship between the Animal and Vegetable Kingdoms," read before the assembled members of the Chemical Society in 1850 (Warington, 1850) and followed by his other papers and articles in gardening and in scientific journals, and with this and the opening of the Aquarium at the London Zoo in 1853 and the publication of Philip Gosse's book "The Aquarium: an unveiling of the wonders of the deep sea" in 1854," the aquarium hobby finally got its start and much more is known now about the construction of aquariums during these times.

BLOWN AQUARIUMS

In the early 1850s, bell-shaped vessels could be obtained at any glass shop in England at prices varying from 1s. ($7) to 15s. ($98). (Those most

FIGURE 2: Hand propagating glasses used by gardeners in the 1800s.

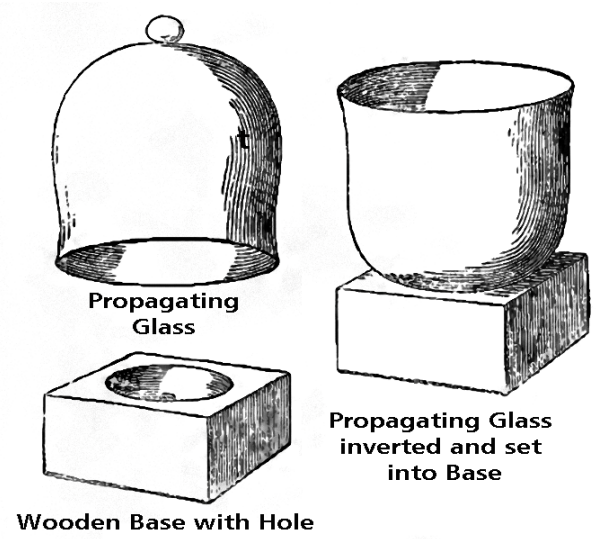


FIGURE 3: Converting a propagating glass into an aquarium.

in use were the common hand-propagating glasses or cloches used by gardeners (Figure 2), which were inverted and supported on a turned wooden stand (Figure 3). Suggested by Thomas Hall (Figure 4), a taxidermist, curiosity dealer and proprietor of an exhibition of stuffed birds and animals, curiosities and natural phenomena, and the owner and exhibitor of the first Kangaroo ever to be brought to Europe, this was the simplest and cheapest vessel ever hit upon for the purpose, and their adoption placed the pleasures of the aquarium within the reach of the poorest student, the village school master, and the inquiring youth. This should come as no surprise since after Warington published his research on the proof of principle of the balanced aquarium in 1850, two years later he was also publishing aquarium material in gardener's magazines.

It is rather curious that while Gosse and others were giving manufacturers perplexing orders for blown aquariums, which cost from fifteen to twenty shillings ($98 to $131) each, a better kind of vessel was to be found in every horticultural glass warehouse, needing only to be turned upside down to bring the difficulty to an end in a moment. This simple trick of creating a cheap and elegant aquarium did more to popularize the

FIGURE 4: Thomas Hall, unknown artist, late 18th century.

aquarium than all the exhibitions and all the books that have been written on the subject, for it enabled thousands to enjoy a delight which had previously been confined to the wealthy few. In time, vessels of this kind of an improved shape, of a quality of glass less liable to fracture than was previously used and of much more elegance were placed on the market (Figure 5).

One shape that was much recommended is that depicted in Figure 6. It is certainly very graceful, but its narrow base was a great drawback, as it neither allowed the introduction of rockwork nor of a variety of bottom plants. Fig. 7 represents a vase which probably surpassed any other for utility since the nearly flat bottom was much desirable. They could be had from twelve to twenty inches in diameter, but a medium size was better as the larger ones were more apt to fracture in frosty weather.

FIGURE 5: An ideal blown glass aquarium.

The greatest objection to all of these circular vessels was that they distorted the objects contained in them.

FIGURE 6: This was a more artistic aquarium, but too narrow at its base for plants or rockwork.

FIGURE 7: This vase probably surpassed any other for utility since the nearly flat bottom was much desirable.

Lastly, a few words about goldfish bowls, the type shaped by a somewhat flattened sphere (Figure 8). They could, of course, be used to hold all sorts of fish but because of their shape, the fish would be distorted both horizontally and vertically, and almost impossible to observe or study with any accuracy. Although this would not have bothered the typical goldfish fancier, it was a deal breaker for the aquarists of the time. The flat-sided goldfish bowl (Figure 9) would have removed most of this distortion but it was not invented until 1916, by George R. West of Pittsburgh, Pennsylvania.

EARLY TANK PROBLEMS

Water weighs 8.34 pounds per gallon so aquariums must be strong. Table I shows the relationship between gallons and weight, and does not include the weight of the tank. Aquarium pea gravel weights about 12.7 pounds per gallon so replacing water with gravel would make the weight even greater. In any event the water in an ideal aquarium should not come into contact with metals that corrode in water, such as iron, zinc or brass and for marine aquaria this is a definite requirement. Goldfish

FIGURE 8: The typical goldfish bowl of the 1800s.

bowls of capacity 1, 2 and 3 gallons were the usual sizes and made completely of glass, so strength and materials of construction were not factors here. Thus the main problems with the tanks of the day included the following:

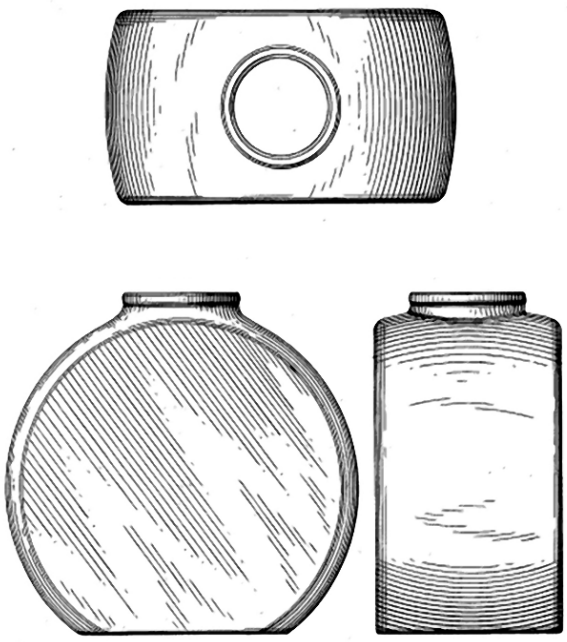


FIGURE 9: The first flat-sided goldfish bowl, patented in 1916.

1. The material of which the frames were made was corrodible or brittle, being of iron, zinc, brass or clay (the last-named will be discussed later in this essay); the glass sides were generally not thick enough and the bottom was commonly either metal or a thin friable slab of roofing slate. All metals will corrode or dissolve in water to some extent. Therefore it is a good policy to keep metal directly out of the aquarium water. This is especially true when the water is soft and acid. The more toxic metals are zinc and brass.

When zinc or brass dissolves in hard water or salt water, the calcium present nullifies, to some extent, the toxicity of the zinc while the magnesium present helps nullify the toxic effect of the copper. Copper is fairly well known as a dangerous metal in the aquarium. It is bad in hard or soft water but especially so in the latter. Very beautiful aquariums were made of copper and brass (a copper alloy) but unless every precaution was taken to insure that the aquarium water would not come in contact with the metals, the fish could be poisoned.

Although not as toxic as copper, zinc in the aquarium is bad enough. For one thing, it dissolves faster than copper, especially in aquariums where the pH is below 7. Here, as in the case of copper, hard water is antagonistic. It is best to keep all aquarium water from contact with this metal. Brass, as mentioned, is an alloy of copper and zinc. The remarks pertaining to the two metals hold as well for brass. In soft water, zinc usually leaches out first, leaving a skeleton of copper which is attacked next. Both metals are dangerous to fish.

As is well known, iron rusts in the aquarium. Iron itself is not particularly toxic, but if enough dissolves (and this happens rarely), the resulting suspension of iron hydroxide or oxide can precipitate on the gills of the fish and cause suffocation. For large homemade tanks, it was a good cheap metal to use for the frames, but in view of its rusting tendencies, the inner surfaces of the frame had to be painted with asphaltum and the top of the frame checked from time to time for rust.

2. Their whole construction was not strong and rigid enough to bear the long continued pressure of the quantity of water. Frequent leakages and occasional ruptures were the consequence and *Punch* in 1857 made sport of the aquarium in this regard (Figure 10).

3. The grooves by which the joints were made were cut on a wrong principle, a very serious error. Thin iron, zinc or brass columns and top-rails were used, upon which the glass was merely abutted as on a shoulder, but not inserted, thus causing continual leakages. Furthermore, the cement usually employed became decomposed and friable in a few months. The glass should be set into deeply sunk grooves cut in the solid slate, firmly wedged in on both sides and secured by slightly elastic cement.

4. Not the smallest attention was paid in the general form and construction, to adapt certain kinds of tanks to certain places. All were made alike, to suit every position, and consequently very serious errors of choice were being constantly made by purchasers.

5. The proportions were usually not such as to secure the largest amount of health to the greatest number of specimens in the smallest space. The law that the value of water for aquarium purposes

FIGURE 10: A Punch cartoon from 1857.

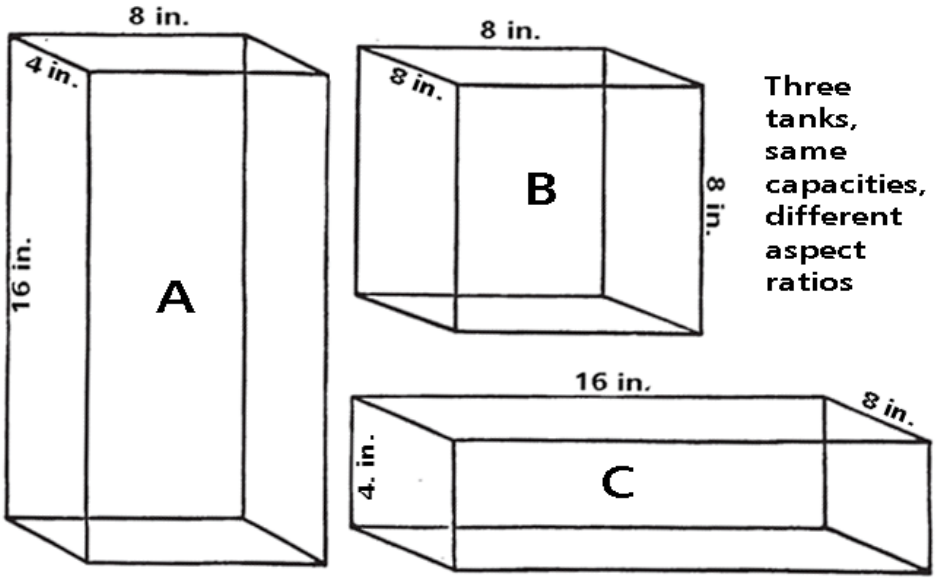


FIGURE 11: Aspect ratio affects water/air surface area even though the tank capacities are the same.

does not, within certain limits, depend so much upon the bulk of it, as upon the advantageous distribution of that bulk over large spaces. Therefore the shape of the tank is a very important matter; and that this is the case is proved by a simple experiment. If a wide-mouthed bottle be filled with water, and an equal quantity of water be poured into a shallow dish or pan about 2 inches deep, and three or four minnows be placed in each vessel, it will be seen that while the fish in the pan remain apparently well, those in the bottle will, after having ascended to the surface of the water, die. The reason that the fish in the one case die and in the other live, is because water is simply a vehicle for holding in solution the oxygen which is necessary to animal life. And the greater the surface of water exposed to the air, the more oxygen will it absorb in proportion to its bulk.

An aquarium of the shape and size of A in Figure 11, which would present to the air a surface of water of 32 square inches, would hardly supply the oxygen necessary for the health of three small fish; while one like B, having a superficial measurement of 64 square inches, would hold comfortably six small fish; but one of the shape and size of C, presenting a surface of 128 square inches, would supply sufficient oxygen for twelve fish. And yet all three aquaria would contain exactly the same quantity of water, viz., 512 cubic inches.

6. No provision was made for the cover as a necessary portion of the tank. Figure 12 shows a tank sold by Lloyd with a plain glass cover for the exclusion of dust, arranged so as to drop into a cavity but made in two or more pieces for the admission of air and ease of removal.

7. Too much glass was used, and too little opaque material. Glass, of course, must be used if it is wished to see the inhabitants as they appear to one another, and not simply as when looked down upon from a higher level. At the same time, glass, unless it is used with caution, has unfortunately the disadvantage of admitting too much light. If the tank is made with all four sides of glass, it must be placed in a comparatively dark situation, and this renders it difficult to see the minute details in the structure of its inmates. On the other

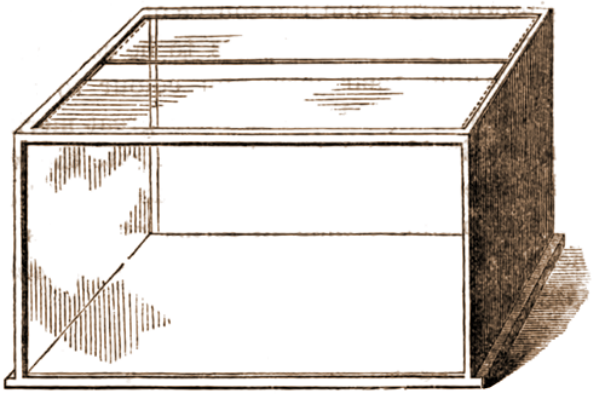


FIGURE 12: An aquarium sold by William Alford Lloyd with a plain glass cover.

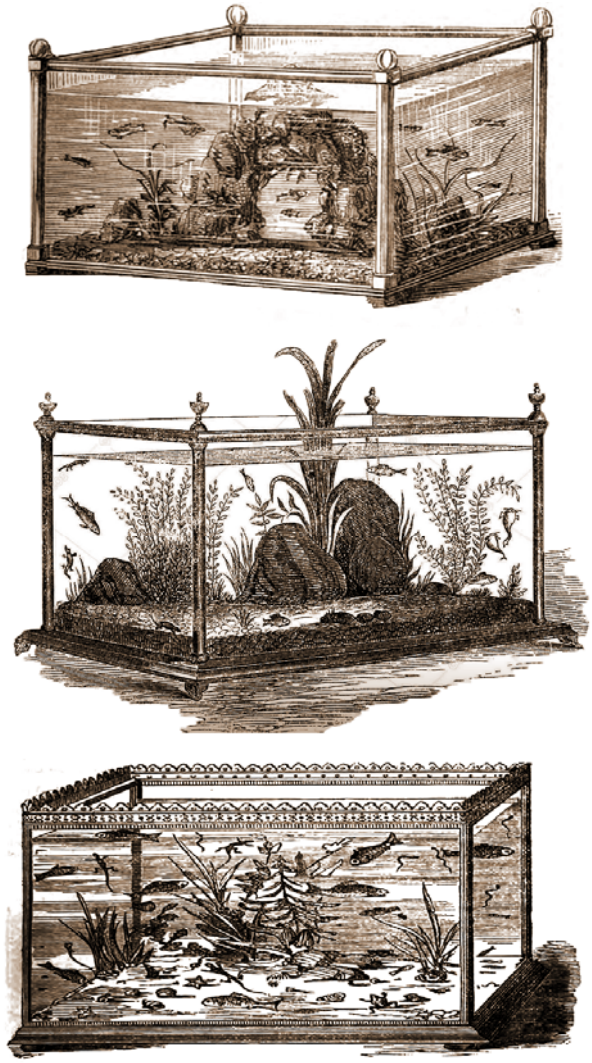


FIGURE 13: Typical ornamentation in the 1800s.

hand, if made partially of opaque material and partially of glass, the light is kept in check, and the tank can be placed in almost any situation such as an ordinary house furnishes.

8. They were not sufficiently ornamental to suit advancing requirements. In the 1850's ornamentation was reasonable simple, as shown in Figure 13. Extreme ornamentation was more common between the Two World Wars (see Figure 14).

THE INVENTOR OF THE FRAMED TANK

The following is from the January issue of *The Garden Companion, and Florists' Guide* (Warington, 1852):

Since the reading of my paper before the Chemical Society, on March 4, 1850, respecting the Miniature Aquarium (*Quarterly Journal of the Chemical Society*, iii 62), I have continued the investigations, introducing other water plants, and also three other varieties of water snail. But the principal alteration has been the construction of a better form of vessel for holding the water, as I found that the globular form of the glass receiver [*see Figure 15*], produced a distortion in the vision of the fish, besides being very inconvenient for observation. I have therefore adopted the form of vessel, of which a sketch is appended [*see top image of Figure 16*], having flat surfaces of plate-glass at the back and front, the bottom and ends being formed of slate, and supplied with a loose plate of glass at the top to keep out dust and soot. To render the whole more ornamental, as it was to stand in a sitting room, some pieces of tufa, or sandstone, were attached to the ends by means of Roman cement so as to form ledges and slopes rising from the water line, on which mosses

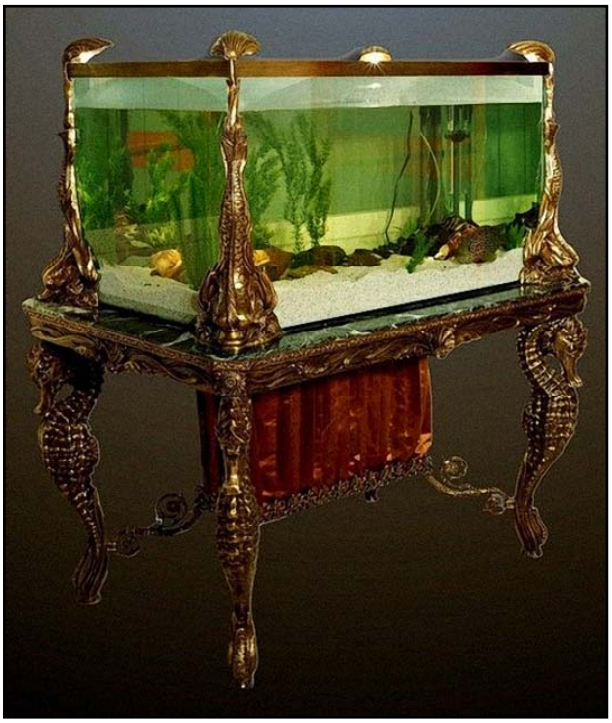


FIGURE 14: Extreme ornamentation was more common between the Two World Wars.

FIGURE 15: Warington's original globular aquarium in which he conducted his first experiments.

and ferns, such as luxuriate in an atmosphere loaded with moisture, could be grown. These materials are set in a stout angular zinc framework, and connected with a mixture of white-lead ground in oil, to which about an equal quantity of red-lead is added. This arrangement I have found to answer all my expectations, as it has been going on most flourishingly since January 1851.

Note: Present day concrete uses a paste of water and Portland cement, a fine powder made mostly of limestone and clay, to hold together small rocks. But it degrades within decades, especially in harsh marine environments. Instead of Portland cement, the Roman concrete used a mix of volcanic ash and lime to bind rock fragments.

This is the first record of the construction of a framed tank. The editors also provided the design shown in the bottom image of Figure 16 with the following comments:

We have already given a view of the parlour aquarium, contrived by Mr. Warington, and which may well bear his name; and have also explained in his own words the principles on which success depends. These principles, it must be obvious, admit of various modes of application so that our former illustration is to be regarded rather as an exemplification of the principle than as a model.

**Figure 16: Top figure - Warington's rectangular aquarium design.
Bottom figure - The Garden Companion's idea of combining this with an upper part that afforded space for a variety of plants.**

The editors also commented as follows:

We now subjoin another design [*see bottom image of Figure 16*] for an aquarium, or Warington case, with the view to indicate, to some extent, the variety which may be attained, by combining this with the Wardian case. It will be obvious that this combination will afford scope for a much greater variety of form than would have been brought out by confining them chiefly to the growth of aquatic plants, and this amount of variety will afford opportunity for the display of a greater amount of ornamentation.

VARIATIONS ON WARINGTON'S AQUARIUM

Thus, Robert Warington is the inventor of the framed tank and of the cover glass as well. His tank was the catalyst for others to devise a plethora of modifications to his design. Figure 17, for example, shows a marine aquarium with the two end sides and the bottom side made of slate and the front and rear sides made of glass. The slates were grooved to receive the glass and the aquarium cement, and two iron bars through the end slates held the aquarium together. I'll discuss this type of construction later in this essay. Figure 18 shows two of the hexagonal and octagonal tanks, framed in iron, that were popular in those days.

In *The Annals and Magazine of Natural History* [Warington, 1854], Warington wrote:

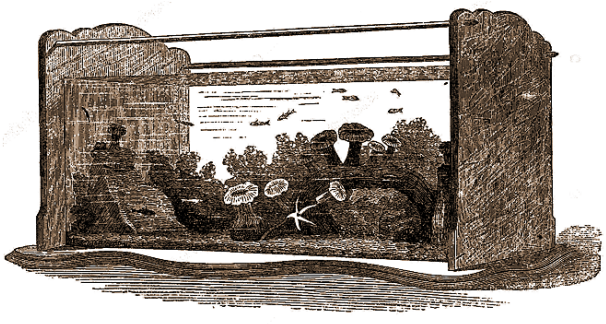


FIGURE 17: A marine aquarium built using two iron rods.

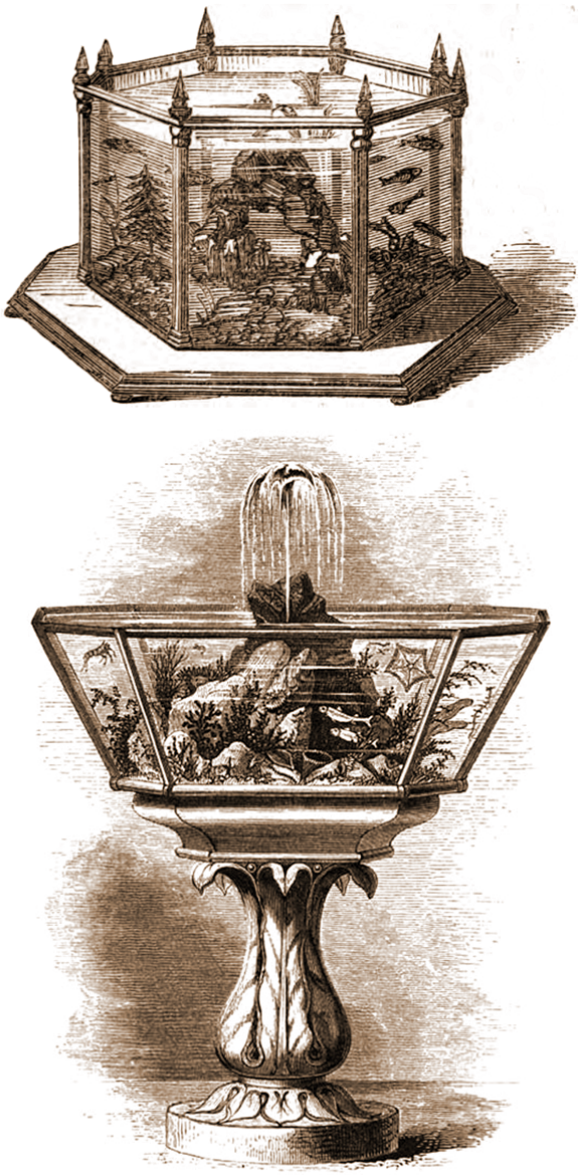


FIGURE 18: Hexagonal and octagonal tanks were expensive but popular aquariums in the 1800s.

The form of aquarium which, after upwards of five years' experience and observation on the natural habits of the various animated tenants, I have now adopted, consists in a four-sided vessel having the back gradually sloping upwards from the bottom at an angle of 45 to 50 degrees, and the consequently extended top sloping slightly downwards and resting on the upper part of the back. The bottom, therefore, becomes necessarily nar-

row. The front for the purposes of observation, and the top for the admission of light, are to be of glass; the back, ends, and bottom being constructed of slate; the whole fixed in a stout framework. The advantages of this arrangement are:

First. That it allows of a most extended view of the whole interior of the aquarium.

Secondly. That it enables the occupants to resort to water of any depth they may desire, or even to ascend the sloping back and emerge from the water.

Thirdly. It admits of a much larger surface of water being exposed to the action of the light; and

Fourthly. The sloping top allows the water which condenses on the glass, from the effect of radiation, to trickle off and return to the aquarium without first resting on the zinc or iron framework.

I need hardly mention that the sloping back is to be covered with light rock-work extending to a short distance above the water line.

This was essentially a triangular-shaped tank (Figure 19) and by "back" Warington meant the sloped bottom side of the tank. Such a tank, of course, could not stand by itself so a supporting framework was supplied for this purpose (bottom image in Figure 19). However, Gosse was a severe critic of the slope-back design:

I have also another tank with a sloping back, made on Mr. Warington's plan. It is of zinc, with the back and two sides of slate, the front and two front-sides alone being of glass. Its form is six-sided, the front resembling a bow window; it is three feet long by one foot ten inches in greatest width, and the same in depth; the peculiarity is that the back slopes inward, so that the bottom is but eight inches wide. I cannot commend this form; its appearance is lumbering and inelegant; the opacity of the back and sides throws the interior into a degree of darkness, (even though placed in a south window), which greatly impedes observation; and I cannot see, by comparison with my others, which are of glass all round, that the advantage anticipated, of admitting the light only from above, is real, or at least of sufficient importance to compensate the uninviting gloominess alluded to. Its depth also is

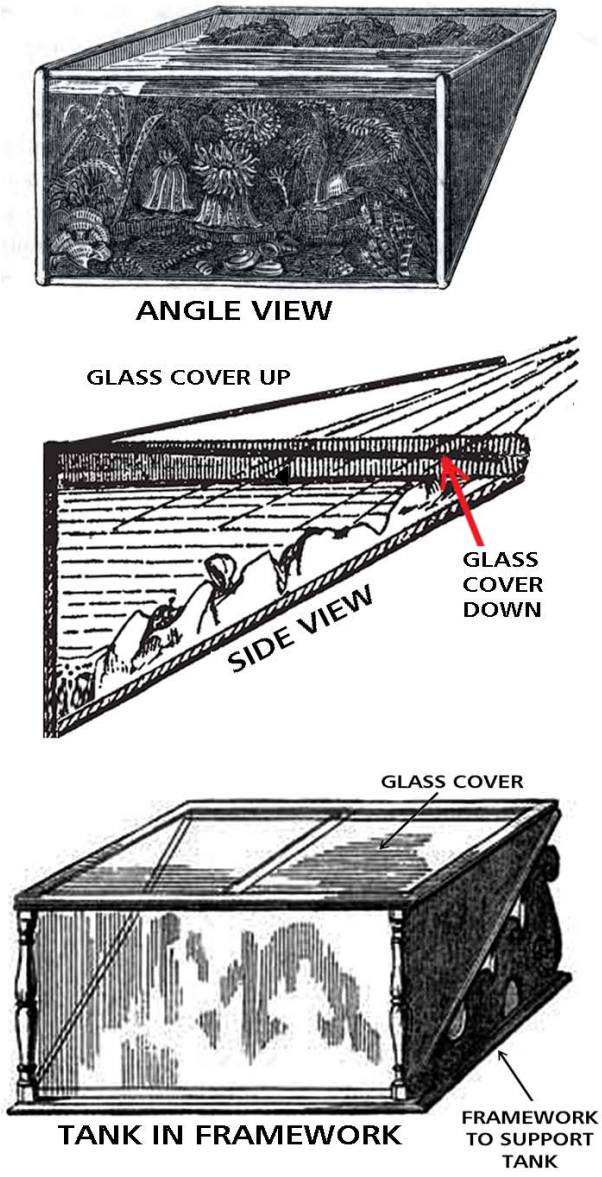


FIGURE 19: Warington's slope-back aquarium.

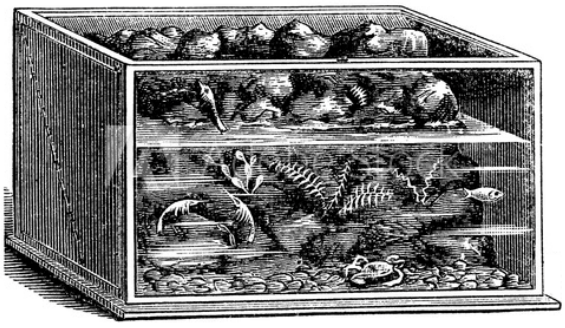
too great; a foot of water is as much as is needful for a parlour Aquarium.

IMPROVEMENTS TO WARINGTON'S DESIGN

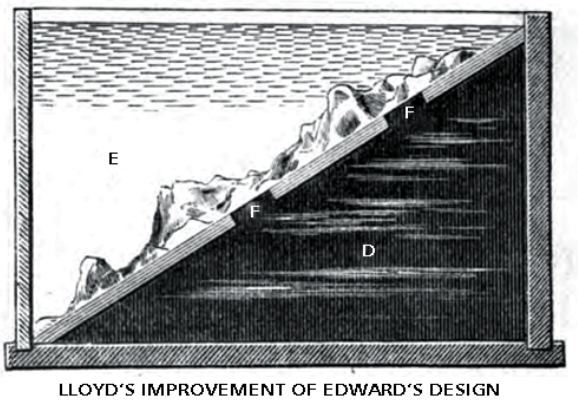
Warington's design was afterwards much improved in 1858 upon by the Welshman, Edward Edwards (1803-1879). Edwards was born in 1803 at Corwen, Merionethshire where he received his education. He started in life as a draper at Bangor, Carnarvonshire, which business he carried on until 1839 when he retired from it. In the following year he established a foundry and ironworks at Menai Bridge, which he carried on for several years with much success. In 1864, being interested in observing the forms of marine life in the waters of the Menai Strait he began to study the habits and characters of the fish in their native element. He was interested in keeping aquatic animals in aquariums in order to study their habits more closely. By imitating the natural conditions under which his fishes flourished, he succeeded in introducing such improvements in the construction of aquaria as enabled him to preserve the fish for an almost an unlimited period without change of water.

His most notable improvement was his dark-water chamber slope-back tank, a modification of Warington's design that incorporated Warington's sloping base within a standard rectangular aquarium provided with a sloping internal divider that converted the triangular space below the slope into a receptacle for water in a state of darkness. This was the result of his close study of the rock pools, with their fissures and chasms, in the rocks on the shores of the Menai Strait. Edwards showed his tank to William Alford Lloyd who suggested that holes be drilled in the divider, small enough so that fish and other animals could not pass through but water could (see Figure 20). Termed the "dark water chamber slope-back tank," it had two advantages: (1) It doubled the amount of water in the tank, diluting contaminants and increasing the oxygen supply, and (2) The dark area decreased algal growth since, without a strong source of light, the algae died. Edwards, in partnership with Lloyd, patented the design on November 24, 1858. The following is a description of the tank in their patent (see Figure 21):

The bottom, sides, and back A of this aquarium or tank are constructed of slate or other suitable material impervious to and not liable to injury from the action of water, and the top and front, B are of glass. C is a partition made of slate or other opaque material so fitted as to divide the tank diagonally, thus forming within it a compartment or chamber D, which is intended to contain water, but is not to be supplied with animals or plants for inspection, and this compartment being sheltered from the light by its situation, by the position of the partition C, and by the material whereof the sides and bottom of the vessel are composed forms a dark chamber, or chamber the contents of which are not exposed to the action of light.



EDWARDS IMPROVEMENT OF WARINGTON'S DESIGN



LLOYD'S IMPROVEMENT OF EDWARD'S DESIGN

FIGURE 20: Edwards and Lloyd's improvements of Warington's design.

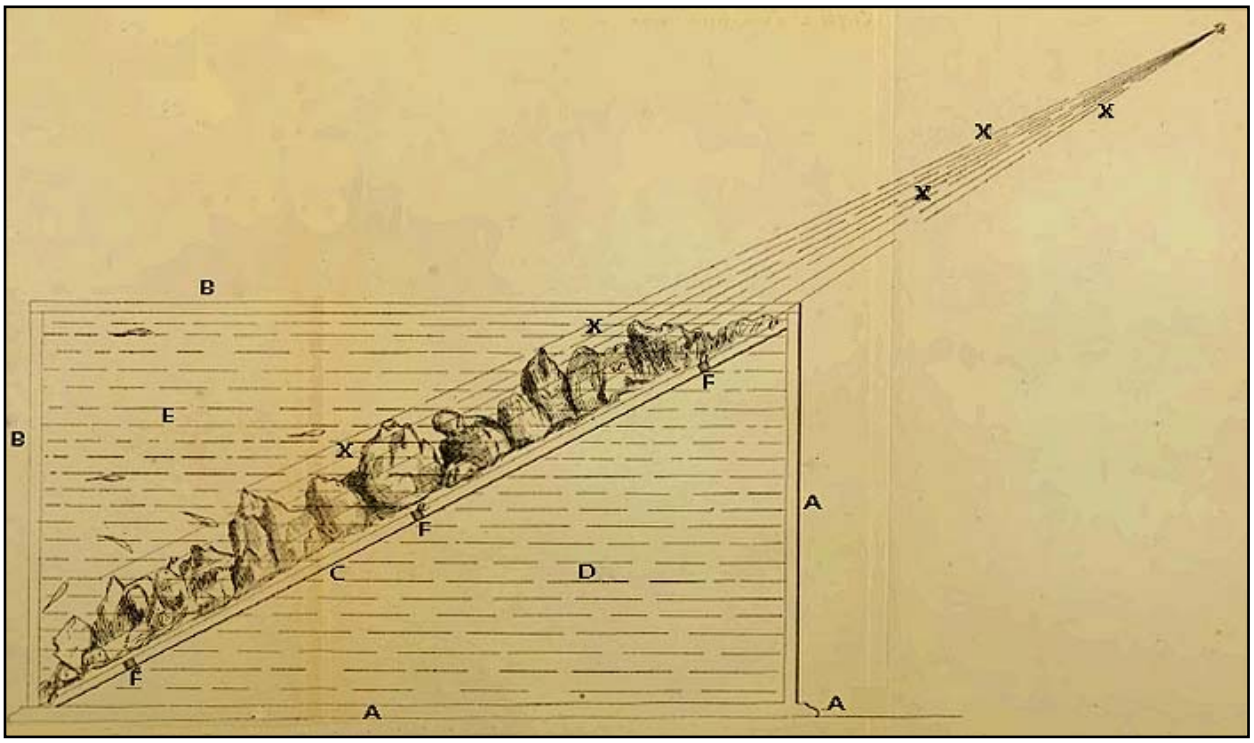


FIGURE 21: the drawing in the Edwards/Lloyd patent.

E is the part of the tank containing the objects exposed to view. The rock work, vegetation, etc., F rest on the surface of the partition C, and the space E is supplied with water and with fish, and other aquatic animals, etc. In some forms of tanks, the portion of the sides enclosing the space E may be of glass, and the other parts or those enclosing D of opaque material. Through the partition C, are a few orifices F, F, F perforating it transversely from surface to surface to afford means of communication between the fluid in the space E, and that in the compartment D. The partition may be fitted in a groove at the bottom of the tank, and rest against the upper part of the back, and it need not quite touch the sides, but may be so placed as to leave a small space between itself and them, through which the fluid in the compartment D may communicate with that in the space E, in this case the orifices through C may be dispensed with. The lines X, X, X etc. illustrate the incidence of the solar rays.

The following is their explanation of what happens in the dark chamber tank:

Now in respect of animals and plants, the construction and arrangement of their receptacles in reference to the effect of light on the fluid contents must be considered as of great importance, and the chief advantage of our arrangement is this, the excessive action of light or actinism on aquaria, &c., tends to develop certain vegetable growths of a nature to render the water turbid, unsightly, and cloudy, and thereby detract from the satisfactory appearance of the collection, and from the clearness necessary for proper inspection thereof; but by forming a compartment in the aquarium, tank, &c., according to our Invention, we obtain a chamber serving as a reservoir of fluid not exposed to the light, and which is therefore retained in a clear and serviceable condition, free from such obnoxious vegetation ; and this fluid being allowed to communicate with that in the space containing the aquatic animals and plants, the excessive and in this respect detri-

mental effects of actinism are neutralized and counteracted. It may also be mentioned that when there is active interchange between the fluid in the space E and that in the compartment D, such minute vegetable growth as may be carried into the latter will speedily perish therein from want of light, and by its destruction will restore the fluid to its original limped condition.

Lastly, the following were the specific claims for the invention:

And having now described the nature of the said Invention, and in what manner the same may be performed, we declare that although we have shewn as one mode of carrying the Invention into effect, an arrangement in which the rock work is placed on a slanting partition, we do not claim as of our Invention the supporting of the rock work of aquaria on a slanting surface, and we lay no claim to any particular external form of aquarium, tank, or such like receptacle; but what we claim as our improvements in aquaria tanks, and similar receptacles for aquatic animals and plants, is, forming therein a compartment or compartments which may be preferably so contrived as to form a dark chamber or chambers, and which is or are to contain no animals nor plants, but to be supplied with fluid caused to communicate with that in the space containing the animals and plants.

The patented dark chamber tank was sold exclusively by Lloyd. Unfortunately, Edwards would be recorded in history as the inventor of this kind of aquarium on a design which had evolved from ideas already explained and published by others, notable Robert Warington and also William Thompson (see Thompson, 1853).

At the time the patent was awarded, Gosse was persuaded by Lloyd to change his mind, at least with regard to the dark-chambered slope-back tank. These improvements on Warington's design staved off for a long time the falling off in the taste for domestic aquaria, and the principle of Edward's and Lloyd's tank was successfully adopted in many of the large public aquariums of the time and in many of the Continental and American zoological schools.

A NOVEL TANK CONSTRUCTION

Gosse, in his "Hand-book to the Marine Aquarium" (Gosse, 1856) described a novel mode of constructing tanks suggested to him by Mr. W. Dodgson, of Wigton, Cumberland. That gentleman kindly furnished him with the following further information on the subject:

I have lately been constructing two Aquariums, and as the way in which they are made may be new and perhaps useful to you, I take the liberty of communicating it. Slate we have no opportunity of procuring in suitable pieces for joining, and our stone is too porous for the purpose. I therefore got the bottom and two ends made in one piece out of the yellow clay used for garden vases, chimney-tops and other coarse pottery, and found it answered exceedingly well and has several advantages. Partly as a means of supporting the ends, but principally to form artificial rockwork and shelter for the animals, the two ends are buttressed inside with very rough pieces of clay, put on so as to leave plenty of holes and fissures; the fire fastens these firmly together and makes them as hard as stone. Grooves are left along the bottom, and up the two ends, for the glass to fit into (Figure 22). The outside is relieved with ornamental work.

Cheapness is a great recommendation; the pot being charged 1d. [$0.55] or 2d. [$1.10] per hundred cubical inches, according to the amount of ornament. I should think your London potters would make something very neat, and the mould once made, they could be supplied very cheaply; and considering their freedom from leakage and their strength, I think they would prove as satisfac-

tory as any kind of cistern. Mine are about three feet long, and thirty inches high and broad, holding thirty gallons each. I bed the glass with white lead, leaving about a quarter inch in depth of the groove unfilled. When the putty is set, I fill it up with shellac dissolved in naphtha and made into a paste with whiting. This sets very quickly, becoming as hard as stone; it is quite insoluble, and prevents the water from coming in contact with the lead, which I think must constantly be giving off small quantities of oxide."

In reply to some inquiries by Gosse, the same gentleman wrote Gosse further as follows:

I have delayed replying to you respecting the price of pottery for Aquariums till I had an opportunity of seeing the party who made mine. The price of one such as you name would be 6s. [$39] or 8s. [$52], but, as it would weigh four hundredweight, the carriage to London would be quite as much. He was rather doubtful whether with his coarse clay he could make one the length you name to hold together; as two or three of mine, which were shorter, separated in the middle when being burnt, from the great weight of the ends preventing the centre contracting regularly. He thinks your best plan would be to get one of the terra-cotta workers to make one, which he thinks he would do more cheaply than it could be sent from here; and their clay being finer, a much neater article could be made. It would be well to be on the spot, and see the rough clay put on the ends, as workmen in general have not much idea of what is required. To prevent the water filtering through the pots, mine were well glazed inside with flint-glaze, free from lead. Probably it would be better to glaze the outside, and leave the inside porous.

More information was published in an 1865 article about aquariums in *The Corner Cupboard:*

The earthenware tanks for aquaria, named by Mr. Gosse, in his "Hand-book" were made by Mr. Robert Lucock, of Broughton-moor [*he was an owner of a brick and tiles works in Broughton-Moor, Cumbria*], and hold about thirty gallons each. The earthenware consists of a bottom and ends, thickly glazed inside, with a groove along the inner edges to receive the glass sides. These, of quarter-inch plate glass, were bedded in red-lead putty, leaving about a quarter of an inch of the groove empty, along the insides, where the putty would have to come in contact with the water, and might have been injurious to the plants or animals. This space was fitted up with cement, made as follows:—Dissolve eight ounces of shellac in one pint of naphtha or spirit of wine. When wanted for use, stir a small quantity of this solution into a smooth thin

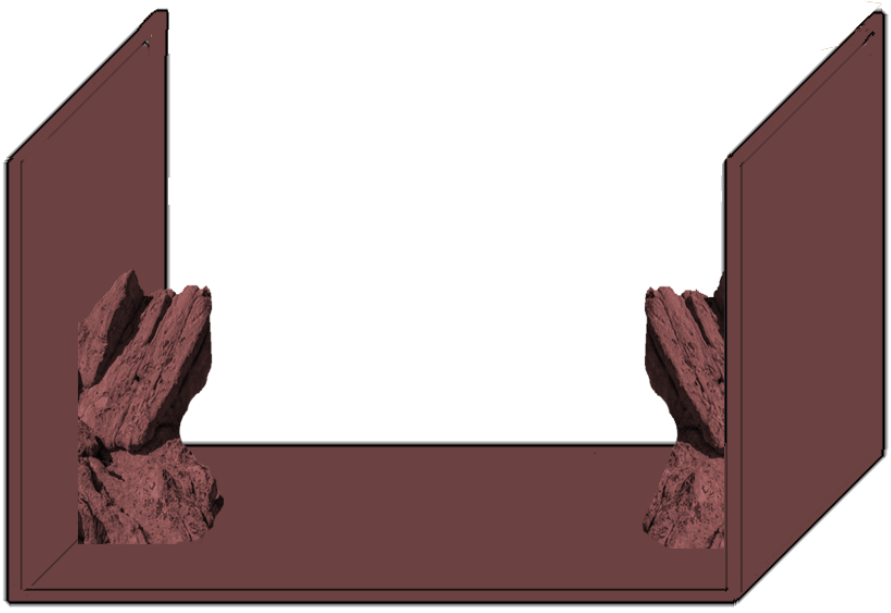


FIGURE 22: The clay aquarium with the artificial rockwork along with the bottom and the sides. The lines denote the grooves for the back and front glass.

paste, with whiting, and apply immediately. If much is mixed up at once it is apt to dry on the outside before it is used. Where there is not a great body of it this cement will set very hard in a few days, and is not injured by water. When the poisonous nature of red-lead is not an objection, it will form a still harder cement than whiting.

Before the tanks were burned in the kiln, rough masses of fire clay were attached to the lower parts of the ends and the bottom, in imitation of rockwork. Owing to the porous nature of the clay at Broughton-moor, and probably in part from the glass not having penetrated the crevices of the rockwork, the water was found, when they were filled; to percolate through the substance of the tanks. They should therefore be made of closer clay, or the rockwork left out and attached artificially afterward. Probably it might be an improvement to glaze the outside and not the inside; the parts exposed to the water would then have more the character of real stone. The earthenware cost about 8s., the glass 18s, for each tank, so that for their size they are cheaper than any other form, and if made of finer clay they would not be liable to leak or get out of order in any way.

Dodgson was not the only one who used clay as a vessel for aquatic creatures. In 1857 Richard Owen (Owen, 1857) described a fourth type (he mistakenly called it a third type) of "cage" that was used by Jeanne Villepreux-Power to study marine life. Her cage, like Dodgson's was made of clay, but fashioned from one half of a clay cylinder cut lengthwise. It was attached by circular metal strips to a board, the openings at the end closed by a framework that was sufficiently open to admit water without allowing its marine animals to escape. It is not known when Villepreux-Power first used this cage but it was sometime after 1834 and before 1857 when Owen described it. Note, however, that this was not an aquarium as it was not designed to hold water.

ROD TANK No. 1

Returning now to the construction tanks held together with rods, it was comparatively easy to make an aquarium to resemble that of Figure 24. It was constructed of glass, wood and slate. The ends and bottom were made of 1 inch well-seasoned pine, dovetailed together, and they were grooved. The grooves ran with the grain, and were 3/8 inches deep, about the same wide, and 3/4 inches from each edge. The ends were held firmly in their places by two bars at the top of the aquarium (G in Figure 23). These bars were 2 inches broad and 1 inch thick and were dovetailed into their places (Figure 24) and had grooves to correspond with those in the bottom and the ends.

The ends were lined with window-glass and the bottom was lined with slate. The sides were formed of plate-glass 1/4 inches thick and were put in their places before the crossbars at the top of the aquarium were fastened, the grooves into which they went having previously been half-filled with the following cement. One pint each of plaster of Paris, litharge, fine white sand, and one-third pint of finely-powdered resin. This (or in this proportion) was kept in a well-stoppered bottle, and when needed, the necessary quantity was made into a putty with boiled oil and driers.

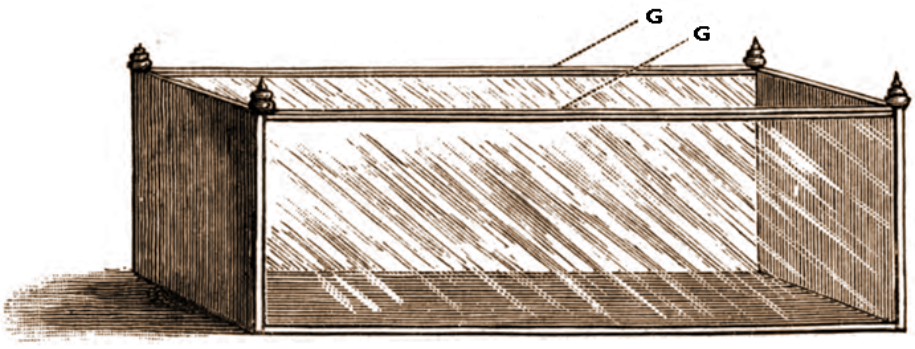


FIGURE 23: The Rod tank No. 1.

This was a very quick-drying cement. It became, if anything, too hard.

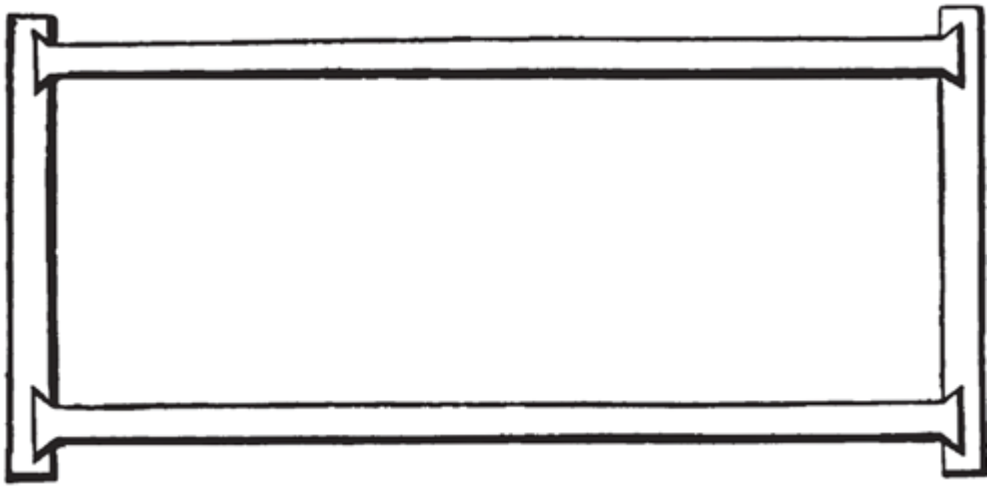


FIGURE 24: The setting of the bars into the top ends of the aquarium.

The bottom was covered with a thin layer of the cement just mentioned, and the slate was pressed firmly and gently into place. In the same way, the glass linings were placed for the ends. The corners were filled with a cement of red and white lead to a depth of 1/4 inch, and when it was somewhat hard, a coating of the cement which was first mentioned was put over it. This cement could be employed throughout but then, for safety, it had to be used a little more liberally than the plaster of Paris cement. The junction of the glass linings with the ends and the dovetailing of the crossbars could be hidden by four strips of wood, 2-12 inches wide and 1/4 inch thick, neatly mitered together and the corners of the framing could be decorated with small turned ornaments as shown in Fig. 23. The woodwork looked pretty good when stained, sized and varnished, or French-polished (this involved applying many thin coats of shellac dissolved in denatured alcohol using a rubbing pad lubricated with one of a variety of oils; it produced a very high gloss surface).

ROD TANK No. 2

Slate, 3/4 inches or 1 inch thick, and plate-glass was required to make a tank like the one shown in Figure 25. The slate could be bought at a slate merchant's at a cost of about 10 penny ($5.50) a foot. The bottom 30 inches long and 16 inches wide and the ends were each 16 inches by 13 inches made an aquarium of good dimensions. At 1 inch from the extremity of each end - that is, across the broad part - a groove 1/2 inch deep and 1-1/8 inches broad was cut. This was supposing that slate 1 inch thick had been chosen but if it was only 3/4 inch thick, then the groove had to be proportionately smaller each way.

The groove could be cut in the following manner: First, the exact place and dimensions of the groove was marked with an awl. Then two straight-edged pieces of wood some inches longer than the breadth of the end were obtained and placed on each side of the line which was to be cut and then nailed to the bench. They had to be just wide enough apart to admit a tenon-saw (see Figure 26).

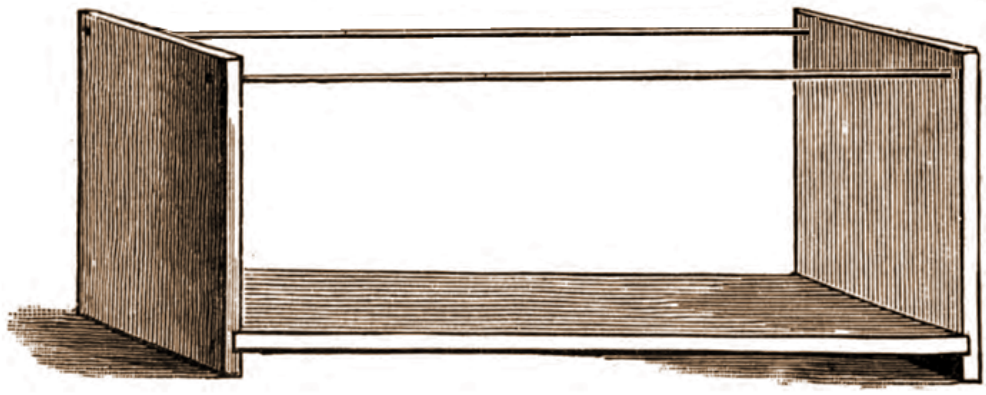


FIGURE 25: The Rod tank No. 2

With the saw, the line was cut to the required depth, 1/2 inch. Without some such preparation as this it would have been difficult to cut the sides of the grooves with the necessary accuracy. When both lines had been sawn in this way, a chisel and mallet were used to cut out the slate that lay between them. But before using the chisel, the precaution had to be taken to put two or three folds of carpet or the like between the slate and the bench to prevent all jarring and the danger of a crack. These grooves were made to receive the ends of the bottom.

There is another way of making the cuts for these grooves. A piece of hoop-iron (i.e., flattened iron in long thin strips used for binding together the staves of casks or tubs - see Figure 27) was obtained, about a foot long, and straightened. Then for a handle, 10 inches of broomstick, more or less, was sawn half through lengthwise, and the hoop-iron was hammered into the groove. The place on the slate where the cut was to be made was marked with an awl and the mark deepened a little by running the point of a three-cornered file a few times carefully up and down. The slight groove thus made was filled with fine white sand, and moistened with water by means of a wet brush. The edge of the tool that had just been made now was run to and fro in this sand and water. By continually doing

FIGURE 26: A tenon-saw.

FIGURE 27: The round bands on these barrels are known as hoop irons.

this, always keeping plenty of sand and water under the edge of the iron, the cut would gradually become deep enough. When the cuts had been made, the portion of slate between them could be chiseled out as before. As a rule, the slate could be split cleanly out by striking the chisel against the edge and not on the top of the slate. This way, there was less danger of breakage. The latter method of making the cuts was the more satisfactory of the two - the former blunted the saw too quickly.

Now along both sides of the bottom and of each end, at a distance of 1/4 inch from the edge, grooves 1/2 inch deep and 3/8 inch broad were cut. These grooves were to receive the plate-glass sides, 1/4 inch thick. After this were bored four holes, 1/4 inch in diameter, right through each end. Two of these were placed 1-1/2 inches from the edge and 1/4 inch below the groove that was to receive the end of the bottom, and the other two 1 inch from the top and just within the grooves cut for the glass (Figure 28).

The holes were for the bolts which ran across from end to end to hold the aquarium together. They were bored with an ordinary brace and a bit used for metal. The bolts preferably were made of brass wire but iron would do. It was a wise pre-

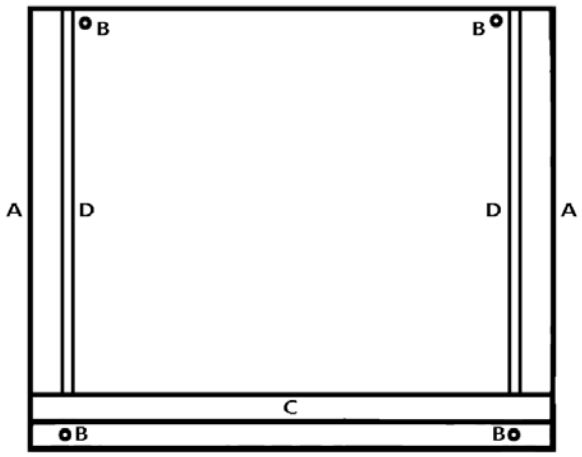


FIGURE 28:
A - End side.
B - Position of the bolt holes.
C - Grooves for the glass.

caution to have the thread for the nut a little longer than necessary, for it could easily be shortened when the bolts were in their places, and the long threading was a great convenience in the screwing-up. Before putting the aquarium together, a little cement was placed in all the grooves. Then the bottom was raised on blocks of wood to such a height that it was level with the grooves cut to receive it in the two ends. When this had been done, the ends, plate-glass, and bolts were put into position and screwed together, turning the nuts of the bolts with only the finger and thumb. Before the nuts were quite screwed home, the glass was pressed gently downward, so that it was forced firmly into its place. Carefully finish by filling up the grooves with cement, and the aquarium will be completed. If iron bolts were used, paint them with Brunswick Black (a quick-drying black varnish used for metal, particularly iron, stoves, fenders and surfaces of indoor equipment. Because of its bitumen content, the coating was highly protective and the finish was attractive and reasonably durable).

A POPULAR TANK FOR HOBBYISTS

An aquarium like Figure 29 was perhaps more suitable for its purpose than any yet described, but was not so ornamental. It could be made either of wood, slate and glass, or of slate and glass only. If made on the former plan, the directions given for the construction of an aquarium like Figure 23 will suffice, with the following exceptions: A wooden side lined with window-glass or roofing-slate, would take the place of a plate-glass side. As the aquarium would be broader than shown in Figure 23, the grooves in the ends for the glass front had to run across the grain and the bottom had to be made the required breadth by clamping and gluing on another piece of wood. The wood work was best dovetailed together, but if this could not conveniently be done, nailing with long French (wire) nails would do. The front had to be framed as well as the top. It made an excellent tank for freshwater fishes.

A useful size for an aquarium of this description was 24 inches long, 20 inches wide and 10 inches deep. If the tank was to be made of slate and plate-glass only, the directions given for making an aquarium like Figure 25 will be enough, except that in the place of a glass side there will be a slate one, and for this the grooves, instead of being 1/2 inch deep and 3/8 inch broad, ought to be 1/2 inch deep and 1-1/8 inches broad. It made an excellent tank for marine specimens.

GOSSES'S AQUARIUM DESIGN

In his book titled "A Naturalist's Rambles on the Devonshire Coast" (Gosse 1853), he wrote the following:

But my attention has been directed to the realization of … a Marine Aquarium for the

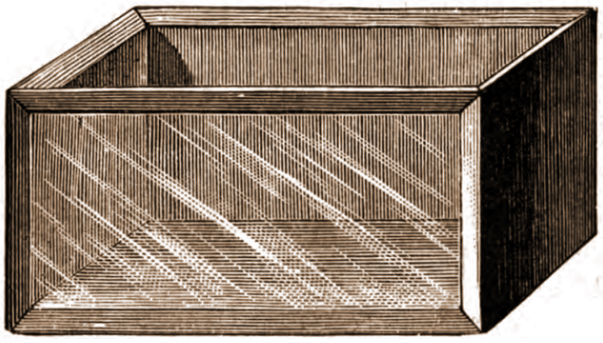


FIGURE 29: A popular tank for hobbyists.

Parlour or Conservatory. An apparatus for this purpose has been for some time in the manufacturer's hands; and though there are some minor difficulties attendant on the mechanical part of the execution, they are not such as to throw any material doubt on my confident expectation, that in a short time an elegant vase stocked with algae and sea-anemones, and comprising within itself the elements of its constant self-purification, will be before the world.

Although the tank in question was not finished at the time of this printing, I suspect that Gosse was trying to establish some sort of priority in tank construction. In any event, as a marine aquarium it evidently did not prove satisfactory and in his book titled "A Handbook to the Marine Aquarium" (Gosse 1853), he wrote the following:

My largest tank (now in use as a fresh water Aquarium,) is a parallel-sided vessel, two feet long, one and a half foot wide, one and a half foot deep; the sides and ends of plate glass, three-sixteenths thick; the bottom, a slab of slate one inch thick; the corners of birch-wood, turned into pillars, each surmounted by a knob, and united by a frame-top or bar going all round. The glass is set in grooves in the slate and wood, and fastened with white-lead putty. I have two others agreeing with this in all respects, except in dimensions, the smallest being (in the clear) fifteen inches long, twelve inches wide, and twelve inches deep. This is a very neat and pretty object for a parlour table, and will hold at least fifty animals appreciable to the senses, provided they be well selected, and a sufficient growth of plants established.

The details on how Gosse's tank was constructed was provided by Reginald A. R. Bennett (Bateman and Bennett, 1890) who commented that if the aquarist was a good hand at carpentering, he could make an aquarium for himself in the following way. A slab of slate was used to form the bottom of the tank, the size of which depended on that of the future aquarium. A good size was l-1/2 inches or 2 inches thick, 30 inches long, and 18 inches or 20 inches wide. In this slab grooves of about 1/4 inch in depth and breadth were formed, running round the sides at about 1 inches distance from the edge. Four pillars were constructed, preferably of birch or mahogany, each 12 inches in length, and two grooves, about ¼ inch in depth and breadth, were made down each pillar at right angles to each other.

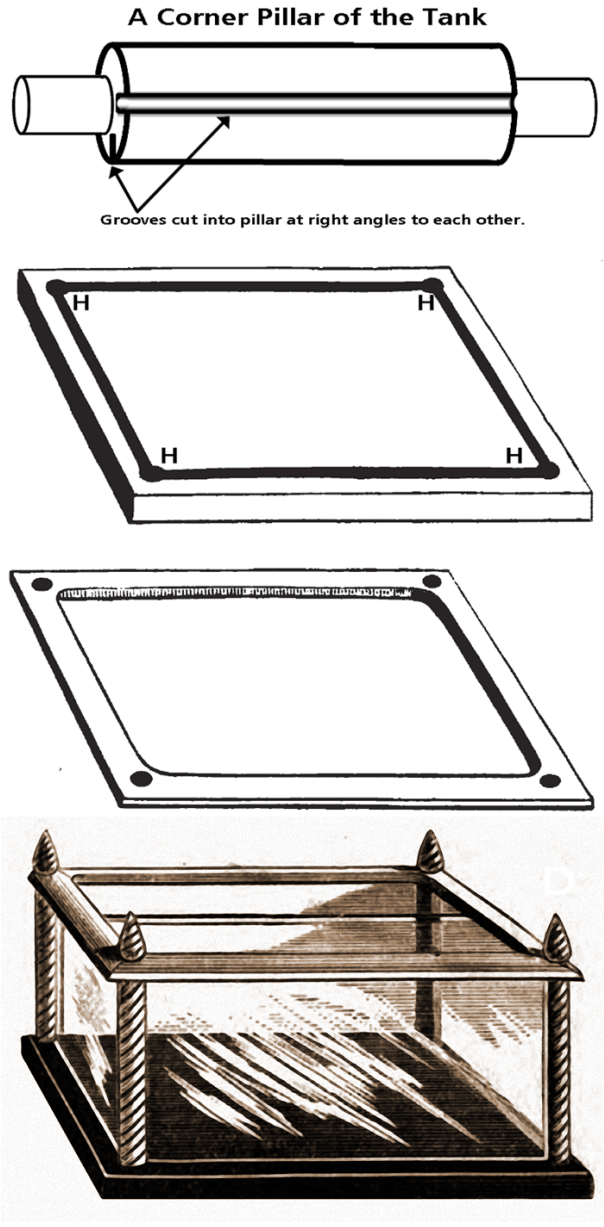


FIGURE 30: Gosse's aquarium design.

These pillars were turned off at the end on a lathe (see image A in Figure 30) so as to exactly fit four holes (each about 1 inch in diameter, and the same in breadth) that was made to receive them at the four corners of the slab of slate where the grooves joined (see H in image B in Figure 30). The pillars were bedded firmly in with a cement to be described in the next paragraph, and allowed some time to set firm in their places. Next, four pieces of what is known as 32oz. sheet-glass of the required dimensions to form the sides of the tank was procured. These were bedded firmly into the grooves in the slate and pillars with the cement, after which a framework was made to exactly fit the tops of the pillars and hold all firmly together (see image C in Figure 30). The last touch was given by inserting ornamental knobs at the top of each of the pillars, and the tank is then completed. Its general appearance is shown in image D in Figure 30.

As to the cement, the following was used in the construction of the tanks at the Zoological Gardens. It resisted the action of salt water and so was used here: 2 gills of litharge, 2 gills of plaster of Paris, 2 gills of fine dry white sand and 2/3 of a gill of powdered resin. It was mixed, sifted and kept in a dry place until required for use. When ready to use it was made into a paste with a small quantity of boiled linseed oil to which a little dryer has been added. The cement had to be used within twelve hours. It would take about a week to dry, and if left for a much longer time, so much the better.

There are several points of importance that Bateman pointed out that had to be carefully observed in the construction of the tank; neglect of them would be a cause of complete failure, or at any rate of considerable discomfort to its owner. A sharp look-out had to be kept on the carpenter to whom the job of making the tank was entrusted to see that he did not use ordinary putty, as this did not withstand the action of the water in the slightest degree. Another point requiring supervision was the insertion of the glass sides, which were sometimes fastened on by abutments, like ordinary window-panes. This was actually done with a tank in Bateman's possession, and the consequence was that it leaked even though every description of cement had been tried to render it watertight. The glass had to be set in grooves and the deeper the grooves the less chance there was of leakage. The red cement used by ironmongers for cementing taps, pipes, etc. at the time was never to be used for an aquarium. It answered well for a short time, but it soon gave off a most peculiar odor that contaminated the water, causing the untimely decease of occupants of the tank if they were not removed immediately when the smell was detected.

If slate could not be easily procured, the bottom of the tank could be made of hard wood, with a piece of glass cemented over it when the tank is put together. The glass would prevent any leakage through the wood that might otherwise take place. The tank could be made broader and longer than described if a larger tank was needed, but a foot of water was considered amply sufficient at the time for a marine aquarium.

As I previously noted, Gosse had designed this tank as a marine aquarium in 1853 but later recommended it only as a freshwater tank. Oddly enough, Bennett described this tank construction in the marine section of the Bateman and Bennett book some 37 years later.

A METAL FRAMED TANK

Although this tank was much more difficult and took much longer to make, it was not beyond the powers of the ordinary amateur mechanic. The materials that were required for its construction were zinc, solder, cement, and plate-glass. The tools necessary were an old tenon-saw, square, hammer, soldering-iron, and a pair of scissors made for cutting sheet metal; but besides these a few blocks had to be prepared. The amateur could either make the blocks himself, or he could get

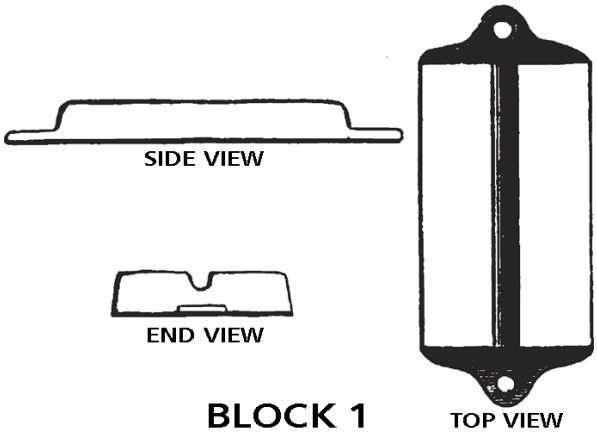


FIGURE 31: Block 1.

them made at a trifling cost. I will describe them in the order in which they were required.

Figure 31 shows an iron block, 6 inches long, having a U-shaped groove down its center. The groove is 3/8 inches wide and 3/8 inches deep. I will call this Block 1.The holes at each end of the block are for the screws that fasten it firmly to the bench. It will not only be useful for the purpose for which it has been made, but at any time it was serviceable as a small anvil for straightening nails and the like.

Figure 32 represents a steel bar a little less than 1/4 inches in diameter, and a little longer than the aquarium is intended to be. Figures 33 (Block 2) and 34 (Block 3) illustrate blocks made of some hard wood. That in Figure 33 ought to be not less than 6 inches long, and the groove in it should be at least l inch deep, and just broad enough to receive a double thickness of zinc. Figure 34 has a groove exactly the same size as that in the iron block of Figure 31. Figure 35 (Block 4) is made of hard wood, faced with two iron plates. The groove in this block must equal that in Block 1 in Figure 31, and the iron plates should be just far enough apart to receive

FIGURE 32: Steel bar with hand hold.

BLOCK 2

FIGURE 33: Block 2.

a double thickness of zinc. Besides these blocks an ordinary miter-block was useful, and all of them were more or less necessary, not only for the preparation of the zinc framework of this particular aquarium, but also for other aquaria of much easier make. The zinc should be moderately stout - that is, about No. 12 gauge.

Having decided upon the dimensions of the tank now about to be made, cut four strips of zinc its exact length, four its exact breadth, and four its exact height. Each piece ought to be 2-1/4 inches wide. Now take a strip of zinc, mark a line down its center, and place it upon Block 1 in Figure 31, the line marked on the zinc being exactly over the middle of the groove and running lengthwise with it. Then take the steel bar in Figure 32 by the handle in the left hand, hold the rod part of it exactly over the line marked on the zinc (and which, of course, was over the center of the groove in the block), and, with the hammer in the right hand, drive the bar and the zinc home into the groove, and about 6 inches of the strip of zinc was bent into the shape of A in Figure 36; bend the rest of the strip in this way, then press, by means of a pair of pincers (B in Figure 36), the zinc tightly round the steel bar. When this has been done evenly and carefully along the whole length of the strip, put the flat part of the zinc into the narrow groove of Block 2 in Figure 33, the bar not having been withdrawn.

BLOCK 3

FIGURE 34: Block 3.

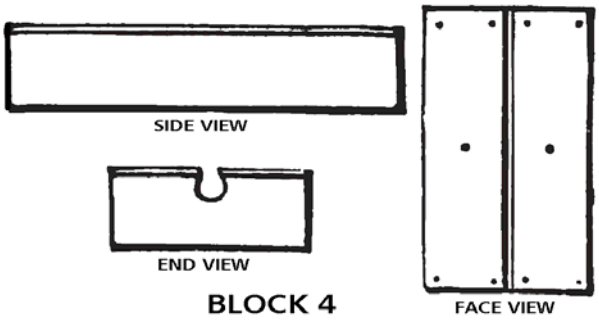


FIGURE 35: Block 4.

FIGURE 36: A - Cross section of the frame; B - Pincers.

This shown in Figure 37 where the flat part of the zinc (A) has been pressed together (B) and inserted into the slot of Block 2 (C).

Take Block 3 in Figure 34, place it over the tubing now formed in the zinc and strike it (the block) with a hammer to rectify any inequality that may have appeared in the molding. Separate the steel bar from the zinc and slide the latter, tubing downwards, into the iron-faced block in Figure 34. Then with a chisel or other like tool open the flat portion of the zinc now facing upwards until it forms as nearly as possible a right angle as in Figure 38. When this has been done, withdraw the molding from the block, and it should now have assumed the shape of Figure 39. If the edges be found to be not quite straight and true, they may easily be made so by hammering them on a side of the miter-block.

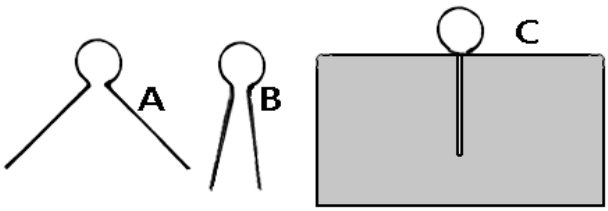


FIGURE 37: Placing the frame into Block 2.

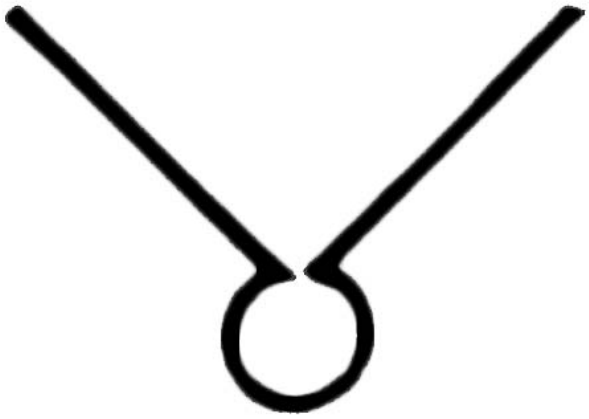


FIGURE 38: The right angle now of the frame.

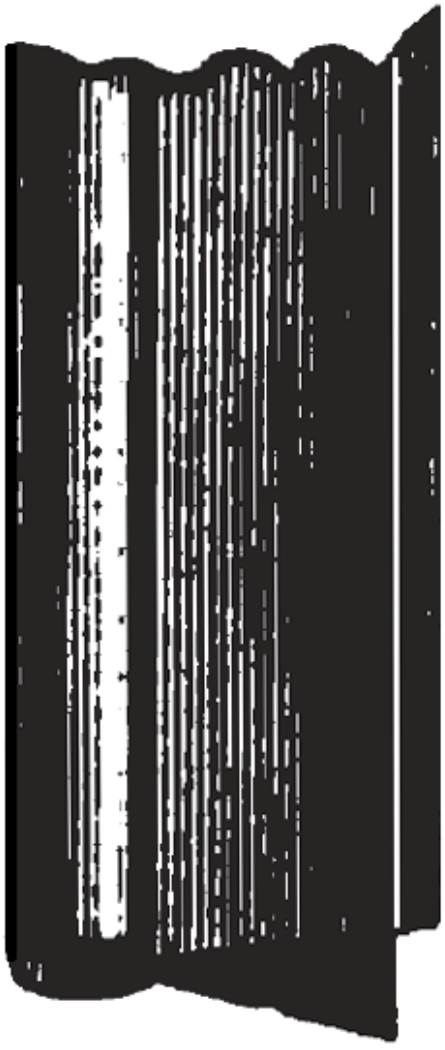


FIGURE 39: The finished frame.

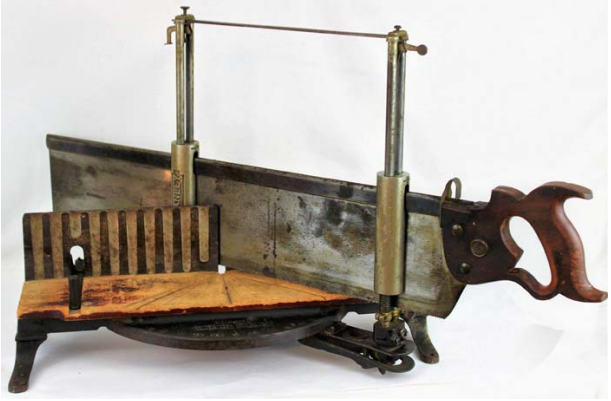


FIGURE 40: Miter-block.

Bend all the other strips in the same way, and then take two of them the length of the proposed aquarium and two of its breadth, and miter them together. The miter cuts can readily be made by means of an old tenon-saw and an ordinary miter-block (Figure 40). Having fixed them in position (Figure 41), solder the corners neatly and firmly together, taking care to have the flat portions of the molding perfectly square - that is one edge quite perpendicular and the other perfectly horizontal (Figure 43). This was for the bottom of the aquarium.

Now take four other pieces of molding, corresponding to the last four, and repeat exactly the same operation, and then the top of the tank was formed. Next join the top and bottom together at the corners by means of the remaining four pieces of molding. Figure 43 will show the way in which these joints are to be made. Care, of course, should be taken that everything is square and true. The framework of the aquarium will now be complete. It is, if properly done, very strong.

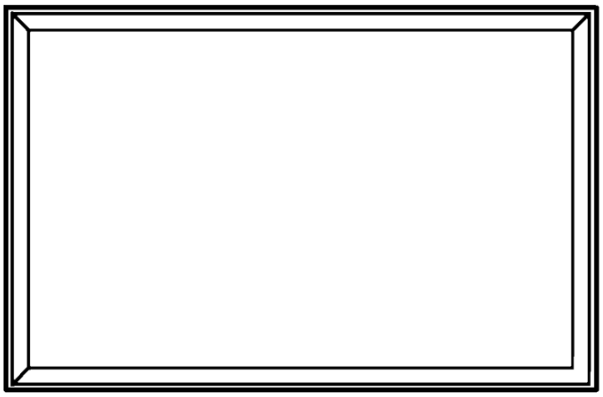


FIGURE 41: The frame ends fixed together and soldered.

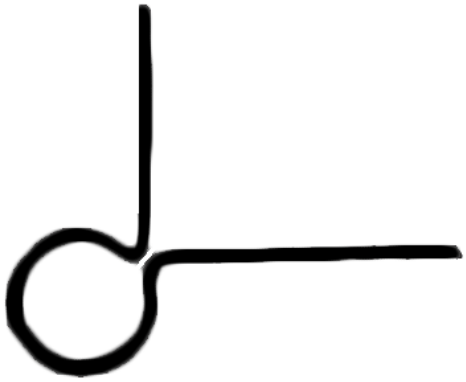


FIGURE 42: Make sure the flat sides are at a right angle to each other.

For a bottom, cut a piece of zinc or slate (the latter being far preferable) the length and breadth of the tank (inside measurements), place it on the ledge that is running round the lower part of the frame inside, and solder or cement it there. The glass for the sides should be 1/4 inches thick, and long enough to go quite across from end to end. But the glass for the ends ought just to touch the glass in the sides, so helping to hold it in its place. Before putting the glass into the frame its bed ought to be painted with gold-size, and then covered with a thinnish coating of cement. Recipes for several kinds of cement are

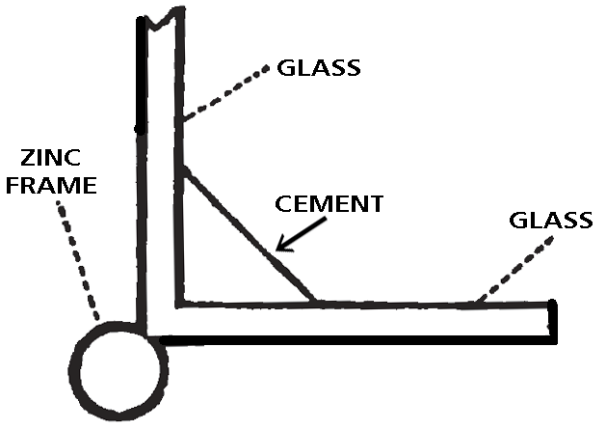


FIGURE 43: Schematic showing how the parts fit together.

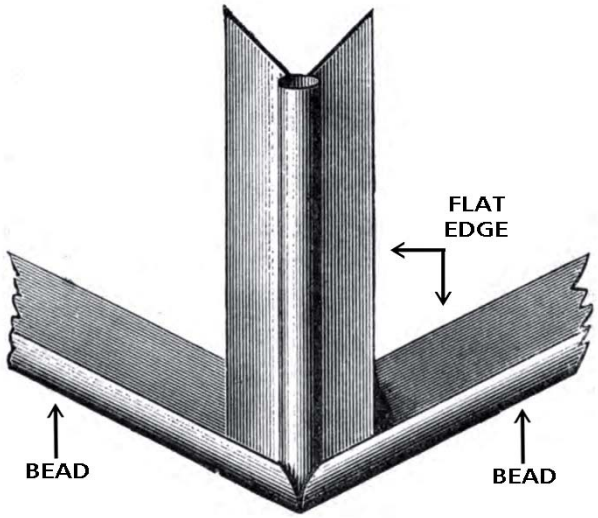


FIGURE 44: Diagram showing how the joints are made.

given at the end of this chapter. But, for an aquarium of this kind, a mixture of red and white lead is recommended. Now put the glass in, and press it gently into its place. Put the sides in first. Paint all the corners with gold-size, and then fill them in with cement to the depth of about 1/4 inches (Figure 45). When the cement has been roughly put into position, the fixing of it may be firmly and neatly completed by gently rubbing it with the finger upon the end of which is some gold size.

The tank should now be left to dry for some days; but during this time a stand and covering for it may be prepared. The stand (Figure 46) can be made of oak, mahogany or pine; this last should be stained and varnished. It ought to be a trifle longer and broader than the aquarium. A groove must be cut in its surface, to receive the beading of the zinc that is at the bottom of the tank. The whole should stand quite firmly. Instead of the heavy-looking covering usually made for such an aquarium as this, a flat piece of glass or of perforated zinc is to be preferred: the former is the better. At the end of a week the cement will have become somewhat hard; and if red and white lead has been used as the cement, it should now receive two coats of a varnish made of the best sealing-wax dissolved in spirits of wine. With this the zinc bottom ought also to be painted two or three times. Japan black may be used instead of the above varnish, but it will not be so satisfactory. If no varnish at all is used, the aquarium must be filled with water for three weeks or a month before it is stocked with plants and fish, the water being frequently changed during the time. The framework of the aquarium was much improved in appearance if carefully painted with Brunswick Black (a quick-drying black varnish used for metal, particularly iron, stoves, fenders and surfaces of indoor equipment. Because of its bitumen content, the coating was highly protective and the finish was attractive and reasonably durable) or enamel of some suitable color; if black is used, it may be "picked out" with gold or yellow.

AQUARIUM CEMENTS

The following eleven cements were used in the 1800s. I have not included minor variations on these formulas. Table II is a list of the definitions of the ingredients used in these formulas.

l. Mix equal parts of flowers of sulphur, pulverized sal ammoniac and iron filings with a good linseed oil varnish, and then add white lead to form a worked mass.

FIGURE 45: A bottom for the aquarium.

2. Whiting, 6 parts; plaster of Paris, 3 parts; white beach sand, 8 parts; litharge, 8 parts; powdered resin, 1 part. Mix thoroughly, and make into a putty with the best coach varnish. Leave the glass in the aquarium a week before disturbing.

3. Linseed oil, 3 oz.; tar, 4 oz.: resin, 1 lb. melt together over a gentle fire. If too much oil is used, the cement will run down the angles of the aquarium: to obviate this it should be tested before using by allowing a small quantity to cool under water- if not found sufficiently firm, allow it to simmer longer or add more tar and resin. The cement should be poured in the corners of the aquarium while warm (not hot). This cement is pliable, and is not poisonous.

4. Take 10 parts, by measure, litharge, 10 parts plaster of Paris, 10 parts dry white sand, 1 part finely powdered resin, and mix them when wanted for use into a pretty stiff putty with boiled linseed oil and driers. This will stick to wood, stone, metal or glass, and hardens under water. It is also good for marine aquaria, as it resists the action of salt water. It is better not to use the tank until three days after it has been cemented.

5. Litharge, fine, white, dry sand, and plaster of Paris, each 1 gill; finely pulverized resin, 1/3 gill. Mix thoroughly and make into a paste with boiled linseed oil to which drier has been added. Beat it well, and let it stand four or five hours before using it. After it has stood for fifteen hours, however, it loses its strength. Glass cemented into its frame with this cement is good for either salt or fresh water. It was used at the Zoological Gardens in London, with great success.

6. Red and white lead, the two being mixed together into a stiff paste. The bed for this cement ought to be painted with gold-size.

7. Gutta percha, in shreds, 4 oz.; black pitch, 8 oz.; shellac, 2 dr. Melt in an iron ladle on a sand bath and stir together. Pour out on a wet slab and roll into sticks. This cement is especially useful for an aquarium made of wood.

8. The best Portland cement.

9. One part pitch and one-fourth part gutta-percha, applied when warm. These should be melted together in an iron ladle over a gas-flame or lamp. This cement is especially useful for an aquarium made of wood.

10. Dissolve eight ounces of shellac in one pint of naphtha or spirit of wine. When wanted for use, stir a small quantity of this solution into a smooth thin paste, with whiting, and apply immediately. If much is mixed up at once it is apt to dry on the outside before it is used. Where there is not a great body of it this cement will set very hard in a few days, and is not injured by water. When the poisonous nature of red-lead is not an objection, it will form a still harder cement than whiting.

11. Gypsum, 2 parts; chalk, 2 parts; litharge, 2 parts; powdered rosin, 1 part. Mix with boiled linseed oil until a mass resembling glazier's putty results.

12. An excellent material for tightening aquaria has been found to be a mixture of litharge and glycerine, which turns as hard as stone within a few hours.

Some of these cements were dangerous. Red and white lead were toxic when breathed, and handling boiled linseed oil and heating pitch and tar -based cements sometimes resulted in severe burns.

EPILOGUE

The modern aquarium was born in Great Britain during the last half of the 1800s but by the end of the century it was in its demise there, to be taken up in the 1900's with a vengeance by aquarists in Germany and the United States. As the Century

FIGURE 46: Gilsonite ore.

moved on, basic aquariums manufactured by firms such as Jacob C. Cassel, the Pioneer Aquarium Company and Excell Tropical Aquarium generally were framed in the typical rectangular pattern and constructed of sheet metal electrically welded (or spot welded, a subset of electrical welding) and finished in green duro.

Gilsonite is a natural, resinous hydrocarbon found in this country in the Uintah Basin in northeastern Utah. It is similar to a hard petroleum asphalt and is often called a natural asphalt or asphaltum. These basic aquariums were generally sealed using a cement made of Gilsonite (1 lb.), a finely mashed resin (1-4 lbs.) and beeswax (1 oz.) the last providing some elasticity to the otherwise brittle compound. They were mixed over a slow fire and applied while hot. Later on, solvents such as linseed oil were added to the asphaltum so that the cement when only moderately warm had the consistency of putty and did not have to be heated for use.

In 1915, John J. Halterbeck was the first to put a one piece aluminum aquarium on market. Others, like Jewel Aquarium, followed with their own designs (Figure 47). Towards the end of the 1920's, an aquarist named M. Raymond Potts of Caldwell, New Jersey, started making tanks under the firm name of the Potts Aquarium Co., Inc. Potts, who was an aquarist, obtained several backers and started producing a new kind of aquarium. Before this time most were made either of sheet metal for the smaller sizes and cast iron for the larger sizes. The former rusted easily and the latter was heavy. Potts, who was treasurer of the firm he founded, came up with a brand new idea - sheet metal that did not rust. Thus the first stainless steel tanks were made available to the American aquarium hobby. This was definitely an American innovation, not popularized in Europe until after World War II. In 1931 the name of the firm was changed to the Metal Frame Aquarium Corporation, although "Potts Aquariums" were still featured. Later the firm was internationally known as Metaframe, Incorporated.

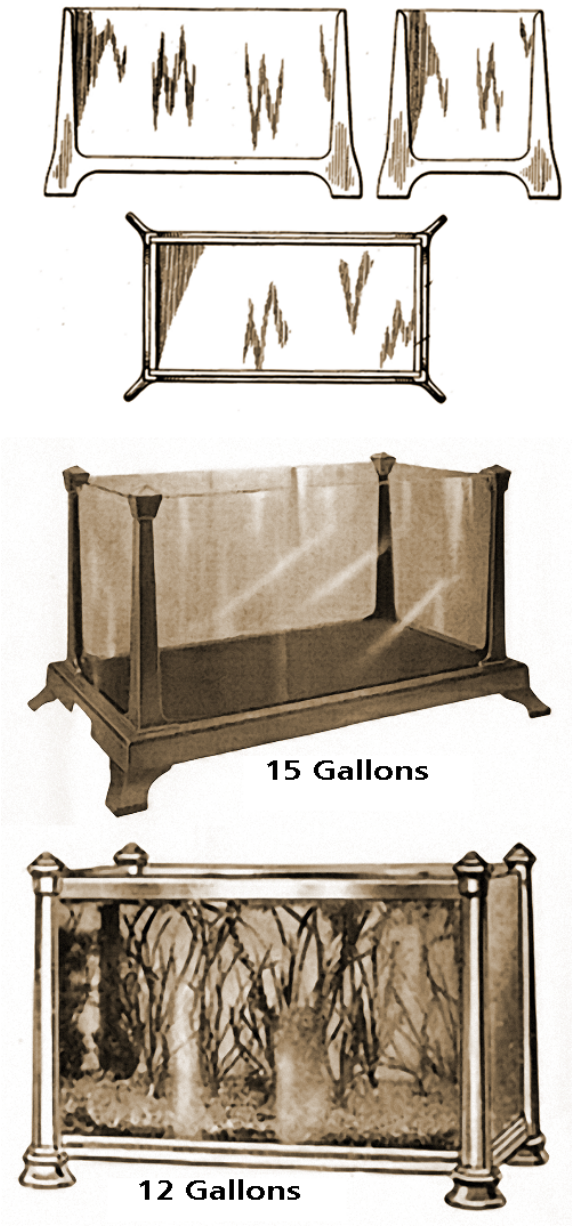


FIGURE 47: Three aluminum aquariums. Top: is Halterbeck's design. Lower two are Jewel Aquarium designs.

FIGURE 48: Two bulb-edged top glass designs.

Because cast iron was very strong, some aquariums were constructed without a top frame. Cut glass is sharp and the top edges had to be smooth and so were rounded off, resulting in a bulb-like edge. Two examples are shown in Figure 48.

Under the Name Jewel Aquarium, the Hans Jensen Manufacturing Company of Chicago created some of the world's finest aquariums circa 1906 to the early 1930s. Their most recognized aquariums featured beautiful iron legs shaped liked seahorses that were hand-hammered then coated with patina bronze (Figure 49). Most of the high-end models Jewel Aquariums sold sat on full black marble slabs. Needless to say, these were exorbitantly heavy. Jewel also made a cheaper line of cast iron tanks in an art deco design. Although these aquariums were cheaper, they were still fitted with a Jewel name tag attached to the lower frame, or had the Jewel name cast into the tank frame on the cast iron tanks (Figure 50). Jewel also made novelty aquaria and one constructed in cast iron in the shape of a house is shown in Figure 51.

The Company thrived during the “Roaring 20s” when tax cuts and loose banking regulations created a glut of easy-money. People spent like drunken sailors, buying up luxury items such as Jewel Aquariums. The company produced aquariums for public consumption from the 1920s but then it all came to a crashing end when the Great Depression hit in 1929. In the 1940s, they shifted to commercial production due to falling public demand for their aquariums and in the 1950s the company stopped operations. Today, original Jewel Aquariums are valuable collector items because of their exquisite workmanship and solid construction. In good condition, they are worth thousands of dollars today.

After World War II another technological development that was to revolutionize the glass aquarium was the invention of rubber-like polymers called polydimethsiloxanes or RTVs, the latter standing for “room temperature vulcanizing,” or simply a rubber which cures at room temperature. Silicone rubber adhesives are made from a complicated process that turns elemental silicon

FIGURE 49: An ornate Jewel aquarium.

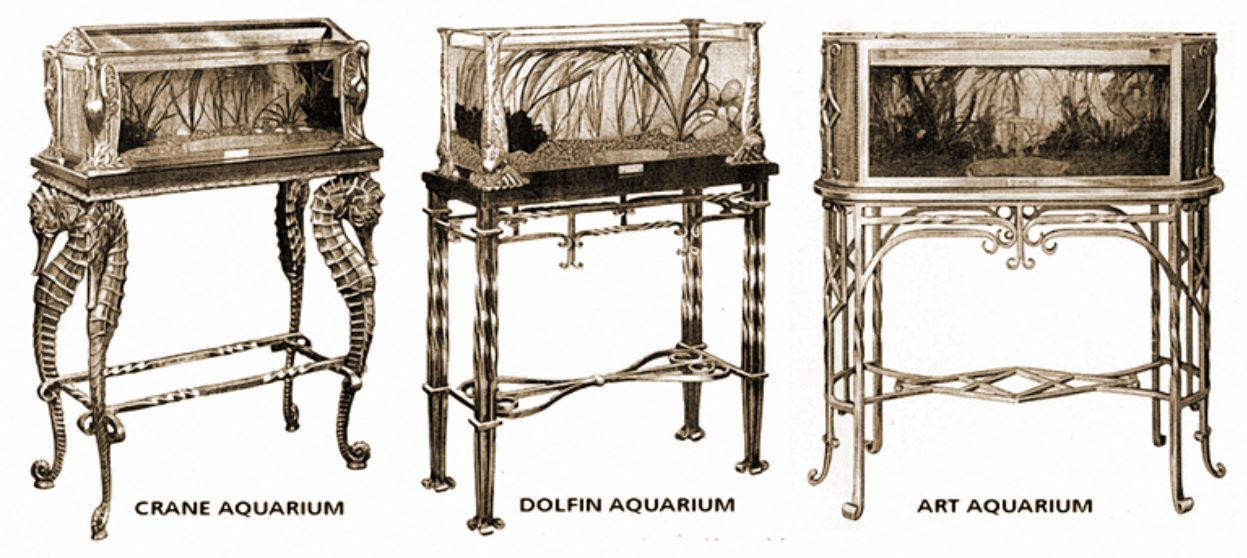


FIGURE 50: Three Jewel Aquarium cast iron tanks and stands.

metal made from sand (silica) into a rubbery polymer. When cured, silicone rubber adhesealants have excellent resistance to moisture that makes them exceptionally suited for bonding glass together to form an all-glass aquarium. In 1963 Dow Corning Trademarked the name, "Silastic," but it was another nine years before the first patent was awarded that involved using this material to bond glass in an aquarium. The patent was filed in 1970 and was awarded to Jerry C. Callan of Dallas, Texas in 1972. Callan described forming his bonds on the outside of the tank rather than the inside because he got his inspiration from a furniture design that constructed corners in a similar manner. In any event, the age of the metal-framed aquarium soon came to a close, to be replaced with plastic top and bottom frames and no vertical supports and all the glass joints sealed with Silastic (Figure 52).

Shortly afterwards, acrylic aquariums became popular. Prior to the invention of UV stabilization, early acrylic aquaria discolored over time with exposure to light but this is no longer the case. Acrylic is generally stronger than glass,

FIGURE 51: A Jewel Aquarium novelty tank in the form of a house.

FIGURE 52: An aquarium with all glass edges sealed with Dow Corning's Silastic.

weighs less and provides a certain amount of temperature insulation but it is more expensive. Acrylic-soluble cements are used to directly fuse acrylic together. The material allows for the formation of unusual shapes, such as the one shown in Figure 53. They are more expensive than glass and are easier to scratch but unlike glass, it is possible to polish out scratches in acrylic.

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FIGURE 53: An acrylic aquarium.

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ROBERT OLIVER CRIGER (1925-2011)

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, July 26, 2019)

Robert O. Criger was born on November 29, 1925 in Trenton, New Jersey to Clo and Euna Criger. His father and mother (nee Euna Hollomon) were born in Jackson, Missouri. At the time Bob was born he had a sister, Elizabeth, some five years his senior. Shortly after his birth his folks moved back to Missouri with the two children where a year later a second sister, Barbara, was born. The 1930, census listed his father's occupation as "Salesman, Sanitizer (i.e., disinfectants, especially in the food industry)."

After finishing one year of college he enlisted on February 2, 1944 at Ft Leavenworth Kansas in the Air Corps with the rank of Private, Reserves. The terms of enlistment were for "The Duration of the War or Other Emergency, Plus Six Months, Subject To The Discretion Of The President Or Otherwise According To Law."

On November 20, 1947 Bob married Sylvia Lee, another Missourian, in Kansas City, Missouri. They had two sons, David and Barry, and one daughter, Cathy. Silvia died in 1985 in Visalia (about 43 miles from Fresno), California at the age of 62. She was born in Missouri and was two years older than Bob.

Bob was a photographer in his early married life but became editor of an 8-page black and white employee newspaper at the Sheffield Steel Corporation in Kansas City, a company that had been purchased in 1930 by the Armco Steel Corporation. The newspaper had evolved into a 32 page four-color magazine. Armco named him Manager of Employee Communications in 1964. Bob also served as area director of the International Council of Industrial Editors - a world-wide group of 5000 industrial editors. He was also was selected by the Council to represent the American Iron and Steel industry on a tour of Russia and Czechoslovakia.

Since I have written extensively on Bob Criger's involvement in the formation and early years of the American Killifish Association I won't repeat them here (see Klee, 2011 and Klee, 2013). Bob's last official activity in the American Killifish Association was in 1963 when he was the Associate Editor of *Killie Notes*. However, Bob was still an AKA member in 1964. It is not known why but we do know that he left Kansas City to go to California in 1966 where he and his family resided in Visalia. In any case, the aquarium hobby did not hear from him between or after this time.

I had always been unhappy that Bob was not better-known to AKA members in the generations that followed. To this end I wrote an article in 2004 about his contributions in the *Journal of the American Killifish Association* (Klee, 2004). A few years later - in 2006 - I tracked him down to where he was currently living in Fresno California and we reconnected after 43 years! At that time Dr. Harry Specht, a very good friend of mine, was writing a series about the Fellows of the AKA and I suggested to him that he interview Bob as he was one of the Association's early Fellows. I supplied Harry with Bob's telephone number and Harry did his interview with Bob that appeared in the *Journal of the American Killifish Association* in its Sep/Nov/Dec/ 2006 edition.

This year I checked again and after some research found that Bob had passed away in Fresno on March 6, 2011. I was very sad to hear of this; he was a good friend and an important part of the formation of the *American Killifish Association*. God bless him in that Great Aquarium in the sky where he no doubt is once again breeding the killifishes he loved.

ADDENDUM

I wish to correct two historical errors about the formation of the *American killifish Association*

that have appeared in the aquarium literature. In Harry Specht's article on Bob Criger's involvement with the formation of the AKA (Specht, 2006b), he writes:

"The first member of the American Killifish Association was Robert Criger. In the previous 'AKA Fellows Profile' we described Al Klee as "Father of the AKA" but that was not, strictly, correct. In fact, it was Bob Criger who, in 1961, took the initiative to contact Al and voice his idea of forming an organization devoted strictly to killifish."

This, however, is incorrect, and the following explains how it happened. In June of 1961 my telephone rang: "Hello! I'm Bob Criger. I'm interested in killifishes and wonder if we couldn't get together tonight for dinner?" Bob, who was visiting his home offices of the Armco Steel Corporation in Middletown, Ohio, some 20 miles from where I lived, projected such bright enthusiasm over the phone that I accepted the invitation and drove out to meet him. It turned out that his telephone call to me was triggered by a series of articles on the genus *Aphyosemion* that I had authored for the old *Aquarium Journal* (Klee, 1960). In any event, Bob had read the series with interest and, knowing that I lived in the area, took a chance, located my telephone number and called me out of the proverbial "clear, blue sky."

Bob was prepared with a list of killy topics for discussion that could have formed the basis for a good -sized book. These were tackled with enthusiasm, for in those days, finding persons who were devoted to killies wasn't that easy. The conversation continued after dinner. We bemoaned the scarcity, not only of information about killies, but of the scarcity of the fishes themselves. Temperamentally, we hit it off beautifully. Bob and I were about the same age and were both interested in editing and knowledgeable about printing technologies.

We were about to call it a night when sometime after midnight, Bob thought out aloud: "Wouldn't it be great if we had some sort of club devoted solely to killies?" At first I was reluctant, but as Bob was particularly interested in developing a professionally produced publication strictly for killies and as he had had considerable publishing experience and access to processes and printers, his suggestion became persuasive. Then, too, the challenge of developing a really successful national aquarium organization was appealing and ultimately irresistible to me. By our fifth highball then, we mutually agreed to attempt the formation of a national killifish association. On this note we parted, Bob returning to Kansas City, his home at that time.

In short, the original intent of his visit to me had nothing to do with the formation of a national killifish association. Furthermore, any reference to either myself or Bob Criger as "The Father of the AKA" is ridiculous. We were, however, its cofounders and we each had our assignments to bring it to fruition and they differed considerably. Bob handled the jobs of publicizing the new organization, correspondence, membership and designing and printing the first issue of Killie Notes. My involvement was in planning, the writing of the By-Laws and the formation of the Charter Committee, of which I was Chairman. In short I built the structure of the organization and determined how it would operate in order to avoid the mistakes of the plethora of unsuccessful prior attempts to organize a successful national aquarium organization.

On a minor point, in Harry Specht's article on my involvement with the formation of the AKA (Specht, 2006a), he writes: "Next they invited five prominent aquarists… to assist in forming the organization." Actually, Bob had nothing to do with the formation of the Charter Committee except that perforce we were both members. Actually, I formed the Charter Committee primarily as a test to see if the Board of Trustees portion of the By-Laws worked as I had written them. As a bonus, the other five committee members provided very helpful recommendations for the operation of the new organization.

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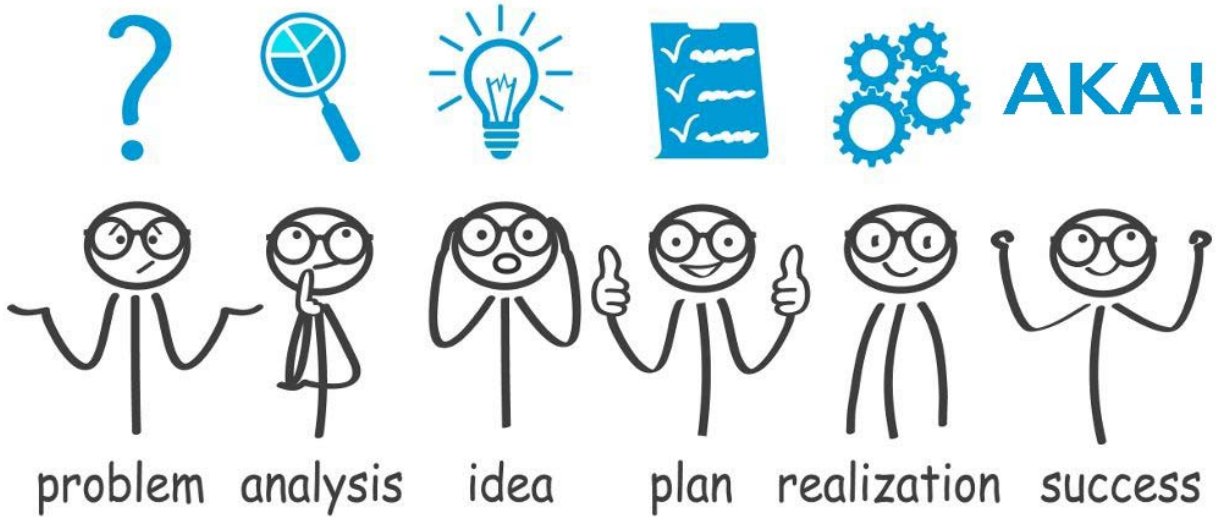

5,000 YEAR-OLD IMAGES OF AQUARIUM FISH GENERA BY PREHISTORIC MAN IN NAL, PAKISTAN

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, September 21, 2019)

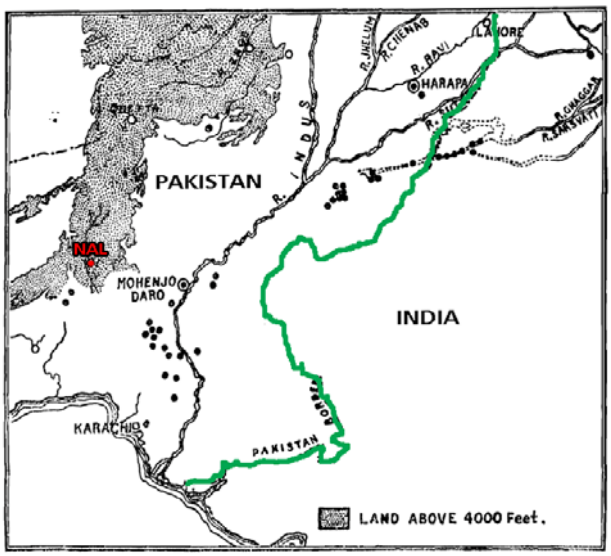

Figure 1: Indus Valley, location of Nal.

The knowledge of the occurrence of fish in India dates back to the third millennium BC. Nal (Figure 1) was located in Baluchistan, India, but after the partition of India in 1947 it is now in Balochistan, Pakistan's largest province. The mound known as Sohr Damb (Figure 2) - the type site of Nal - was founded on a gravel accumulation near a small river. It is about 1,000 feet in length, 600 feet across in its widest part, 43 feet high and is located about 4 to 5 miles to the east of Nal. It had been sporadically excavated in 1903, 1908 and 1923-24 by treasure-hunters, and its beautiful pottery had drawn the attention of archaeologists as early as 1904. But it was in 1924 that it was systematically excavated by the archaeologist Harold Hargreaves of the *Archaeological Survey of India*.

After one season of excavation by Hargreaves in 1924, which made the polychrome Nal pottery widely known, no further work took place until the Joint German-Pakistani Archaeological Mission to Kalat resumed excavations in 2001. So far, 4 seasons of excavations have been undertaken and the Hargreaves excavation has been radiocarbon dated from 3100-2700 BC. Since the Egyptian Eighteenth Dynasty spanned the period

Figure 2: The excavation at Sohr Damb.

Figure 3: Nal vase with an omphalos base.

from 1549/1550 to 1292 BC, this is 1400 years older than the tilapia tiles found in Egyptian fish ponds.

The typical cemetery pottery comprised the following types: (i) bowls with a vertical, inverted, in-turned or everted featureless rim, a vertical or oblique body with a sharp carination (i.e., a shape defined by the joining of a rounded base to the sides of an inward sloping vessel (see the two vases marked A in Figure 4); between the body and the base; (ii) small jars with an out-turned featureless rim and a sharply carinated or concave neck, the profile being squat (with or without carination) or bulbous; (iii) tall vases with similar rim characteristics. A notable feature was the predilection for stable bases in the form of a ring-base, footed base, flat base and even omphalos-base (i.e., a raised, ornamental round base; see Figure 3). The specialized types included (i) bowls with a ring-base, the rim and body deeply pinched at four places to form an Indian lamp (see the vase marked B in Figure 4); (ii) cylindrical bowls with short vertical featureless rim, broad and high shoulder, vertical body and a carinated omphalos-base; and (iii) double cylindrical bowls. Some of these jars and bowls are shown in Figure 5.

The pottery was invariably wheel-made and was of fine texture. The color ranged from greenish grey to buff and pinkish but is also rarely dark brownish or almost black. A large proportion of the pottery had distinctive paintings, the patterns consisting mostly of geometrical designs - vertical or oblique hatching, crisscross, zigzag, dia-

Figure 4: Various Nal pottery designs and three artifacts.

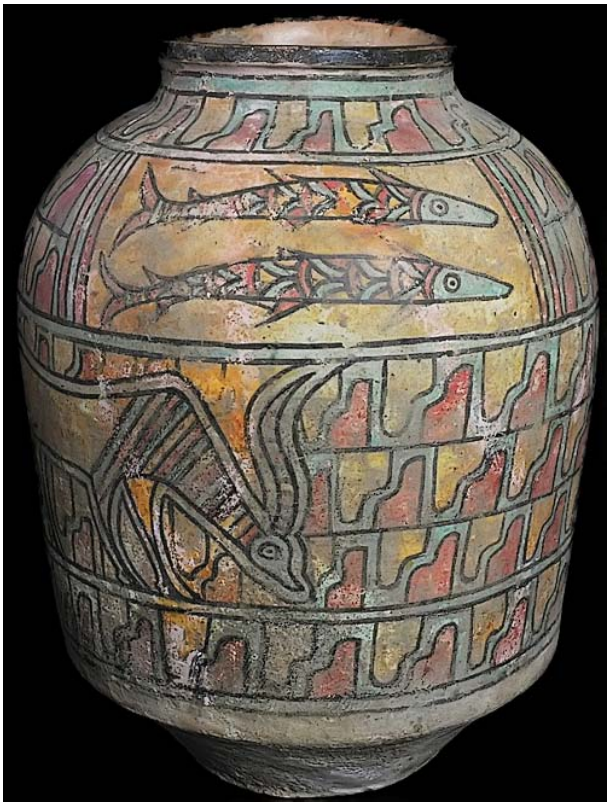

Figure 5: Nal vase showing a fish above and an Ibex below.

mond, single or multiple loops, roundel, omega and multiple "steps." The animals represented were humped bulls, scorpions, birds, fish and ibex. The tumbler shown in Figure 5 contains a drawing of a fish above and an ibex below. Leaf designs were rare but included the *Pipal* (Figure 6). A distinctive feature of the painting was that it was polychrome, the colors used being red, blue, green and yellow. The large variety of colors, applied on a white, red, blackish, greenish grey, buff or pale brown slip, marks out the Nal pottery as unique among the cultures of the Ancient East. Both the pottery forms and painted designs indicated sophistication and maturity.

Figure 6: Nal vase with a painting of the *Pipal*.

At the beginning of 1956 Sunder Lal Hora (Figure 7), a well-known ichthyologist and Director of the *Zoological Survey of India*, Calcutta, noticed a vase in the Prehistoric Gallery of the Indian Museum that had fish paintings on it. The paintings were accurate enough for determining the species as *Tor putirora* Hamilton, the Golden Himalayan Mahseer celebrated amongst anglers. The impressive advancement of art during the Nal Culture made him look for other Nal vases with fish decorations. Six others among those excavated by Hargreaves at Nal were found in the collec-

Figure 7: Sunder Lal Hora (1896-1955).

tion of the Indian Museum with paintings of different fishes that could be immediately identified generically.

FIGURE 8: VASES NOS. 115 and 140 of HARGREAVES' LIST

These are *Garra*-like fish paintings, *Garra* being an aquarium genus. The scales on the body and both the vertical and paired fins are conventionally represented in the painting. With the exception of the dorsal fin, which is shown forward in position, the positions of the pectoral, pelvic, caudal and anal fins are accurately indicated. The caudal fin is deeply forked. The body is sub-cylindrical, with the upper surface gently arched and the lower flat and horizontal. The snout is rounded and fleshy. The general facies of the fish painted on this vase shows that it is adapted to live in rocky streams, where it can cling to stones and boulders with its flattened ventral surface. It strongly resembles fishes of the genus *Garra* Hamilton, which are characterized by the possession of a suctorial disc behind the mouth for adhering to rocks in swift currents. The genus *Garra* is known from the Baluchistan hills, and both Zugmayer (1914) and Jenkins (1909) have identified the species as *Garra lamta* Hamilton. In Hora's revision of the genus (Hora, 1921), he recorded *Garra rossicus* (Nikolsky) and *Garra* sp. from these hills.

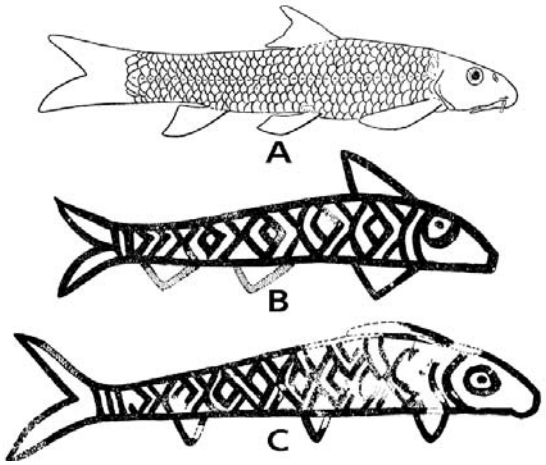

Figure 8:
A. Lateral view of *Garra nagaensis*.
B. Tracing of the painting on vase 115.
C. Tracing of the painting on vase 140.

Garra does not grow to a large size, but occurs in abundance and forms large shoals during the spawning period where they climb up vertical rocks and below waterfalls. They contain much oil and are greatly relished by hill people. It is not improbable, therefore, that the people of the Nal culture also considered *Garra* a food fish of great value and painted it on funerary vases. It may be of interest to add here that when Rama was at the Pampa Lake in South India, he was advised to eat *Cakratunta* (=*Garra*) as a great delicacy.

FIGURES 9 and 10: VASES NOS. 184 and 195 of HARGREAVES' LIST

The paintings in Figures 11 and 12 are comparatively the most accurate representations of fishes, with scales and fins properly drawn. The fish in Vase 184 seems to represent *Crossochilus latius* (Hamilton). C*rossochilus* is an aquarium genus, usually referred to as algae-eaters. The species lives in hill streams all along the Himalayas and is an important food fish. The fish in Vase 195 seems to represent *Labeo dyocheilus* (McClelland) and is of larger size than *Crossochilus*. Both live in hill streams all along the Himalayas and are important food fishes. They are included in Zugmayer's list

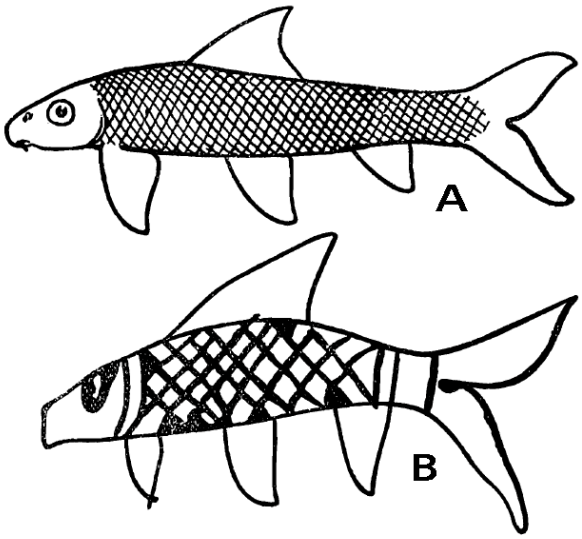

Figure 9:
A. Lateral view of *Crossocheilus latius*.
B. Tracing of the painting on vase 115.
C. Tracing of the painting on vase 140

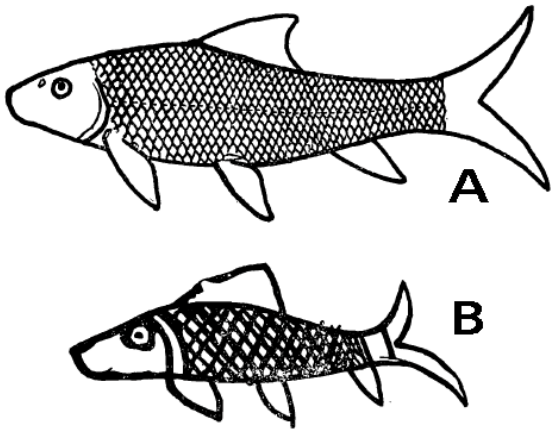

Figure 10:
A. Lateral view of *Labeodyocheilus*.
B. Tracing of the painting on vase 195.

of freshwater fishes from Baluchistan as C*irrhina latia* (Hamilton) and *Labeo dyocheilus* (McClelland). *Labeo dyocheilus* may be regarded as the *Rohita* of the Himalayan torrential streams. The place of *Rohita* in Sanskrit literature is well known (Hora, 1953).

FIGURE 11: VASE NOS. 193 and 196 of HARGREAVES' LIST

The general facies of all the drawings in Figure 11 are the same, but there are variations in the form of the snout as shown in B, C and D. The scales on the body are depicted in the same conventional way as in the case of *Garra.* The position of the dorsal fin is somewhat more accurate, but the painter has omitted to show the pelvic fins. These paintings can be readily identified as those of the Golden Himalayan Mahseer, *Tor putitora* Hamilton. Due to its size, *Tor* is not an aquarium genus. Zugmayer (1914) recorded this species from the Baluchistan hills as *Barbus (Tor) tor* (Hamilton). In Figure 12B the variations in the form of the snout are more marked but the pelvic fins are correctly shown. Variations in the form of the snout ate not due to any fancy of the painter, but are correct representations of what happens in nature. The lips are simple in some specimens, but in others they may be slightly or greatly hypertrophied, as shown in Figure 12. It is remarkable that such differences were observed by the painters of the Nal pottery. The Mahseer, besides being highly prized as a sporting fish, is also esteemed as food. In the Hindu *Dharma-sastras* it is considered superior even to *Rohita* and *Pathina,* as the Brahmins fed on Mahseer remain satisfied forever (Hora, 1953). Even hermits are advised to build their huts at those places in the jungle where Mahseer are available. The value of Mahseer as a food fish seems to have been fully realized by the people of the Nal Culture.

FIGURES, 13, 14 and 15: VASE NO. 256 of HARGREAVES' LIST

For the study of the fish fauna of Nal, the fish in this vase are important, as three pairs of different species of fish are painted on it, with sufficient detail for generic recognition. This it seems desirable to describe each pair of paintings separately. All three are aquarium genera. It also should be noted that the fish are pictured upside down, but it is their positions on the vase.

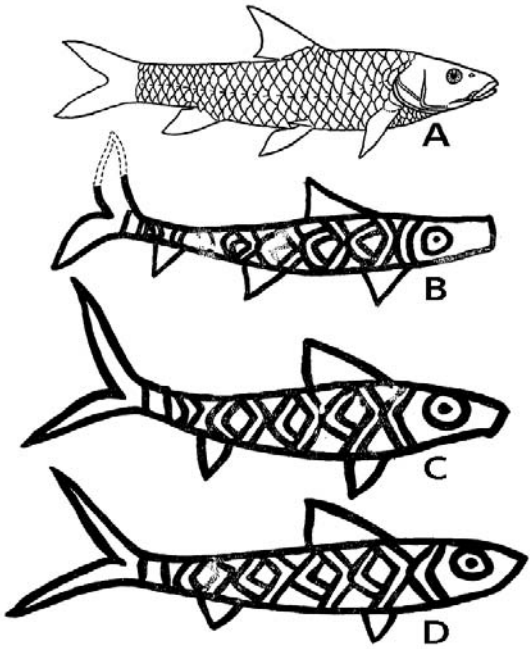

Figure 11:
A. Lateral view of *Tor putitora*.
B. Tracing of the painting on vase 193.
C. Tracing of the paintings on vase 196.
D. Tracing of the paintings on vase 196.

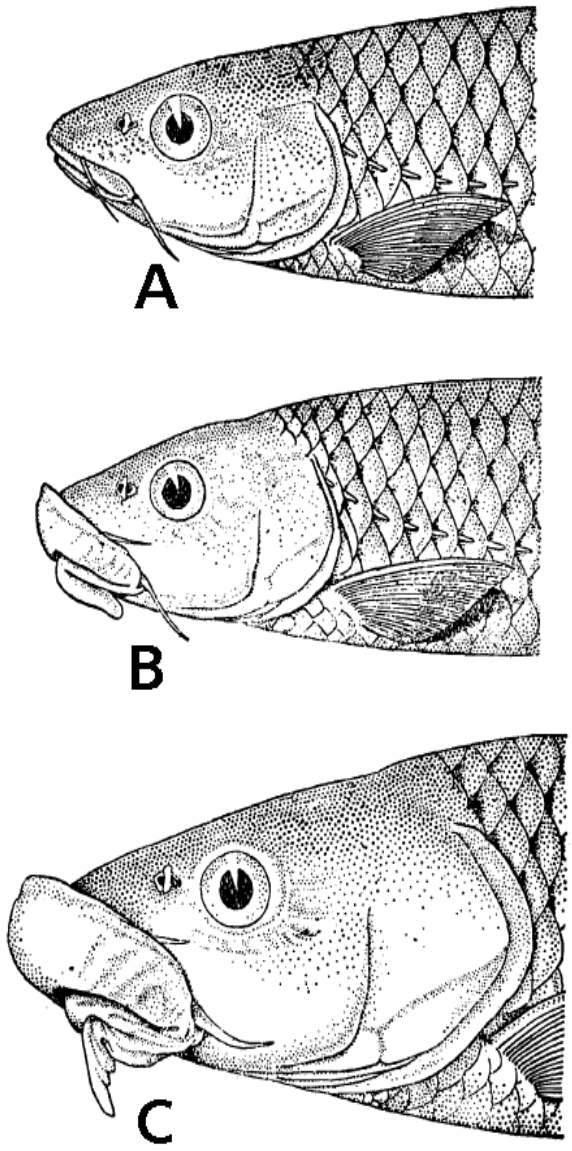

Figure 12. Head and anterior part of the Golden Himalayan Mahseer to show the variations in the shape of the head due to hypertrophy of the lips.

Figure 13: *Nemachilus* van Hasselt.

The painting seems to be that of a banded loach of the genus *Nemachilus.* Zugmayer found three species of this genus in the Baluchistan hills and in regard to coloration the painting seems to represent *N. baluchiorum* Zugmayer rather than the other two species. Such loaches are abundantly found among pebbles and shingle at the bottom of fast-running rocky streams. They do not grow to a large size but they are much prized and are regarded as a delicacy.

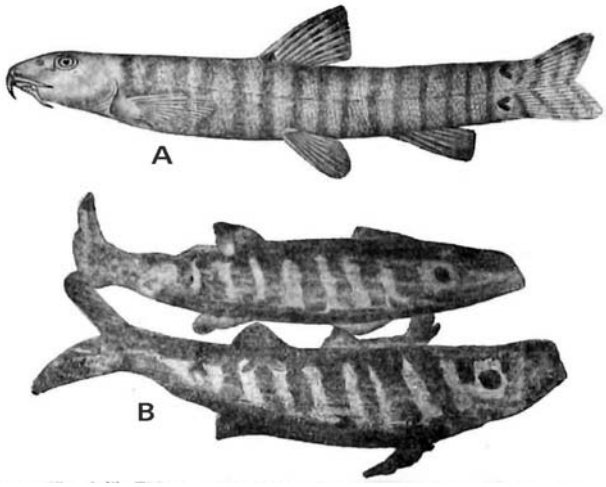

Figure 13:
A. Lateral view of *Nemacheilus baluchiorum*.
B. Tracings of the paintings of a pair of *Nemacheilus*-type fishes on vase 256.

Figure 14: *Botia* Bleeker.

Botia is also a loach-like genus but is usually deeper of body and of a larger size. It prefers to live in the pools of hill streams where the current is slow and debris accumulates at the bottom. Zugmayer recorded *Botia geto* (Hamilton) from Baluchistan but *B. geto* is now considered (Hora,

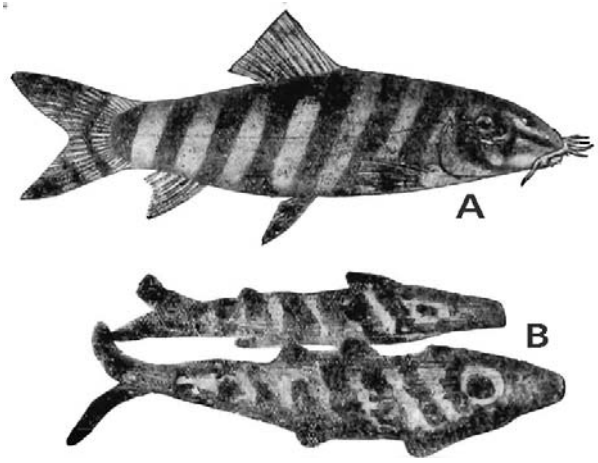

Figure 14:
A. Lateral view of *Botia dario*.
B. Tracings of the paintings of a pair of Botia-type fishes on vase 256.

1932) to be a young form of *Botia dario* (Hamilton). The commonest species in the northwest of India and in the Kashmir Valley is *Botia birdi* Chaudhuri, in which the coloration varies considerably. The color bands on the body run anterio-posteriorly from the dorsal surface, but the Nal painter has shown them running in the reverse direction. With this exception, the likeness between *Botia dario* and the painting is very striking.

Figure 15: *Glyptothorax* Blyth.

This painting represents a pair of catfishes in which the body is not covered with scales. Zugmayer recorded three catfishes from Baluchistan, *Wallago attu* (Bloch and Schneider), *Mystus gulio* (Hamilton) and *Rita rita* (Hamilton). These three species are inhabitants of ponds and rivers and are not found in hill streams in association with the type of fishes referred to above. In the depressed head and body, and the flattened ventral surface, the painting is similar to fishes of the genus, *Glyptothorax* Blyth, which is widely distributed from the upper Euphrates and Tigris river basins in the west to India, Burma, Thailand, Central and Southern China, Indo-China, Malay Peninsula, Sumatra, Java and Borneo. Though the range of the genus is discontinuous at present, it is certain that it once had a continuous distribution. Therefore, it may have occurred in the Baluchistan hills during the period of the Nal Culture.

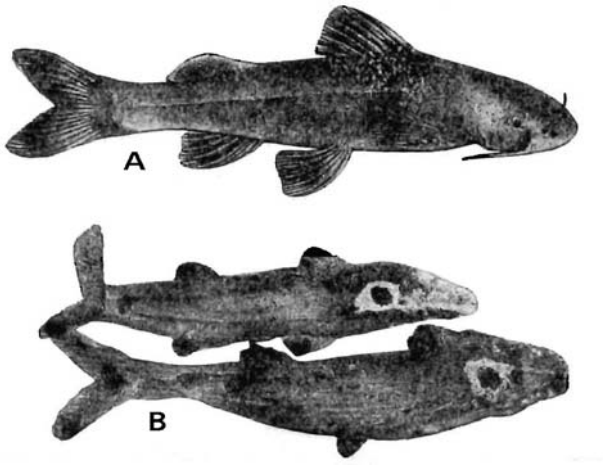

Figure 15:
A. Lateral view of *Glyptothorax pectinopterus*.
B. Tracings of the paintings of a pair of *Glyptothorax-type* fishes on vase 256.

FISH OF PREHISTORIC NAL AND THEIR ZOOGEOGRAPHICAL SIGNIFICANCE

From the fish decorations on Na1 pottery, it is not possible in all cases to be certain of their specific identity but there can be little doubt about their generic identifications. The following genera represented in the paintings, with the exception of *Tor*, are aquarium genera:

1. *Garra* Hamilton
2. *Labeo* Cuvier
3. *Crossochilus* van Hasselt
4. *Tor* Hamilton
5. *Nemachilus*. van Hasselt
6. *Botia* Bleeker
7. *Glyptothorax* Blyth

The association of these genera at Nal shows the presence of fast· running clear streams in its vicinity. Fishes of these seven genera can be collected from any Himalayan perennial stream, as all of them have migrated westwards from their probable origin in the hills of southern China. *Garra, Labeo, Tor* and *Nemachilus* have extended their range as far as Africa though they are not found at present in the barren areas of the Middle East.

Glyptothorax has extended its range as far as the upper ·reaches of the Euphrates and the Tigris, though it is absent from the intervening areas. Its occurrence at Nal about 5,000 years ago would indicate heavier rainfall and far more voluminous perennial streams. The Nal paintings of *Glyptothorax* serve to fill a part of the eastern portion of the gap in the range of its distribution. Another important inference that can be drawn is that the present discontinuity of distribution of some of the Indian hill-stream genera may have come about in the early centuries of the second millennium BC. It can also be presumed that the westward migration of genera, such as *Botia* and

Crossochilus, was interrupted about the same time.

PROBABLE METHOD OF FISHING AT NAL

No fishing implements have been excavated from Nal. Moreover, the usual methods of fishing by nets are not applicable to the torrential streams found at Nal (see Figure 16 for a topological map of the Nal area). The methods of fishing by hill tribes are (i) by damming small channels and allowing them to run dry, then when stranded the fish are caught by hand; and (ii) by poisoning the pools with certain plant juices which stupefy the fish and cause them to float to the surface. Both are now regarded as illegal methods, though still practiced everywhere in the hills. The fish decorations on Nal pottery show that fish were relished as an article of diet and that the fishes used as food came from torrential streams. But how these fishes were procured in sufficient quantities can only be guessed at, though the long survival of traditional fishing methods suggests that the techniques now practiced in the hills are probably derived from these known during the Na1 culture.

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A HISTORY OF FISHPONDS

By Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society of America, Facebook Files, January 4, 2020)

Fishponds (or vivaria in old books) are important in the history of the aquarium hobby since they are the forerunner of the aquarium as we know it. In point of fact, fishponds are, in the Linnean sense, aquariums (Klee, 2014). Fishponds can be of two categories, Storage and Cultural. The former are nothing more than temporary holdings of fish designed to be eaten and are often referred to in older references as "stews." The latter can be, for example, of a religious, ornamental, sports or farming (*i.e.*, "aquaculture or pisciculture) nature. Storage fishponds started in the Neolithic Age, the final division of the Stone Age, about 12,000 years ago when the first developments of farming appeared in the Near East and later in other parts of the world. The division lasted until the transitional period from about 6,500 years ago (4500 BC), marked by the development of metallurgy and leading up to the Bronze and Iron Ages. From the Neolithic Age, and in most countries, fishponds have been an important feature in the rural landscape. Wherever we turn, no matter in what clime or country, there we will find them cultivated with great care and perseverance.

A. MESOPOTAMIA

Mesopotamia is a historical region of Western Asia situated within the Tigris-Euphrates river system in the northern part of the Fertile Crescent, in modern days roughly corresponding to most of Iraq, Kuwait, the eastern parts of Syria, Southeastern Turkey and regions along the Turkish-Syrian and Iran-Iraq borders (Figure 1). It is necessary to distinguish between the three main peoples of this area and roughly apportion the periods of the four thousand odd years of history during which each was predominant.

The Sumerians occupied before - perhaps long before - the close of the fourth millennium the land on the lower plain of the Tigris and Euphrates, and on the sea coast as it then was. They possessed an advanced civilization with an organized government, many large cities and considerable agricultural and industrial development. The Sumerians made extensive use of music, especially in their religious ceremonies; they were the founders of liturgical music, which unfortunately it is impossible to reconstruct, as the notes themselves have not survived.

From what place their emigration, to what family, Mongol or other, they belong is not clear. It is settled that they were not Semites like the Babylonians and Assyrians as the language was not well adapted to express peculiarly Semitic sounds. Their language, preserved in liturgies down even to the time of the Persian conquest, and their writing, adopted by the Babylonians and Assyrians which runs, unlike the Hebrew from left to right, disprove Sumerian descent from Shem, one of the sons of Noah in the Hebrew Bible as well as in Islamic literature.

It is impossible at present to fix a definite period for their immigration. The dates assigned vary from 7000 to 4000 BC. The statement, however, that "the Semites and Sumerians were all in a no-

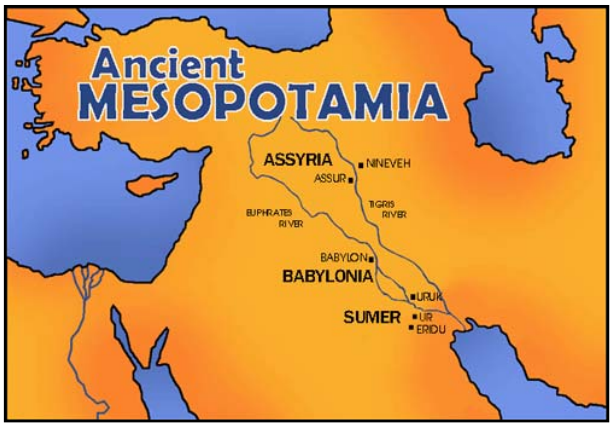

FIGURE 1: Mesopotamia. The Babylonians conquered Sumer and then the Assyrians conquered Babylonia.

madic condition when the early Sumerian settlers in Lower Babylonia betook themselves to agriculture, built great cities and established a stable government" seems hardly exaggerated, even though it postulates a very ancient era.

The Semitic Babylonians started possibly from South Arabia by way of the Syrian coast, and reached the lower part of the Tigris and Euphrates about 3800 BC. It was not, however, until some thousand years afterwards, that they effected a conquest of the Sumerians. Like other defeated peoples, such as the Canaanites with the Jews and the Irish with the English, they grafted their policy on that of their victors and perpetuated many of their racial characteristics and customs as well as their religion. The Semitic invaders seem to have been completely converted. In fact, the Babylonian religion has scarcely anything characteristically Semitic in it.

The Assyrians proper, an offshoot from Babylonia, are found before 2300 BC pushing their way north along the Tigris, on whose western bank they founded their first city and earliest capital - Asur. Wars between them and Babylonia mark the history of centuries. Their definite suzerainty over that country was only established by King Tiglath-Pileser III, *circa* 730 BC and thus, according to many scholars, were the founders of the Assyrian empire.

FIGURE 2: A painting depicting an Assyrian King's Palace.

Vivaria or fishponds, known only late in Palestine, were early and generally constructed in Mesopotamia. As adjuncts of Sumerian temples, they can be traced as far back as 2500 BC. No decent-sized township eventually lacked or could afford to lack, these *piscinæ* with their ever-ready supply of fresh fish. How real was the importance attached to fish and how recognized its value as a food can be discerned from early Sumerian documents. The excavations of Telloh, an ancient Sumerian city, furnish an elaborate description of the new temple built in honor of the god Ningirsu. With this god went also other deities, such as his musician, his singer, his cultivator of lands and his guardian of fishponds.

The Assyrians of Western Asia, including both the Sumerians and Babylonians, were keenly addicted to the eating of fish, which was not, as in Israel or Egypt, half-banned by a prophet or whole-barred to priesthood by custom or a system of belief in which humans are said to have kinship or a mystical relationship with a spirit-being, such as an animal or plant. They attached very real importance to the maintenance of an ample supply of fish.

In their apparent preoccupation with water and hydraulic engineering well before 2000 BC**,** these ancients were known to keep large resources of fish in lakes created by the construction of dams on the Tigris and Euphrates rivers to improve the irrigation of their crops. They built sacred *vivariae piscinae* for their temples, but also *piscinae* or simple fishponds, to provide food and to make a commercial profit. Virtually every Assyrian township had its own fishponds. Records of 422 BC described fishponds belonging to rich merchants and civic prefects that operated under contract for one -half talent of silver and a daily supply of fish for their tables. Each pond had a keeper who taxed the

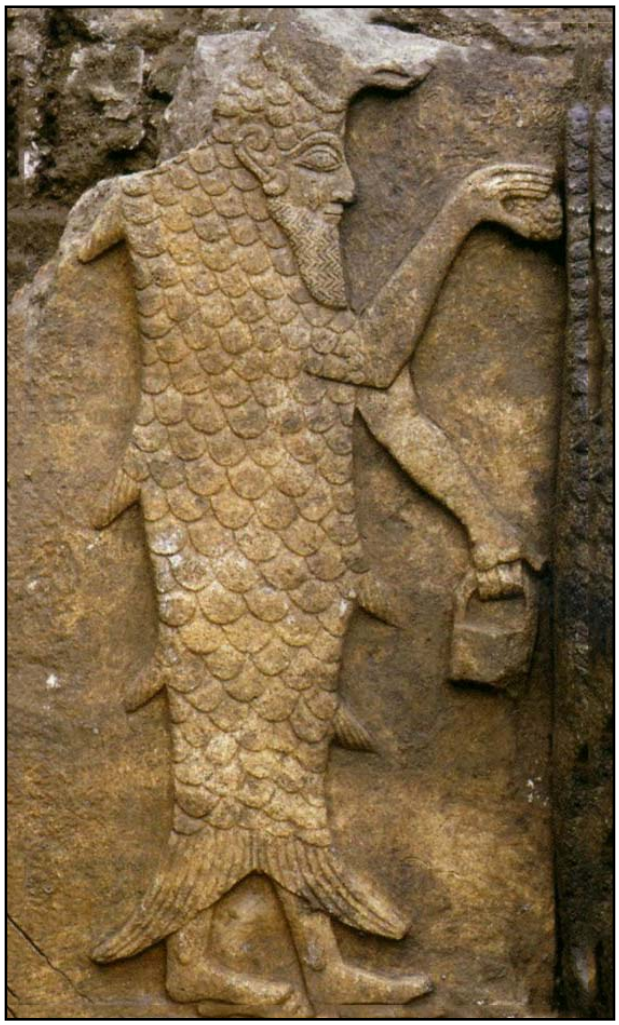

FIGURE 3: Oannes, the Babylonian Fish-God.

public to fish in the commercial pool. Further evidence indicated that small ponds became quite numerous among the Assyrian commoners, but not all were protected by the earliest known regulations regarding fishing rights and ownership. It was noted, for example, that fishponds built by "poor men" were often poached, and that there was no legal redress.

The *Inspectors of Fisheries* were established via the drastic reforms and the thorough cleansing of the bureaucracy initiated by Urukagina, the ruler of the city-state Lagash in Mesopotamia. This sprang from his desire to improve the condition of his poorer subjects, who for years had suffered from the oppression of the rich or the venality of public functionaries who illegally sold fish from these ponds. How general and how numerous fishponds had early become shows in the complaint that "if a poor man built himself a fishpond, his fish was taken; he received neither payment nor redress."

The neighboring Israelites, in spite of their propensity for fish and links with Egyptians and Assyrians, both hostile and friendly, never constructed *vivariae* or fishponds. There is no record of *vivariae* or *vivariae piscinae* in all their prolific writings until almost the beginning of Christianity, when they were probably influenced by the practices of the Mediterranean civilizations.

A1. FISH-GODS

Oannes, in Mesopotamian mythology, is an amphibious being who taught mankind wisdom. Oannes, as described by the Babylonian priest and author Berosus, had the form of a fish but with the head of a man under his fish's head and under his fish's tail the feet of a man (see Figure 3). Dagon or Dagan is an ancient Mesopotamian deity. He is mentioned occasionally in early Sumerian texts but becomes prominent only in later Assyro-Babylonian inscriptions as a powerful and warlike protector and appears to have been worshipped as a fertility god in Assyria and is pictured as a merman in Assyrian art (see Figure 4).

FIGURE 4: Dagon, the Assyrian Fish-God.

The Hebrew Bible mentions him as the national god of the Philistines with temples at Ashdod, Israel and elsewhere in Gaza. Authorities disagree whether Dagon derives his name from the Hebrew *Dāg* signifying fish, or *dāgān*, sheaf or agriculture. The ancient Phoenician writer Sanchouniathon early held, as do most modern writers, the latter view.

Aquarium hobby historians like to picture Mesopotamian fish-gods but in actuality they are neither gods nor did they have anything to do with fish. There is no trace in Mesopotamia of ichthyolatry, *i.e.*, certain fish being accounted sacred or forbidden as food. The nearest approach to abstention occurs in the warning that on the 9th day of Iyyar, a month in the Hebrew calendar, to partake of fish was almost certain to bring on an attack of sickness, just as in Syria ichthyophagy was held to entail ulcers and wasting diseases. Despite the Dagon or Oannes traditions, I doubt that there can be found in the crowded pantheon of Babylon or Assyria there can be found a fish-god proper, or god of fishing, *i.e.* a deity similar to those of Greece and Rome with a temple and established priesthood to whom fishermen made prayer and offerings either for boons received or favors to come.

A cylinder seal is a small round cylinder, typically about one inch (2 to 3 cm) in length, engraved with written characters or figurative scenes or both, used in ancient times to roll an impression onto a two-dimensional surface, generally wet clay (Figure 5). If the word fish-god is limited strictly to those images, half-man, half-fish, which are to be found on cylinder seals or sculptured or depicted in the outer halls or walls of some deity's temple, there is certainly considerable proof of their existence. But if the word connotes the attributes of a special temple, priesthood and sacrifices, such as we find in connection with the Philistinian Dagon at Ashdod in Israel, there is no proof whatever. The fact is that in early Sumer, the fish-god or man-fish was a symbol of Ea, the god of water, probably derived from Aquarius.

There were to be seen in the temple of Belus, according to Berossus, a Hellenistic Babylonian writer, priest and astronomer (Mosshammer, 1979), sculptured representations of men with two wings, or two faces, with the legs and horns of goats or the hoofs of horses; also bulls with the heads of men, and horses with the heads of dogs. Thus the mystic fish-form of Dagon or Oannes is of the same nature and in the same category as the man with the legs and horns of goats, or with the hoofs

FIGURE 5: A cylinder seal. When this seal (foreground) is rotated over a wet-clay surface (background), its surface shows a school of fish.

of horses: but these mythic goat or horse forms were not elevated into goat-gods or horse-gods.

The idea of the deification of the fish-forms, whether that of a man issuing from a fish or of a man whose upper half was human but lower piscine, may, perhaps, have sprung from the undoubted worship by the Philistines at Ashdod and elsewhere of the god called Dagon, and partly to the original description of him in the Authorized Version (A.V.) of the Bible but is now corrected in the Revised Version (R.V.). Dagon, it will be remembered (I Samuel v. 4), after being confronted with the ark of the Lord in the morning, was found fallen: "the head of Dagon and both the palms of his hands lay cut upon the threshold, only the fishy part (A.V.) or stump (R.V.) of Dagon was left unto him." From this passage Milton undoubtedly drew his conception of "Dagon his name; sea-monster, upward man and downward fish" (Milton, 1674).

It is possible that the theory of his having from his navel down the form of a fish, and from his navel up the form of a man - a theory which is unknown to the *Targum*, an ancient Aramaic paraphrase or interpretation of the Hebrew Bible; Josephus, a first-century Romano-Jewish historian; or the *Talmud*, and perhaps is as late as the twelfth century AD merely transfers by the help of etymology the description given by the Assyrian satirist and rhetorician, Lucian, of the goddess Derceto, worshipped on the same coast-line by the Syrians, who were more partial to fish deities than the Assyrians.

B. EGYPTIAN FISHPONDS.

Although the ancient Egyptians enjoyed a plethora of fish in the fruitful Nile, yet they were not contented with the abundance it afforded but constructed within their grounds spacious ponds for fish where they fed them for the table. It is very questionable, however, whether the ancient Egyptians understood or practiced pisciculture. However, they did export dried and/or salted fish to other countries.

Egyptians relied upon the periodical inundation of the Nile to furnish them with stock for their ponds. Herodotus comments (Macaulay, 1890) that the quantity of fry in the Nile on these occasions was something enormous, as it is indeed at the present day and they undoubtedly were caught in great abundance when the river overflowed its banks. His explanation of the cause of their apparently sudden production is questionable and unnecessary, however, as the ponds were always filled by artificial or natural conduits. Also, the same species of young fry which are found there appear at the present time in the river where they aren't of any particular kind but the young of the various fish inhabiting the Nile. The Egyptians evinced a great interest in fatting their pond fish for their table, and brought their ponds to a perfection not short of that attained by the Romans.

They usually constructed their fishponds in the form of a square, an oblong or a canal. Unlike the Roman and Grecian ponds, one cannot form any detailed ideas with respect to the *modus operandi* of their construction or dimensions inasmuch as they have left no literature on the subject to posterity. However, there is no lack of illustrations, sculptures, paintings, *etc.* of their ponds, and from

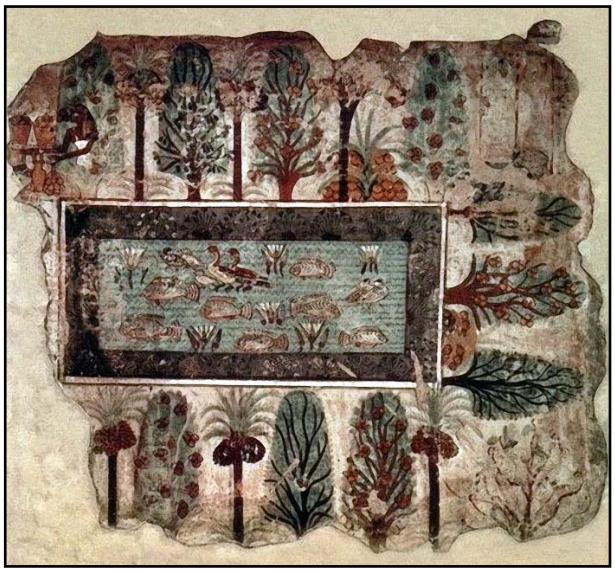

FIGURE 6: A rectangular fishpond with *Tilapia* from the tomb of Nebamun, Thebes, 18th Dynasty.

FIGURE 7: Left: A funerary model of an Egyptian garden, 11th Dynasty, *circa* 2009-1998 BC.

these we can gather very conclusive inferences. Some of those relics among the Egyptian collection in the British Museum represent every pond containing numbers of fish, waterfowl and lotus flowers. On the margin of the ponds fruit trees were invariably planted.

As to the species of fish most prized for the table, and preferred as being more wholesome as well as superior in flavor to others may be mentioned (Wilkerson, 1874) the búlti or booltee (the Nile Perch, *Lates niloticus*), the gisher (*Oreochromis niloticus*), the benni (*Labeobarbus bynni*), the shall (*Synodontis shalli*), the shilbeh (S*chilbe mystus*), the byad (*Bagrus bayad*), the garmoot (*Clarias gariepinus*), and a few others (a differing opinion was "The fish of the Nile are very numerous, but there is not one worth eating; they are all soft and wooly and have a strong flavor of mud," Anon, 1888). However, it was unlawful to touch those that were sacred, such as the oxyrinchus, phagrus, and lepidotus. The inhabitants of the city of Oxyrinchus objected even to eat any fish caught by a hook, lest it should have been defiled by the blood of one they held so sacred.

Oxyrinchus was a mormyrus remarkable among the fish of the Nile for its pointed nose, as the word oxyrinchus implies. The sanctity of the phagrus, which has been identified as one of the Mugilidae (*i.e.*, mullets), like that of the oxyrinchus was probably owing to its unwholesome qualities; the most effectual method of forbidding its use being to assign it a place among the sacred animals of the country. Linnaeus believed the lepdotus to be the carp, Sicard assumed it was the benni and Sir John Gardiner Wilkinson supposed it to have been the kelb el bahr or the dog-fish of the Nile. Sicard was right. The lepidotus is the benni (*Labeobarbus bynni*).

However, the same reverence was not given to the sacred fishes in some parts of Egypt as was observed in others. The people of Cynopolis, according to Plutarch, were in the habit of eating the oxyrinchus, which, he adds, "was the origin of a civil war between the two cities, till both sides, after doing each other great mischief, were severely punished by the Romans." Of all fish the

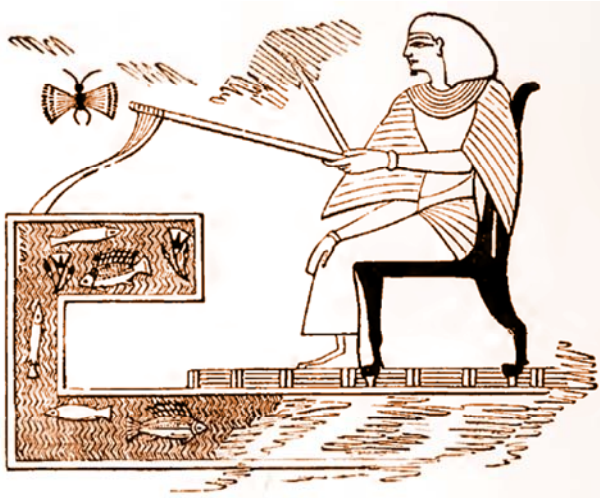

FIGURE 8: The oldest representation (but one) of fishing, circa 1400 BC.

búlti was evidently preferred, and not, indeed, without reason, being still considered inferior to none produced in the Nile.

There can be no doubt that the ancient Egyptians devoted considerable care and attention to their fishponds and fisheries. This we may conclude as beyond dispute for three very tangible reasons. Firstly, the queens of Egypt received all of the revenues accruing from fisheries to the State as their particular special right. Hence we may conclude that they lost no opportunity of sustaining that branch of industry with all their royal influence.

Secondly, we learn from Herodotus that the revenue derived therefrom was very large. During the six months that the water from the Nile flows into the artificial pond or lake Moeris, the take of fish from it realized something under twenty minae (about $1270) per day; and during the other six months, while the water was receding, it yielded a talent of silver ($3830) per day, which was duly paid into the royal treasury for the exclusive benefit of the queen. Thus we find that the aggregate revenue her majesty received from this artificial fishpond was equivalent to $847,000 per annum.

Thirdly, ichthyophagy formed an important feature in their religion, as at a particular period of the year, on the 9th day of the first month (Thoth) every person was obliged, by a sacred ordinance to eat a fried fish before the door of his house, with the exception of the priests who were content to burn one in honor of the occasion. If further evidence were required to establish this case, we need only appeal to the Bible, to find that the Israelites lamented the loss of the fish which they "eat in Egypt freely" (Exod. xi. 5). In summary, every Egyptian of note had fishponds in his gardens for his amusement, profit and convenience of a plentiful supply of water, without which the villa, like those of the Roman nobles, would be incomplete.

C. THE ROMANS

The Romans spared no expense in the development of their fishponds. This fact we know from a variety of authorities, any one of which would be sufficient to place the matter beyond dispute. Great profits accrued from such fishponds, more than amply repaying the investments so profusely lavished upon them. But this abuse, if we can strictly call it such, was not observable in the primitive days of the Roman fishponds. It rose and fell as the extravagance of the age flowed or receded. There can be no doubt that the Romans first conceived their ideas as to the creation of fishponds from purely economic attributes, which subsequently became completely reversed, particularly among what we may term the aristocracy of the age.

Lucinius Murena was perhaps the principal propagator of this branch of rural economy. He was soon after succeeded by Sergius Orata, whose ponds at his house in Baianum, a region on the gulf of Naples were to ichthyophagists the wonder of the world. But this man did not reserve his ponds for his exclusive palate or requirements. Indeed, Pliny (the Elder) assures us that he dealt in their production and derived great revenues from them. The same authority tells us that he was the first person who introduced the Lucrine fishes into Rome (Lucrine was a lake in southern Italy,), and that he was the first to construct ponds for saltwater fish.

The next most conspicuous ponds were those of Lucullus, concerning which so much has been

FIGURE 9: The fishpond at Hadrian's Villa at Tivoli, Italy.

written. Their produce seems almost fabulous, and the sums the fish sold out of them realized read incredulous. Yet, there can be no doubt that when Cato was guardian to Lucullus, he disposed of the fish in those ponds for 400,000 sestertii, or $62000; and at the death of Lucullus they were sold for 3,000,000 sestertii, or $465,000. Plutarch tells us that Cato, who flourished about 150 years before Christ, commenced his distinguished career as the raciest radical of the period. He opposed every unnecessary expense and as Censor would not tolerate expensive fishponds or expensive fish. He railed against the extravagance of that age when a fish cost more than an ox.

The remedies he instituted to prevent the excesses of the time, ,however, proved unsuccessful and fish, instead of becoming cheaper, became more expensive. At last he saw the ineffectiveness of his policy and like most radicals, after he had acquired some riches became a violent conservative. As his thirst for wealth increased and finding his efforts in agriculture rather amusing than profitable, he turned his thoughts to safer bets and employed his money in purchasing and constructing fishponds from which he derived a great revenue. “Such a one,” he used to say, “as Jupiter himself could not disappoint him of.” Here we have an instance of a Roman vivarium properly stocked, being esteemed beyond the power of the gods to mar, and calculated to yield a greater profit than any other branch of rural economy.

C1. THE PONDS OF PHILIPPUS

The ponds of Philippus, at Cassinum, appear to rank next to those already enumerated. Hortensius vied with Lucullus and Philippus in the extent of his, which were constructed at immense cost, with some of them so formed that the tide flowed into them. Under the promontory of Bauli, travelers were shown the *Piscina mirabilis*, a subterraneous edifice vaulted and divided by four rows or arcades, which is supposed by some ancient writers to have been a fishpond of Hortensius. Concerning his ponds at Tusculum and Laurentum we have no particulars but he appears, as Varro tells us, to have been very chary of those at Bauli and when he gave parties at his villa there he usually sent to Puteoli (where he probably had ponds to store fish) to obtain fish for supper. This showed his reluctance to diminish the supply in his favorite ponds. He had a large number of fishermen in his service and devoted so much attention to the feeding of his fish that he had always ready a large stock of small fish to feed the great ones. It was with the utmost difficulty he could be prevailed on to part with any of them and Varro declared that a friend could more easily get his chariot mules out of his stable than a mullet from his ponds. He was more anxious about the welfare of his fish than the health of his slaves and less solicitous that a sick servant might take what was unfit for him than that his fish might not drink water that was unwholesome.

C2. CRASSUS AND CAESAR

Marcus Crassus was another distinguished Roman who evinced great pleasure in the cultivation of his fishponds. Although his moral character was unimpeachable during the greater part of his career, yet when he was somewhat advanced in years he was suspected of criminal intercourse with one of the vestal virgins named Licinia. It seems that the vestal had a beautiful country house, appended to which were some famous fishponds that Crassus coveted, and from paying his court to the lady with great assiduity fell under the suspicion mentioned, and the upshot was the case being brought before a court of the period. But the judge, as Plutarch tells us, knowing

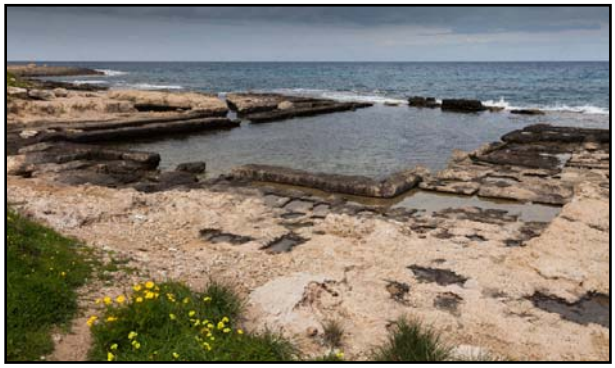

FIGURE 10: The Saltwater fishpond in the ruins of the Roman Lambousa, North Cyprus.

what was at the bottom of it all, acquitted him of corrupting the vestal; the same authority adding that he never let her rest until she had sold him her house and ponds.

Pliny tells us that the emperor Caesar had many country houses where he kept fishes in ponds that would ordinarily come to hand and take food. Nor was this an unusual thing, for fish were commonly so gentle and tractable in small stews and fishponds that it was not looked upon with any undue surprise. Some notable instances have been recorded where fish have evinced this kind of domestication, *viz*., at Floras, a castle in Sicily not far from Syracuse and at the lake of Jupiter Labradius where the eels would take food from the hand, and were sometimes adorned with earrings. The same was observable at the temple of Veterum Delubrum, and in Mesopotamia. Perhaps those at the fountain of Apollo in Lycia were the most remarkable of all, as they answered to the sound of a whistle with the sagacity of a dog. Again, those in the lake of Venus, near Hierapolis, a city in Syria, used to obey the voice of the wardens and sextons who had the guardianship of that temple. The fish there were so tame that they allowed themselves to be fondled and would wag their tails like dogs in a fawning and flattering manner. They would gape with their mouths wide open and suffer their admirers to thrust their hands or fingers into their gullets.
Augustus Caesar, says Pliny, reserved one pond exclusively for the breeding of lampreys and Seneca assures us that he had in his ponds at his pleasure-house Pausilupum in Campania, near Naples, fish sixty years old. The preciseness with which he records the fact leaves little doubt of its authenticity. Pliny cites it to show the age fish will attain in ponds.

C3. THE FISHPONDS OF CAIUS HIRTIUS

The fishponds of Caius Hirtius were no less famous than any of the foregoing. During the triumph of Caesar when the dictator gave feasts that were never equaled, Hirtius furnished him with six hundred lampreys, which he estimated to be beyond any amount of money and specified that they should be replaced by fish of the same description, number and weight. Pliny assures us that his country house was of very meagre pretensions, yet the fishponds about it and their contents sold for four millions of sesterces or $620,000. Those of Fulvius Hirpinus, in Tarquinii and others in the same neighborhood were also famous and associated with some distinctive mark that frequently attracted sightseers from Rome to visit them. Pliny, in his Epistle to Apollinaris, describes his villa, which was situated near a town called Tifernum Tiberinum in Tuscany. In the account of this villa there is a great difference between it and his seat at Laurentinum, the former being his constant residence in the summer season where he had a fishpond of large dimensions in the midst of which was a fountain always playing, "delighting," says he, "both the ear and the eye; for the water, falling from on high, is received in the bosom of the pond, which becomes white with foam."

C4. THE "MOST LEARNED OF THE ROMANS"

Marcus Terentius Varro, whose vast and varied erudition in almost every department of literature earned for himself the title of the "most learned of the Romans," was born in 116 BC. Not only was he the most learned of Roman scholars, but was likewise the most voluminous of Roman authors. He read so much, says St. Augustine, that one must feel astonished that he found time to write

FIGURE 11: A fishpond in Ventotene, one of the Pontine Islands in the Tyrrenian Sea.

anything; he wrote so much that we can scarcely believe that any one could find time to read all that he composed. Like Pliny, and all the conspicuous men of the time, whether scholars, poets, nobles, statesmen, or warriors, he too had his fishponds, and moreover, has left us some valuable information concerning them. His famous *De Re Rustica* was not written till he was eighty years old. This is unquestionably the most important of all the treatises upon ancient agriculture, being far superior to the more elaborate production of Columella, with which it can alone be compared.

I'll reproduce Varro's observations on the Omithon (a building for the keeping of birds), as the affinity between fish and waterfowl is too close to admit of separation for wherever there has been a fishpond, there have also been waterfowl.

I have a canal under the town of Oassinum, which runs clear and deep by my villa, 57 feet broad, with stone banks; and there is a passage by bridges from one villa to the other: the length is 950 feet from an island made by the river Vinius to the musaeum [*i.e.,* museum] , where flows another river to the upper part of the canal where the musaeum stands; about the banks of which is an open walk 10 feet broad. From this walk towards the fields, the place of site of the omithon is enclosed on each side on the right and left by high walls, between which the omithon extends, its breadth 48 feet, in the shape of a writing-table with a head; the square part is in length 72 feet, and the round part, which is the capital, is 27 feet. As a margin, without the omithon, is a parterre, in the middle of which are alcoves; and thence are entrances into the area. In the entrance is a porticus on the right and left, with dwarf-trees placed between the stone pillars of the first row from the top of the wall to the architrave; a hempen net serves for a covering to the porticus, and from the architrave to the pedestal it is filled with all sorts of birds, which are fed through the net, and the water flows through in a small stream.

Adjoining to the inner part of the pedestal, on each side of the upper part of the square area, are two oblong fish-ponds opposite to the porticus; between the two ponds is the only path leading to the Tholus, which is a round colonnade, as in the temple of Catullus, except that they are pillars and not walls… Below the pedestal of the pillars is a stove a foot and a half high from the Falere [*i.e.*, a platform]; the Falere is two feet high from the pond and five feet broad, that the guests may walk upon the culcita [*i.e.,* cushions] round by the small pillars; and the bottom within the Falere is a pond with a margin to walk upon, and a small island in the middle: round the Falere and the pond are hollowed pens for waterfowl. Ducks come into this pond and swim, which is connected by a little stream with the fish-ponds in the garden above-mentioned, in which the fishes swim to and fro.

Here I close this brief sketch of a few of the most important fishponds of the Roman nobles as handed down to us in the writings of many of their greatest scholars. It would be impossible to catalogue the numerous and famous ponds that were constructed in the vicinity of Rome from the time of Numa to Augustus. There is no doubt they continued to increase both in extent and perfection until the fall of Rome, as we know the

FIGURE 12: A Roman saltwater fishpond, Alicante, Spain.

ponds and the luxury of Apicius and Vedius Pallio even surpassed those of Lucullus and Hortensius.

C5. ROMAN FISH CULTURE

Fish culture facilities and practices among the ancient Romans have been reviewed in the Ph.D. thesis of James A. Higginbotham (1991). He thoroughly catalogues the fishpond structures of late Republican and early Imperial times now visible and archaeologically attested to in Italy. This is followed by essays on pond construction and operation, and on the fishes Romans then reared. What here follows will summarize the most important sources and Higginbotham's findings, and add only a short discussion of the later Roman period, which Higginbotham does not treat.

The most important information on Roman fish culture is in the Roman writers on agronomy, the management and operation of rural estates. Fishponds *(piscinae)* are not mentioned in the oldest text (Cato, circa 175-150 BC), but do receive at least cursory treatment thereafter. Note that each successive writer was aware of and often used the works of his predecessors.

Most of what modern readers (e.g. Balon, 1995a,b) think they know of Roman fish culture comes directly or indirectly from Varro's *De Re Rustica* (37 BC) and Columella's *De Re Rustica* (about 50 AD). The two authors wrote while artificial fishponds were at the height of Roman elite fashion between the early years of the first century BC and the end of the first century AD. Columella used Varro's material, and Columella's younger contemporary, the Elder Pliny, cribbed from both.

Writing from the viewpoint of the agricultural manager, Varro treated fishponds as social curiosities, emphasizing with many literary allusions their role in luxury display and consumption, especially at the estates of wealthy Romans around the Bay of Naples. Once, he says (Varro, 1935), Romans kept small freshwater pools near their villas and stocked them with *squali* or *mugili* ("chubs" and grey mullet, both euryhaline marine varieties), but were now sneered at in favor of saltwater ponds and fishes, notably *murenae***.** He continues with several lurid tales of extravagance in rearing what were likely eels of several sorts, but chiefly *Anguilla anguilla* (Higginbotham 1991).

Varro returns in a second passage to the two types of fishponds, fresh and salt water. Commoners, says he, have the former, where natural sources furnish the water for "our own domestic fish" *(piscibus nostris villaticis)***.** The elite, however, maintain very costly artificial saltwater ponds and fishes, especially mullets and *murenae***,** as much for recreational viewing as for consumption. All he describes are tidal and marine.

About two generations after Varro, Columella took a more serious view of fishponds on a Roman estate farm (Columella, 1941-1968). Fish culture was once, says this expert, a fad using saltwater fish in fresh water and stocking eggs and young brought from the sea. In his own time there was less extravagance and fish culture offered a good profit to a landowner with marine access. He details the fishes appropriate to various coastal habitats. The most recommended ponds are open to tidal flow, with the water kept as cold and well-circulated as possible. The

FIGURE 13: Fishpond of the ancient palace complex on the Palatine hill, Rome.

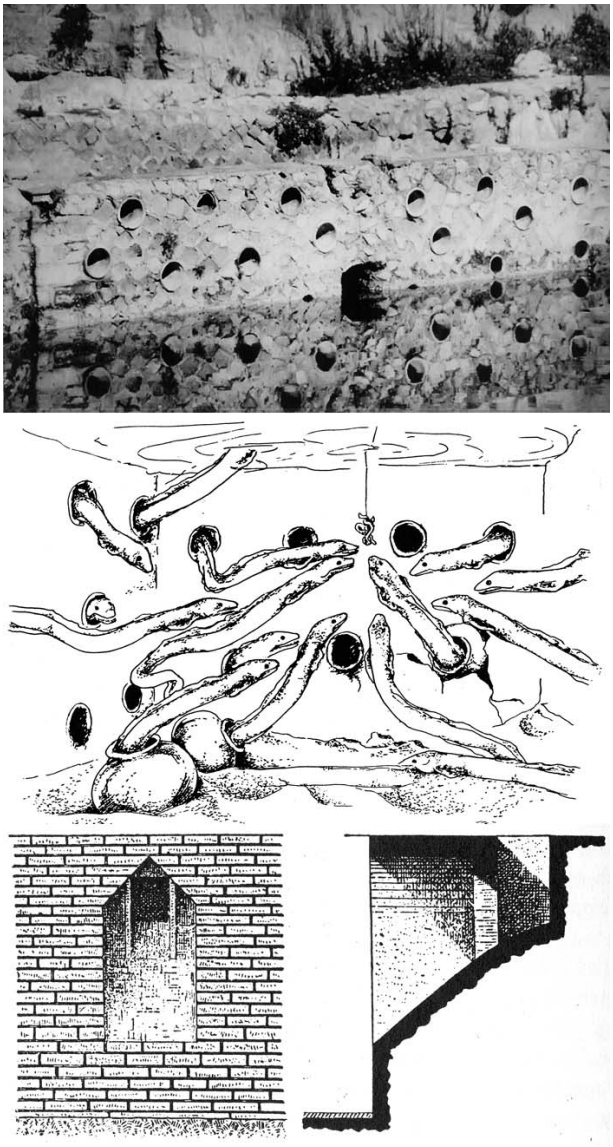

FIGURE 14: Top: Ceramic vessels inlaid in the wall of the Grotto of Tiberius. Middle: Eels in a fishpond with such recesses. Bottom: A different type of recess called a "spectrum." Both types provided protection for fish from predatory tank-mates and the sun.

stock should be chosen in accord with the habitat - again all varieties mentioned are marine - and given small fish or other items to eat. Stock not kept fat would get a poor price on the fish market.

Writing about 70 AD, Pliny (1942-1984) contributed nothing really new to the record of Roman fish culture. He used mainly Varro, but also Columella, to describe a luxury activity using coastal saltwater facilities to rear shellfish, *murenae* and snails for elite consumption and the sheer pleasure of watching the fish. In summarizing this period of intense Roman interest in artificial fishponds, Higginbotham (1991) emphasizes the overwhelming importance of coastal brackish-water ponds for rearing inshore marine species. Sea-trushes were a small spotted fish, not a foot long, of a russet color, with a figure like a tench, living among stones and rocks by which means it was impossible to take them, except in calm weather. They were eaten generally in the autumn, and were esteemed a delicacy among the Romans.

When he was sojourning at his Laurentinum villa during a succession of stormy weather, Flaccus sent to Pliny a present from his ponds of some sea -trushes. It would appear from this incident that Pliny had no ponds at Laurentinum, as he writes a complimentary epistle to Flaccus acknowledging the "delicate" present, for "which during this tempestuous weather," says he, "I can find no equivalent, either from the markets or from the sea. A barren letter, bearing no proportion to the favor I have received, is all the return you will find. I cannot even imitate the policy of Diomedes in exchange. But such is your good nature, that in this point you will more easily grant me a pardon, from the frank confession that I scarce deserve it."

At the peak of fishpond construction they served as elaborate symbols of aristocratic wealth and "demonstrated a control over nature." Fashionable interest waned as first century emperors moved against such ostentation, but smaller, often inland, ponds may have gained favor as a less extravagant way to control nature, please the eye and perhaps supply some food. Fishponds in the Roman suburbs and at villa sites inland of the Bay of Naples, were built of concrete and used to house eel and bass (*lupus),* still euryhaline fishes. Facilities like these have also been recovered from Roman villas in Roman Britain (Zeepvat 1988).

C6. THE LATER EMPIRE

Roman writers of the later Empire had less apparent interest in fishponds. In Oppian's *Halieutica* (Oppian, 1928) the only fish preserve (Greek *bibarion***)** is a marine area kept for imperial use. The next important agronomist, Palladius (1975), who wrote his *Opus agriculturae* about 380, having advised building a cistern of stone and cement, pointed out that the owner could stock "eels and river fish" *(anguillas sane pisces que fluviales)* so that their swimming would make the water surface ripple as if it were moving. His chapter called *De piscinis* (On fishponds) advises choosing a site near the farmstead which is easy to feed from a spring or surface runoff and useful for livestock and waterfowl. It mentions no fish, and neither does any of Palladius' other passing references to *piscinae* as sources of water for irrigation, livestock or household purposes. The word seems disconnected from its original root.

The unravelling thread of Roman agricultural expertise was pulled together about 600AD into a compilation called *Geoponika* (1895), perhaps attributable to a writer named Cassianus Bassus, but now surviving only in an edition made about 950AD under the auspices of the learned Byzantine Emperor Constantine VIII Porphyrogenitus. Book 20 contains 40 chapters on fishes and fishing, which are almost entirely marine, but it begins with one on fishponds. These occur in inland situations, where they are filled with fish from nearby rivers or lakes, or along the coast where sea fish are used. The stock should come from habitats like that in the pond, and can be fed herbage, small aquatic creatures or bits of fig, cheese or bread.

Perhaps it is fitting that a final echo of those classic Roman coastal rock-cut fishponds come in the writings of Cassiodorus, not the letters written in his middle years for the Gothic kings but in the *Institudones***,** a guide for reading and study done in his old age at the Vivarium monastery established on his hereditary estate at Squillace in the Brutti, the ball of the Italian foot. The place even took its name from the fishponds (*vivaria***),** which Cassiodorus described as follows (Cassiodorus, *Institutiones*, 1143):

The site of the monastery of Vivarium conduces to making provision for travelers and the poor, since you have irrigated gardens and the nearby river Pellena full of fish - its waves threaten no danger, but neither is it despicable for its size. It flows into your precincts, channeled artificially where it is wanted, adequate to water your gardens and turn your mills. It is there when you want it and flows on when no longer needed; it exists to serve you, never too roisterous and bothersome nor yet again ever deficient. The sea lies all about you as well, accessible for fishing with fishponds to keep the caught fish alive. We have constructed them as pleasant receptacles, with the

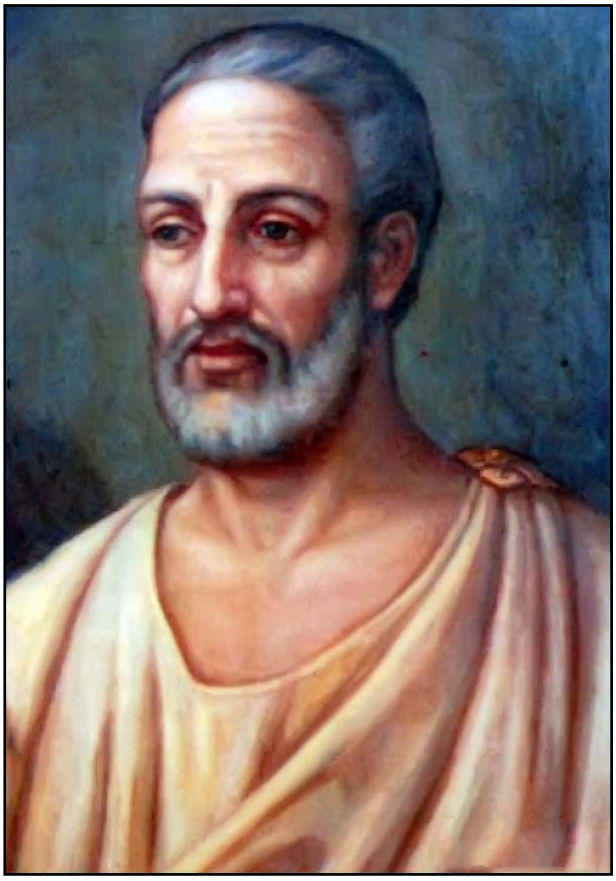

FIGURE 15: Flavius Cassiodorus (c. 485-c. 585).

Lord's help, where a multitude of fish swim close by the cloister, in circumstances so like mountain caves that the fish never sense themselves constrained in any way, since they are free to seek their food and hide away in dark recesses Thus it is that your monastery is sought by outsiders, rather than that you could justly long for other places.

At the site of the one-time Vivarium on the shore at the mouth of the Alessi River south of modern Squillace in southern Italy are still three natural basins in the rock with narrow channels to the sea that could easily have been blocked to create Cassiodorus' holding tanks. But the Vivarium monastery disappeared very shortly after Cassiodorus's death in the 580s (aged over 90!) and book I of the *Institudones* circulated little among medieval historians (O'Donnell, 1979).

D. CHINESE FISH PONDS

In the 1960s, an excavation of Chinese tombs from the Eastern Han Dynasty, in what's now Shanxi Province, unearthed a clay model of a rice paddy that held tiny clay fish. The miniatures, which were created between the years 25 and 220, depict the ancient practice of rice-fish farming, in which farmers stocked their flooded rice fields with carp. It is a symbiotic relationship. When grown together, the rice plants require fewer pesticides and the carp eat weeds and insect pests while also providing natural fertilizer.

References to this kind of aquaculture date back to the oldest surviving collection of Chinese poetry, the *Shijing* or *Book of Odes*, which was written around the 11th century BC. It notes that Chinese farmers reared carp in ponds during the period 1142 to 1135 BC. But the origins of this practice are murky, because fish bones are less easily fossilized than those of other, larger livestock.

The rice-fish farming system is described not only as one of production style, but also as one of the culture. Tombs of the mid-Eastern Han Dynasty (25-220 AD) were excavated in 1964 in Hanzhong county, Shanxi Province1. Two clay models were unearthed: a model of a pond and a model of a rice field. The pond model contained 15 tiny pieces, 6 of common carp, 1 soft-shell turtle, 3 frogs and 5 water chestnuts). These depict the ancient practice of rice fish farming in which farmers stocked their flooded rice fields with carp. It is a symbiotic relationship. When grown together, the rice plants require fewer pesticides; the carp eat weeds and insect pests, while also providing natural fertilizer.

A stone carving of a pond and rice field model was discovered in the brick tomb of the Eastern Han Dynasty in 1977 in Emei County, Sichuan Province. Half the stone was carved into a pond with frogs, fish and ducks. The other half was

FIGURE 16: According to Chinese mythology, carp can be transformations of dragons or can sometimes change into dragons.

carved into a rice field with an inlet and outlet, two farmers toiling on one side, and two heaps of manure on the other. Four mid-Han Dynasty tombs with 200 relics were excavated in 1978 in Mian County, Shanxi Province. One of the intact relics was a rice field model containing 18 pottery miniatures of aquatic plants and animals. There were sculptured frogs, eels, spiral shells, crucian carp, grass carp, common carp and turtles in this model. Another of a winter rice field showed farmland with a reservoir that also contained these fish. These relics not only proved that rice-fish farming system was one of farmer's production practices 1700 years ago. It also proved that the early rice-fish farming system is a very diverse system.

The more detail written record of rice fish farming is from Recipes for Four Seasons which was written by Cao Cao in the Sanguo Dynasty (200-265 AD):

A small fish with yellow scales and a red tail, grown in the ricefields of Pi County northeast of Chendu, Sichuan Province can be used for making sauce.

After that, in Tang Dynasty, in Ming Dynasty, and in Qing Dynasty, there were also numerous written records about rice-fish farming system or culture. For example, Liu Xun (about 889-904 AD), wrote in Wonders in Southern China:

In Xin, Long, and other prefectures, land on the hillside is wasted but the flat areas near the houses are hoed into fields. When spring rains come, water collects in the fields around the houses. Grass carp fingerlings are then released into the flooded fields. One or two years later, when the fish are grown, the grass roots in the plots are all eaten. This method not only fertilizes the fields, but produces fish as well. Then, rice can be planted without weeds. This is the best way to farm.

It indicated that before 1000 years ago, China's farmers had adopted the rotational rice fish farming technology. Another record was found in chronicle of Shunde County, Guangdong Province in Ming Dynasty (1573 AD). It states that:

The periphery of a land was trenched as a plot, called the field base…. In the plot, a pond was dug to rear fish. During the dry season, rice seedlings were transplanted to the plot. The area might be several hectares. It indicated that rice-fish farming technology was further advanced 400 years ago.

References to this kind of aquaculture date back to the oldest surviving collection of Chinese poetry, the *Shijing* or *Book of Odes*, which was written around the 11th century BC. It notes that Chinese farmers reared carp in ponds during the period 1142 to 1135 BC. But the origins of this practice are murky, because fish bones are less easily fossilized than those of other, larger livestock.

D1. A NEW DISCOVERY - 8000 YEARS OLD!

Now, a new study led by Tsuneo Nakajima of the Lake Biwa Museum in Japan and published in *Nature Ecology & Evolution*, suggests the prac-

FIGURE 17: This *wucai* fish vase, intricately decorated with small golden carp, lotus blossoms and undulating grass, dates from the Jiajing reign (1522-1566) of China's Ming Dynasty.

tice of rice fish aquaculture actually began thousands of years earlier than previously believed - around 6200 BC. The researchers had a hunch that these aquaculture systems originated a long time ago, because rice paddies have been around since 5000 BC, four millennia earlier than the first evidence of carp aquaculture. Some researchers guessed that the rice-and-fish system might have developed around that time.

One site showed particular promise for an investigation into the origins of rice fish aquaculture: Jiahu, a settlement occupied from around 7000 to 5700 BC in the Yellow River Basin of Henan Province, in central China. By Neolithic standards, Jiahu was positively cosmopolitan. If you wanted to spend time at a cutting-edge cultural center in Neolithic China, Jiahu was the place to be. It's one of the first places where people learned to make wine from fermented honey and rice, and bone and tortoise-shell artifacts show that the people of Jiahu carved a set of symbols that may be one of the earliest known predecessors of writing. Archaeologists have unearthed many other signs of a complex society there, such as flute fragments carved from the wing bones of red-crowned cranes, some of the earliest examples of playable musical instruments, according to The Metropolitan Museum of Art. In other words, if any Neolithic Chinese culture were to have domesticated fish, it would probably be Jiahu.

To search for Jiahu's ancient fish remains, the researchers excavated the site's trash heaps using a mesh sieve, to filter them from the soil. Mark Hudson, an archaeologist at the Max Planck Institute for the Science of Human History who co-authored the study noted that "Bones from carp and other things that have been eaten are usually jumbled together in rubbish pits. The researchers compared what they found at Jiahu to remains from other contemporary sites in China and Japan, as well as modern-day carp from a farm in Japan's Matsukawa Village.

On land, most species of livestock are physically distinct from their wild counterparts. The skeletons of domesticated sheep, for example, tend to be proportionally smaller and older than those of their wild sheep. This skeletal skewing makes it easy for archaeologists to discern when humans began to rear a given species. But fish bones are much smaller and more fragile than sheep bones, making them far less likely to be preserved. In fish, such skeletal changes are much less well-known, if indeed they exist. Instead, the researchers had to work with the best-preserved part of the carp: their pharyngeal teeth, which are harder and thus more likely to survive than bone.

At Jiahu, the researchers found a surprising abundance of teeth from the common carp. Despite the fish's name, common carp aren't quite as easy to find as crucian carp, which stay closer to shores

FIGURE 18: Henan Province China (light yellow), the location of the Jiahu settlement.

FIGURE 19: Pharyngeal carp teeth.

and riverbanks throughout the entire year, making them an easier catch. Yet 75 percent of the 588 carp teeth that were recovered came from the common carp.

It's relatively easy to extrapolate a fish's body length from the size of its teeth and I refer readers to a short article (Chavez, *et al.*, 2012) that explains the use of a simple regression analysis used to make the connection (see Figure 20). When the researchers calculated the probable body lengths of the Jiahu bones, they found an unnatural pattern, which suggested the carp had been farmed. According to prior research of carp bones at other Paleolithic sites in China and Japan, the body lengths thrown out by hunter-gatherers generally formed a bell curve that peaked at 11.8 inches, the average size of a mature adult carp - the kind you'd want to catch and eat. Bones found in the oldest layers at the Jiahu site produced similar body length patterns.

But starting around 6200 BC at Jiahu, the archaeologists found *two* bell curves, one representing the adult fish and another representing smaller, younger fish (Figure 21). The researchers believe the simultaneous abundance of these two body lengths suggest these fish were not caught wild as adults, but harvested from a pond, meaning that immature fish were caught alongside full-grown ones. This distribution pattern of two common body lengths, adult and juvenile, appeared in excavations of more recent sites with a known history of aquaculture.

The researchers' findings help to answer a larger question at the heart of early aquaculture: whether domesticated carp were moved from Europe to Asia, vice-versa or neither, writes Jennifer Harland, an archaeologist at the University of the Highlands and Islands, in a comment in *Nature Ecology and Evolution* (Harland, 2019). During the Roman Empire, carp were eaten but likely not domesticated in ponds until the 12th century, ac-

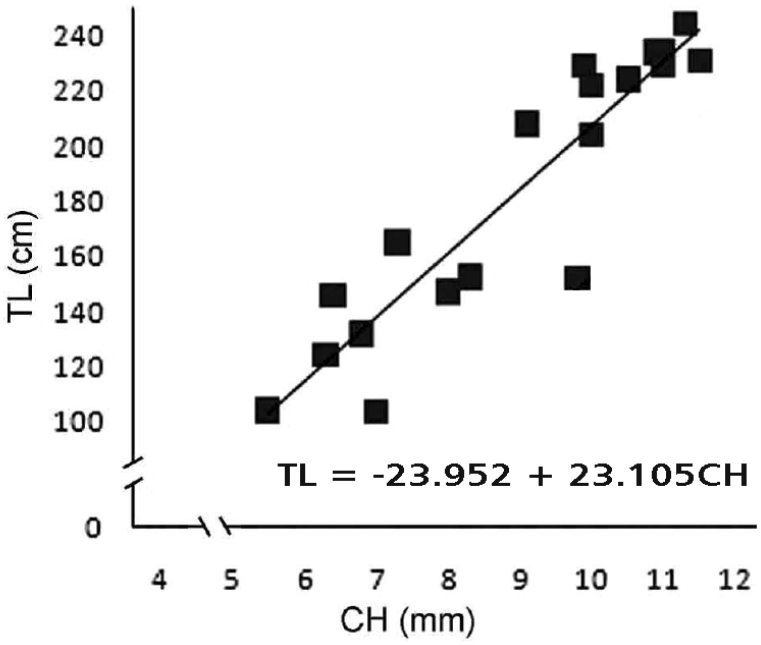

FIGURE 20: Regression line between tooth crown height (CH) and total body length (TL) for the second upper lateral tooth in the *Lamna nasus* shark from the northern Atlantic Ocean. For a given value of tooth crown height (CH), the equation predicts the total body length (TL).

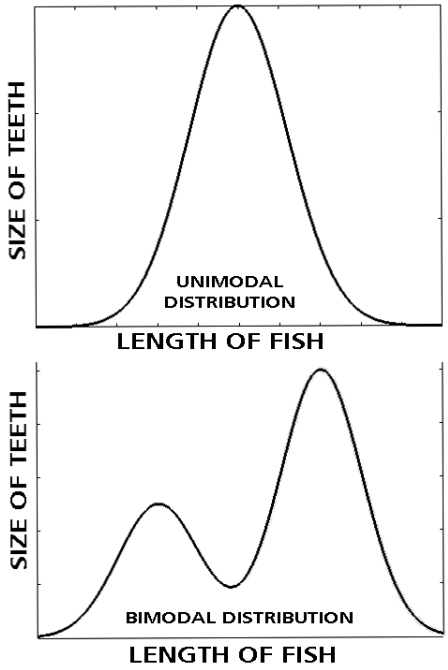

FIGURE 21: The upper image indicates that the sample contained only adult fish; the lower image indicates that both adults and juveniles were present.

cording to medieval historian Richard Hoffman in a 1995 study published in *Guelph Ichthyology Reviews*. Harland believes that the new findings at Neolithic Jiahu suggest the common carp was domesticated twice, once in Asia and once in Europe.

Though the researchers found ample carp teeth at Jiahu, they have not yet found traces of rice paddies. They hope to continue searching for traces of these fields to pinpoint when the rice-fish farming first emerged, as they believe this system - like the domestication of the carp - may be more ancient than previously thought. Today, rice fish farms are found all across China. In the Ailao Mountains in Yunnan Province, for example, a spectacular mosaic of rice terraces cascade down the slopes and support a variety of carp, including crucian (*Carassius carassius*), silver (*Hypophthalmichthys molitrix*), and, of course, the common carp (*Cyprinus carpio*).

D2. LATER RECORDS

The date 500 BC is considered of very great significance in the annals of the history of aquaculture. Many authors round the year as 500 BC although most agree that the exact year is 475 BC and some even use 473 BC as the period when Fan Lai (also spelled Li or Lee by some authors) wrote his book, "The Classic of Fish Culture." This book comprised the earliest monograph of fish culture. Although the narrative also dealt on fantasies and metaphysical aspects, it is the first to record and describe the structure of ponds, the method of propagation of the common carp and the growth of fry. Excerpts of an English translation and Chinese facsimile of this book are appended

The period 500 BC to 500 AD can be considered the Golden Age of common carp culture which has continued to develop in China as well as in

FIGURE 22: Top: The Jiahu team preparing to drain a rice field. Bottom: Junzo Uchiyama preparing to measure the length of common carp removed from the paddy field.

FIGURE 23: Fan Lei, who produced the first written record of aquaculture practices, *i.e.*, a book called *The Classic of Fish Culture,* published about 475 BC.

neighboring countries where the Chinese people migrated or have some form of foreign relations. Not only is actual progress attained in the techniques of culture but also scattered records of the culture systems were made during this period. At about this time in the Indian sub-continent, specifically during the period 321 to 300 BC, the use of reservoirs to hold fish was first described.

The reign of the Tang Dynasty (618-906 AD) is particularly significant in the history of world aquaculture. The Tang emperor in China had the family name of Li which happened to be the common name of the widely-cultivated common carp. Because of this coincidence, an imperial decree was issued prohibiting the culture as well as other activities connected with this fish. This decree, however, instead of putting a constraint to the development of aquaculture turned to be a blessing in disguise. The Chinese people who were then at the time very much engrossed in fish culture as a source of food and livelihood, looked for other species of fish for pond culture. This resulted in the discovery of the silver carp, the big-head carp, the grass carp and the mud carp, all very suitable pond culture species. It was also found that when raised in polyculture in the same pond, these species complement each other by eating different types of food and staying in different environmental strata within the pond. This led not only in the discovery of new species for culture but also in maximizing the productivity of freshwater pond culture,

The initiative to collect fry of cultivable species seasonally along the rivers was started during the Tang Dynasty as a result of the prohibition decree on the common carp, Systematic fry collection and dispersal in natural waters was highly developed during following period under the Sung Dynasty (906-1279 AD), At about this time in India, the published work Manasollasa presented a compilation describing the fattening of fish in reservoirs. In China, in 1243, Chow Mit published his *Kwei Sin Chek Shik* which described fry transport in bamboo baskets.

It was during the Ming period, 1368-1644 BC that works describing the complete aquaculture process were detailed. Methods for culturing fry to adult, the structure of ponds, rearing density, polyculture, stocking/catching rotation, application of food and fertilizer and disease control were dealt with in aquaculture works during this period. In the year 1400 brackish water aquaculture was recorded as having been started in Indonesia. This was suggested in the penal laws of the

FIGURE 24: A "Fish Pond" lobed bowl of the Ming Dynasty was auctioned for $29,000,000 at Sotheby's, setting the second highest record for Ming porcelain.

country (Kutara Menawa) which provided for the prohibition of stealing fish from ponds. In China, in 1639, the Complete Book of Agriculture which included pond fish culture was released. During the Ching Dynasty (1644-1912), further detailed description of fish culture methods were emphasized. This included fry production, season of occurrence of fry, differentiation and separation of fry and transport.

E. ON IDENTIFYING THE CARP AS CYPRINUS

No ancient Greek or Roman text refers to a *carp*. A fish which ancient Greeks called *kyprianos* and subsequent classical Latin authors *cyprinus* is reasonably well documented in the writings of Aristotle (384-322 BC) and others who knew his work. This fish was never then discussed in the context of artificial fishponds or fish culture. In fact, classical writers in Greek and Latin treat it as frequenting both fresh and salt waters, and allude to Asia Minor and the Balkans. None gives this fish a comprehensive description, but rather a passing mention.

In passages of the *History of Animals* Aristotle described *kyprianos* as a river fish with four gills on each side, a fleshy palate, and eggs the size of a grain of millet. It spawns five or six times a year, scattering its eggs in the shallows, but guarding the slowly-developing egg masses if it finds them again. Individuals without reproductive organs become very fat. With less harm than the catfish suffers, *kyprianos* can be paralyzed by a clap of thunder (Aristotle, 1965).

Writing a *Natural History* in Latin some four centuries after Aristotle, the Elder Pliny (23-79AD) noted only that, like the catfish in a river, "in the sea the *cyprinus*" ("in mare ... cyprino") is made drowsy by lightning (Pliny, 1942-1984), a fact he had, of course, copied from the ancient Greek writer. Another hundred years after Pliny, an author from southern Asia Minor, Oppian, dedicated his *Halieutica* ("On Fishing") to the Caesar Commodus, son of the reigning Emperor Marcus Aurelius. Writing in Greek, Oppian once refers to *kyprianos* as a fish of the gently sloping seashore and elsewhere repeats Aristotle on its breeding several times a year (Oppian, 1928). A younger contemporary, Aelian, also speaks obscurely of what he calls the "black *kyprianos*," caught in winter through the ice in the Danube (Aelian, 1958-1959). In perhaps the last ancient reference, a learned Gallo-Roman administrator, Polemius Silvius, included the word *ciprinus* among marine fishes in a list of 147 names of aquatic creatures he put into his *Laterculus*, a compendium of geographical and other knowledge done in 449 (Polemius, 1892).

It is important to note that ancient writers and texts nowhere equate the classical *cyprinus* with a creature called. This seems to happen very much later. Cassiodorus, whose sixth- century reference to *carpa* (Cassiodorus 1973) is acknowledged the oldest extant verbal record in any language, certainly did not gloss this barbaric word with *cyprinus*, despite his famous cultivation of classical literary knowledge. Nor was this done by any of the major scholastic encyclopedists, Vincent of Beauvais, Thomas of Cantimpre, and Albert the Great (Albertus Magnus), whose works were all compiled, revised, and known to each other between 1244 and 1260. In treating *"carpera"* (Vincent, 1624), *"carpo vel carp era"* (Thomas, 1973), and "*carperen*" (Albert, 1916-1920) not one mentions *cyprinus* or any ancient Greco-Roman authority.

It looks rather like the ancient term was put on

FIGURE 25: The Common Carp, *Cyprinus carpio*, a large minnow weighing up to 50 pounds or more.

the familiar common carp only by sixteenth-century humanist-trained authors, always eager to link up their world with that of the classics. For the time being at least, the earliest equation on record is that by Jan Dubravius. Writing in the late 1530s, this learned cleric found in no more than the passages from Aristotle, Oppian and Pliny remarked above, just enough similarity between his carp and Aristotle's description to resolve his doubts. And because the sound of 'carpo' is barbarous, it seems proper on that account to be rejected and in its place 'cyprinus' substituted, which is used widely by the Greeks and the Latins. Plainly the "barbarity" of a non-classical term much bothered Dubravius and he was only too happy to find a more acceptable one. Carp is then ***cyprinus*** in all the path-breaking ichthyologies published in Latin by Pierre Belon, Guillaume Rondelet and Conrad Gessner during the 1550s.

Nowhere in the Roman written or archeological records are there broad dirt-bottomed freshwater ponds with control facilities for complete emptying and filling such as those known in Western Europe from at least the twelfth century and used since at least the thirteenth century to rear common carp. But also nowhere in the Roman written record is there unambiguous reference to the fish now called *Cyprinus carpio* which during imperial Roman times was eaten near the western limit of its natural range at what is now Iza on the middle Danube (Balon, 1995a,b) and near its eastern limit in the Balkans at what is now Novae just above the Danube's mouth (Szymczyk, 1987).

However, Balon (1995 a,b) reports carp remains dating to the second through fourth century AD from the site of a Roman frontier fort on the Danube near what is now Iza, Slovakia. Also, *Carpho* is given as a synonym for Latin *carabus* in a list of fishes in a dual-language lexicon, the *Summarium Heinrici***,** compiled at Worms and the nearby monastery of Lorsch in Rhineland (Hildebrandt 1974-1982). Following publication of the text, Wagner (1975) showed how it must date to about 1100, and not significantly earlier. The revised dating was subsequently acknowledged in Hildebrandt's second volume and by Tischler (1994) and Crossgrove (1994). A mid-fifteenth-century Italian cookbook by a native of Lombardy then working in Rome, Maestro Martino's *Libro de arte coquinaria* provides a recipe for *carpani***,** and thus what so far seems to be the oldest Italian reference to the fish (Faccioli 1966).

F. WESTERN EUROPE FISHPONDS

To serve human demand for fresh fish, medieval Europeans established new freshwater habitats, modified the mix of fish species and created new ecosystems, both domestic and wild. These activities both exploited and multiplied what have been identified as unintended environmental consequences of medieval economic growth.

Artificial constructions for long-term retention and eventual rearing of live fish are plainly a response to inadequacy, whether conceived in nutritional or cultural terms, of natural supply. Fishponds can equilibrate seasonal irregularities, supplement insufficient wild catches, or even entirely

FIGURE 26: This artificial fishpond at Horbach, in Franconia west of Nurnberg, Germany was possessed by lay landowners before Heilsbronn abbey obtained it in the late 1200s. The abbey then managed it in concert with at least five more fishponds it owned there along the spring-fed valley of the River Zenn.

replace wild varieties with preferred domesticates. In some circles the ponds and freshly-reared fish could also make a social statement. The intensity and sophistication of medieval fish culture varied along a spectrum jointly determined by growing technical expertise, priorities, and resources available for investment. Simple storage tanks for seasonally surplus catches were likely always to be found. Heavily capitalized and elaborately managed fish-rearing enterprises were relatively late phenomena.

Even on monastic estates, where rules against eating meat meant proportionally greater fish consumption, hard evidence for fish culture is simply not present in the early Middle Ages. On ascetic grounds the Rule of St. Benedict, since the early ninth century the dominant constitution for monastic life, prohibited eating the flesh of quadrupeds but did allow fish. Monastic dietary regimes generally both reflected and reacted against local consumption practices. No meat did call for more eggs, cheese, and fish than in lay diets. Fish was thought superior food, however, and not eaten daily by the monks. By the eleventh century fish appeared on the table at well-run Benedictine communities two or three days a week and on special holidays, including during the 40-day Lenten fast when monks ate no eggs or cheese. Austere new orders, the Cistercians and Carthusians, avoided even fish during their early decades, and but slowly capitulated to occasional "pittances", special endowments of a fish meal.

All needs of monks and nuns for fish could often and long be satisfied from local wild resources. Of the six freshwater taxa named in Cluny's late eleventh-century customal (a written account of the customs of a manor or other local community), five (pike, trout, lamprey, eel, and sturgeon) could be expected from the extensive river fisheries in the Saone and its tributaries which that house owned two generations later. The rich records of Cluny at its height of wealth and prestige up to the mid-twelfth century refer to the capture and temporary storage of fish but give no sign of their rearing in fishponds. The same may be said of Cistercians well into the twelfth century.

To build a fishpond - and not just a holding tank - is to create a new aquatic habitat. Active construction of ponds for this purpose got under way in the eleventh century and increased rapidly in the twelfth and thirteenth. People built fishponds in regions where human populations and economies were also growing. Disputes over Picard fishponds thus enter the written record around 1100, and major projects in hydraulic engineering there date between the 1170s and 1250s, coincident with such investments in Burgundy and Berry.

It is important to recognize that, despite the ecclesiastical bias of a high medieval record written largely by and for churchmen, both lay and clerical landowners built, owned and operated fishponds in the twelfth and thirteenth-century west. About 1160, while the count of Sancerre was flooding lands near Bourges to make himself a fishpond, Emperor Frederick Barbarossa was ordering construction of another large one at Kaiserslautern. In 1216 Simon de Joinville, Seneschal of Champagne and lord of estates on the upper Meuse River, made sure he exempted his fishponds when he allowed the monks of Clair-

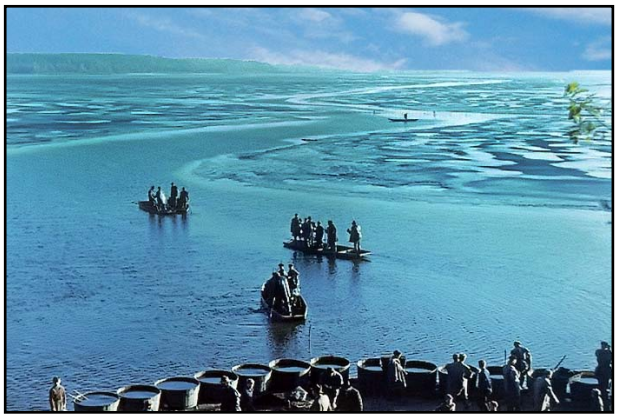

FIGURE 27: A large Bohemian fishpond in the Czech Republic of late medieval origin is drained and ready for harvest by traditional methods still being used in the late twentieth century.

FIGURE 28: The Bream, *Abramus brama*.

vaux to fish in his river. This should in no way be a surprise. Medieval religious and lay elites were everywhere interrelated and interdependent. Church institutions were more durable and kept more records, and by the thirteenth century the Cistercians (latecomers who often received valley-bottom sites) were becoming unusually systematic in their management of water, but recent scholarship is no longer convinced they were any more innovative than their lay neighbors and kin.

Active building of fishponds spread later to east central Europe. The Cistercian house founded in 1133 at Waldsassen in the German-Czech frontier zone of the Egerland did not make its first pond until about 1220. A few ponds may be recorded from eleventh or twelfth century Bohemia, but the first datable construction there was in 1263 and rapid increase came a century after that, when 87 new building projects are recorded between 1347 and 1418. Large and complex hydraulic works were especially undertaken by Czech lords between 1450 and 1550, resulting by the latter year in an estimated 26,000 artificial ponds covering thousands of hectares and some of them fed by rivers which had been diverted as much as 35 kilometers. Pond building in southern Poland lagged a generation or so behind that in Bohemia.

Whether fed by surface runoff, a spring, stream, or diverted river water, fishponds are still, not moving, waters. Medieval Europeans managed their purpose-built fishponds and other appropriate artificial or enhanced ponds (former river channels, millponds, moats) for production of fish varieties well- adapted to lentic habitats with high nutrient levels and warmed water. Probably in the twelfth century and certainly by the thirteenth careful management included close control over the in- and outflow of water and a regular (3-5 year) cycle from stocking with breeders or small fish to drainage of the pond for harvest, followed by a dry season and cultivation of the bottom to raise fertility when the pond was refilled. The elaborate hydraulic system built at thirteenth-century Vauclair put the fishpond where it received nutrient-laden outflow from abbey latrines. A like arrangement fertilized five of Maulbronn's eight nearby ponds. Coordinated management of several ponds serving different functions or at different phases of the production cycle was essential for year-to-year operation of the enterprise. The entire technical system is visible in sources from the western continent and England by about 1200 and seems later further to the east.

Anadromous or cold-water fishes had no place in the pond environment. In the the thirteenth-century they yielded bream, tench, roach, dace, and pike. Most of the fish species recorded in medieval ponds were these western European natives with preferences for still and weedy waters. They now received much increased habitat and even purposeful human help as a consequence of medieval economic development.

Common carp were not native to western and central Europe. Arrival of this exotic species necessarily meant interaction with the ecosystems now receiving it. "Successful establishment of an

FIGURE 29: The Tench, *Tinca tinca*.

exotic species must necessarily precipitate changes in the physical and biological characteristics of the aquatic ecosystem receiving the introduction.... That no effects should result from such perturbations strains one's confidence in ecological principles" (Taylor et al. 1984, pp. 323 and 352).

In common carp, medieval fish culturists introduced a new species remarkably well-suited to colonize the very type of freshwater habitats which economic development was multiplying in the west. Carp are omnivores, feeding principally on bottom- or plant-dwelling small animals. They prefer warm, turbid, slow and still waters with much vegetation for food and where they will broadcast their own eggs in early summer. Carp tolerate low oxygen levels in water and if kept cool and damp can survive some days out of the water. They grow faster than do bream, the native western European cyprinid most like carp in habits and habitat requirements. Medieval western ecosystems offered little competition.

In northern Europe, however, it was difficult to winter and reproduce carp and it was therefore replaced with the crucian carp, *Carassius carassius*, Figure 30, which was bred in ponds and used as food. Other cyprinids (especially bream, *Abramis brama* and pike, *Esox lucius*) were kept as well, but they seldom reproduced in the ponds. These taxa were therefore merely intended for storage ponds. However, the crucian carp was well-suited to the northern climate; it grew quickly if properly tended, and it produced a good yield. By contrast, the common carp was hard-pressed to survive the harsh northern winter. Northern Europe's climate does not allow carp to reproduce either. The crucian carp, however, can be maintained under anoxic conditions for months. It is therefore a very useful species as a pond fish under the conditions northern Europe offers. Both clerical and lay landowners constructed and owned fishponds.

The domestication of the carp, *Cyprinus carpio*, occurred in southeast Europe in the Danube basin during medieval times. Various domesticated varieties have also been available for a long time, especially the leather carp and mirror carp. The tench (*Tinca tinca*) has been kept for food production since late medieval times and it also had a reputation of being good for other cyprinids in the ponds, keeping them healthy.

Ornamental fishponds containing cyprinids have also been kept in ponds for ornamental purposes although only the goldfish has been discussed at length by historians. Crucian carp seems to have been common in ornamental ponds in the seventeenth century. However, with increasing contact with park culture on the continent, various golden varieties of cyprinids were primarily kept for ornamental purposes in garden culture. Other cultural varieties of indigenous cyprinids have also been kept for ornamental purposes. In addition to the crucian carp, four species of cyprinids dominated in the park culture in older times: carp and its varieties, goldfish, and its varieties, and the golden variety of tench known as golden tench, and the golden variety of ide or orfe, *Leuciscus idus*.

The carp is a stunning pond fish, but due to its sensitivity to cold water has been rarely kept in northern Europe. The domesticated mirror carp

FIGURE 30: The Crucian Carp, *Carassius carassius*. It can handle many different environments. Although a warm water fish, it can survive in lakes by lying and pressing against the mud at the bottom of a lake that is not frozen.

FIGURE 31: The fishpond at Skabersjö castle, Scania, Sweden

has been kept in larger garden ponds. Color varieties were developed in Japan in the early nineteenth century. In 1914, color-breed carps were put on show at an exhibition in Tokyo, which was the beginning of interest in the so-called Koi carp in Japan and a real craze for these beautiful fishes developed. Soon exports of Koi carp began and eventually spread worldwide. The name Koi carp is actually a tautology (Koi meaning 'carp' in Japanese). In Japanese they are referred to as nishikigoi, literally meaning 'brocaded carp'.

F1. GOLDFISH

The goldfish that reached Western Europe with their beauty and color attracted the attention of royal courts and academies and no native species could remotely compare with the golden newcomer from China. It was bred for the first time in the Netherlands in 1728 (Tyrbjerg 2006). Few details about its introductions are known though, and therefore some details about its early presence in Sweden may be of interest, based mainly on research by Svanberg (2007).

In Sweden, the goldfish has been known since the 1740s. With the help of Swedish ambassador Nils Palmstierna, the Swedish Academy of Sciences received a preserved goldfish, which was and described by Carl Linnaeus in the proceedings from the academy in 1740. Interestingly enough, Linnaeus also published some information about its care. It was still a fish kept in bowls, not in ponds, in Scandinavia, and it was recommended that it be given fresh water two-three times a week. It should be fed with biscuit, egg yolks, dried lean pork and small snails. It is however unclear if Linnaeus had any personal experience of live goldfish (which he actually might have had from his years in the Netherlands). However, the information he gives about the care of goldfish bears witness that he had received information from someone who knew. One of the depicted gold fish was obviously a fantail.

Linnaeus never ceased to be fascinated by the beauty of the goldfish. In 1744, the merchant Carl Gyllenborg donated "Chinese goldfish" to Linnaeus, but they were preserved in ethanol. Linnaeus was eager to get hold of live fish. In November 1745, he wrote instructions for his pupil Christopher Tärnström that he should bring back goldfish for the queen from his tour to East India. However, Ternström unfortunately drowned in south-east Asia and was never able to complete the task. Linnaeus's enthusiasm for the

FIGURE 32: Nils Palmstierna (1696-1766). A Swedish politician, he was responsible for bringing the goldfish to that country in the 1740s.

goldfish was undiminished. He received further preserved goldfish for his zoological collections from the royal court and King Adolph Fredric and his queen probably kept goldfish in the ponds at the royal palace of Drottningholm.

In 1759, an opportunity arose for Linnaeus to receive a goldfish. One of his pupils, the physician Pehr Bjerchén, was staying in London and kept up a lively correspondence with Linnaeus. He asked Bjerchén to find goldfish for him. Linnaeus became very enthusiastic when he received a letter telling him that Bjerchén had traced down a breeder in his colleague Richard Guy. He had a pond at his country estate with 50 to 60 goldfish. Guy of course was very careful about his rare fish, but Bjerchén persuade him to donate a couple to the world-famous professor in Uppsala. Bjerchén brought them back by ship to Gothenburg. Linnaeus wrote impatiently in September 1759, "Do please send the goldfish already tomorrow with a vessel to Uppsala; they do not freeze that easily; so I will be able to once again see them, something I have dreamed of all my days but never hoped. Let the skipper ask what price he wants, only I get them alive". He finished the letter, "God give I had them alive in my orangery."

Apparently, thrifty Linnaeus was prepared to pay quite a sum to get his coveted goldfish. Bjerchén sent the goldfish together with detailed information about how to take care of them. It is a very interesting sheet of instructions with information about keeping the bowl clean, the importance of fresh water and how to feed the goldfish. In October 1759, one fish was already dead, but the other specimen survived at least the winter and was alive the next year. Dr Guy in England promised to provide Linnaeus with further specimens. More goldfish were offered by Job Baster, a Dutchmen who was breeding them in open-air ponds. It is, however, unclear if Linnaeus received any more live goldfish (Svanberg 2007).

In the late eighteenth century, the goldfish was widely kept in southwestern Europe. In 1780, Louis Edme Billardon de Sauvigny published a famous book about the Chinese goldfish with excellent illustrations. In his book on companion animals, Johannes Matthäus Bechtein (1795: 222–226) gives a rather detailed description of keeping goldfish. The golden tench is mentioned by Marcus Bloch (1777) and seems to have originated in central parts of Europe, probably Bohemia and Silistria. It spread early to other parts of Europe and was kept as an ornamental fish for garden ponds (Shaw and Stephens 1804: 217–218). Another domesticated fish is the golden ide or orfe, which probably came from Germany and seems to have been common in continental fishponds already in the seventeenth century. Leonard Baldner named it "Goldgelbe Rottel" in his manuscript, "Recht natürliche Beschreibung und Abmahlung der Wasservögel, Fische, vierfüssige Thieren, Insecten, und Gewürmb, so bey Strassburg in den Wässern seynt, die ich selber geschossen und die Fisch gefangen from 1666" (Lauterborn 1901).

G. ENGLISH FISHPONDS

FIGURE 33: Pehr Bjerchén, one of Linnaeus' pupils, who shipped live specimens of goldfish to Linnaeus in Uppsala in 1759.

The balance of evidence indicates that fishponds were introduced into Britain after the Norman Conquest (1066) as a secular aristocratic initiative rather than a monastic innovation. Some of the earliest ponds on monastic holdings were actually donated by lay benefactors, and there is no indication that English monasteries adopted a policy of extensive pond construction before the later twelfth century. Investigations of monastic accounts and excavations of dumps for kitchen wastes have now demonstrated beyond question that marine species were extensively marketed, even deep into the English midlands, and contributed far more to the regular monastic diet than freshwater fish. Despite the efforts that went into their construction, the output from monastic ponds can rarely have been sufficient to meet even basic subsistence needs, let alone producing regular surpluses for commercial sale. Other explanations must, therefore, be sought.

Fish in the monastic diet of The Rule of St Benedict, the most widely-applied monastic rule throughout north-western Europe, did not literally promote the consumption of fish: it merely required abstinence from the flesh of four-footed animals by all but the sick. In England, its endorsement and strict observance was not universal before the twelfth century. When Simeon, first Norman prior of Winchester (d. 1082), found the monks there eating meat, he persuaded them to change their ways by having the cook prepare exquisite dishes of fish. Thereafter, observance of customary fish-days every Wednesday, Friday and Saturday, and throughout the season of Lent became well established among the English Benedictines and was generally respected through to the Dissolution, though the prohibition of meat-eating on other days was relaxed later in the middle ages. Different religious orders developed dietary regulations of varying severity. Even when strict abstinence from meat was no longer enforced, marine fish remained readily available and cheap and economic pressures ensured that fish continued to make a major contribution to monastic diet right up to the Dissolution. At Winchester Priory, fish formed the main course of the main meal on 165 out of 278 days between December 12th 1514 and September 19th 1515, 59 per cent of the documented days.

Both documentary and archaeological evidence make it abundantly clear that saltwater fish were consumed in far greater quantities than freshwater fish. Notes of purchases of large numbers of herring and cod abound in monastic kitchens' accounts, and in 1491 over 45 per cent of Winchester Priory's total food expenditure was on marine fish. Even on sites far inland, deposits of monastic food refuse have consistently yielded far greater quantities of bones of sea-fish than of freshwater species. In turn, river fisheries provided far more freshwater fish than managed fishponds. Why, then, are fishponds such a prominent feature on many monastic sites?

The answer almost certainly lies in the concept of

FIGURE 34: View of Whitby Abbey over the fishpond.

exclusivity. Fishponds were costly to construct and to maintain. Pike (*Esox lucius* L.) and bream (*Abramis brama* (L.), their most esteemed products, were considerably more expensive on the open market than herring or cod. Grants to monastic communities of fishing rights in rivers and secular ponds sometimes **imposed** conditions that the catch should be reserved for particular feasts and anniversary commemorations of the deaths of members of the patronal family. In the 1090s, William de Warenne, Earl of Surrey, allowed the Cluniac monks of Lewes to fish in his waters for the great feasts and for the memorial of his parents. Another purpose was the entertainment of important visitors. The large fishpond of Battle Abbey was fished out in 1275 in anticipation of the king's arrival.

Fishponds were never intended to supply the entire subsistence needs of monastic communities, let alone to produce revenue from sales. Their primary purpose was to provide more prestigious meals for special occasions. In support of this contention, the yields from monastic ponds remained relatively meagre, primarily because the fish were left to forage on natural resources. Without supplementary feeding, a pond one acre in extent was able to support only about 200 lbs. of bream; but since bream take five years to reach edible size, it could produce only about 40 lbs. per annum. Assuming 175 fish days a year at which each monk would receive a minimum of 0.37 lbs. (0.51 lbs. of unprepared weight) of fish per day in order to meet its entire needs, a small house of ten monks would need to produce 850 lbs. each year, which would require 21acres under water; a large house of 40 brethren would require 91 acres. Furthermore, the needs of guests, monastic pensioners and servants also had to be met. Even allowing for catches from outlying estates, few monasteries in Britain had ponds on this scale.

The chronology of monastic fishponds English monastic chronicles, charters and accounts contain many incidental references to fishponds but they fail to provide a secure guide to the chronology of construction. The earliest purported references to fishponds on any monastic property occur in two charters claiming to record royal grants of land to the Benedictine abbey of Abingdon in AD 958–9 and AD 968. Both charters had boundary inspections attached, referring to the same fishpond. This has been identified with an artificial rectangular pond within the modern parish of Appleton-with-Eaton. Unfortunately both charters are of dubious authenticity, and the bounds are certainly later than their nominal date. Neither, therefore, proves the existence of artificial monastic fishponds as early as the tenth century.

G1. THE DOMESDAY BOOK

The Domesday Survey compiled by order of William the Conqueror in 1086 contains only two records of fishponds at Benedictine abbeys: Bury St Edmunds had two *vivaria vel piscinae*, St Albans one *vivarium piscium*. The Domesday record of fisheries is, however, inconsistent, and it is entirely possible that further monastic ponds may have escaped notice. The appearance in Britain of regular canons and various reformed monastic orders dur-

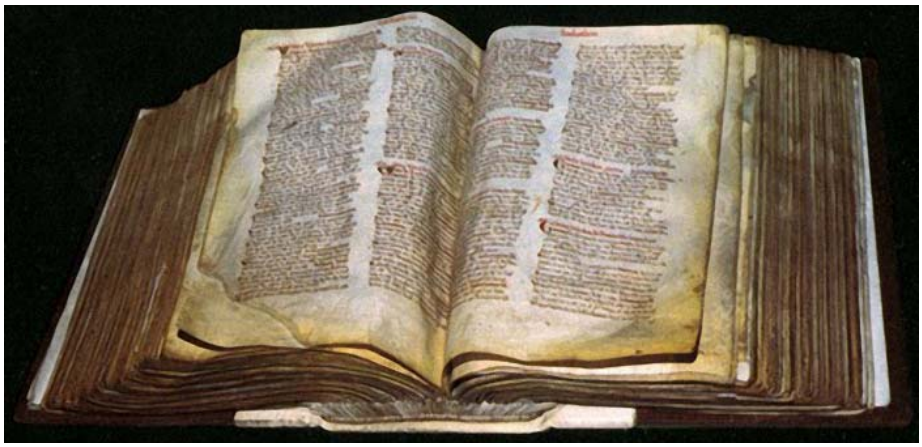

FIGURE 35: The Domesday Book is actually composed of two volumes; here shown is the larger of the two, the Great Domesday book.

ing the twelfth century opened up new links with the continent, which perhaps contributed to the wider adoption of pisciculture. Records of fishponds on monastic properties begin to proliferate only after the middle of the twelfth century.

Many of the earliest examples were pre-existing ponds given to monasteries by lay benefactors. A writ of Henry II permitted the monks of Selby Abbey to have a fishpond "which existed when the abbey was founded," *i.e.*, before 1070. William Ferrers, Earl of Derby, gave the monks of Tutbury a fishpond at Stanfordunder-Needwood around 1170. Religious houses were also often granted special fishing privileges in ponds belonging to their patrons. Geoffrey de Clinton, founder of the castle and priory at Kenilworth, confirmed to the priory canons before 1173–4 the right to fish "with boats and nets" in the large artificial lake alongside the castle on Thursdays. There are many other examples of monastic houses acquiring from secular lords rights in or possession of fishponds before 1200.

The first known record of a monastic initiative in construction is the fishponds made by Abbot Adam (1160–89) on the lands of Evesham Abbey, though unfortunately, the chronicler does not locate them. Fishponds are also recorded on the estates of Pershore Abbey and Fountains Abbey before 1200. References to monastic fishponds become much more numerous during the thirteenth century. To some extent this reflects the increasing range of available sources, but it also coincides with a period of direct exploitation, when enterprising abbots were investing in a wide range of improvements to their lands. Abbot Randulph (1214–29) undertook many new works on the Evesham Abbey estates, including the making of new fishponds at Evesham itself and on at least five outlying demesnes [*i.e.*, lands attached to a manor and retained for the owner's own use]. The Cistercians of Waverley completed construction of a fishpond some 5 km south of the abbey in 1250–51 and the Cistercians of Beaulieu were constructing a causeway alongside their large pond at Sowley in 1269– 70. Though the regime of watermills was not ideally suited to raising fish, Stoneleigh Abbey's millpond at Cryfield was producing perch (*Perca fluviatilis*), roach (*Rutilus rutilus*), bream (*Abramis brama*), tench (*Tinca tinca*) and pickerel (*Esox lucius*) in the 1380s.

Because watercourses so often formed property boundaries, it was a common occurrence for a religious community to be granted land on one side of a stream only. To utilize the valley floor for fishponds, therefore, required negotiations with neighboring landowners. When Byland Abbey decided to construct a new pond in the Wakendale Beck valley in 1234–5, the monks acquired permission to construct a dam and to have a right of way round the western margin of the pond on their neighbor's land for fishing and drawing nets; but if the pond overflowed an adjoining thoroughfare, they would be required to replace the road.

Construction and management of valley-bottom ponds normally necessitated the diversion of the natural stream into a canalized leat [i.e., an artificial water trench]. Such realignments could involve considerable engineering works, as at the priory of Orford. When the surroundings of the Cistercian abbey of Bordesley were first surveyed in the 1960s, it was realized that the entire flow of

FIGURE 36: Great Chalfield Manor and fishpond, near Bradford-on-Avon, Wiltshire. It is a moated manor house built around 1465-1480.

the River Arrow had been diverted out of its natural bed and canalized along the side of the valley for about 1 km to create space for two large parallel fishponds and a separate millpond; subsequent excavation indicated that the river diversion had taken place before about 1180). The creation or enlargement of fishponds usually required the sacrifice of land previously used for other productive purposes, while interference with the natural drainage might cause unintentional flooding nearby. These were frequent causes of conflicts. The Bury St Edmunds chronicler recorded how Abbot Samson (1182–1211),

Raised the level of the fishpond at Babwell […] to such an extent that […] there is no man, rich or poor, having lands by the waterside […] but has lost his gardens and orchards. The cellarer's pasture on the other side of the bank is destroyed, the arable land of the neighbors is spoiled, the cellarer's meadow is ruined, the infirmarer's orchard is drowned through the overflow of water, and all the neighbors complain of it. Once the cellarer spoke to him in full Chapter concerning the magnitude of the loss, but the abbot at once angrily replied that he was not going to give up his fishpond for the sake of our meadow (Butler 1951: 131).

In the 1270s the Augustinian canons of Cirencester enclosed land at Duntisbourne in order to make a new mill and fishponds, provoking complaints from the Benedictine monks of Gloucester, who claimed that the waters encroached over land where they had rights of common pasture. The Gloucester monks were persuaded to relinquish their claim in 1275.

G2: NOBLESSE NOT SO OBLIGING

From this time to the accession of Henry II, considerable progress was made in the cultivation of fishponds. History records the immense sums expended by this monarch in building palaces and castles, and in renovating others in various parts of the country, never omitting those important medieval acquisitions, the fishponds. Half a century later we find they are made a subject worthy of comment in the legislature. Again, in the year 1275, we find in the Statute Book an Act of Parliament passed avowedly to punish with rigorous pains and penalties those found poaching or otherwise damaging them.

In order to show the necessity of this and ulterior laws against poaching and otherwise despoiling fishponds, the following instances are some examples. Destroying the fishponds of noblemen and gentlemen appears to have been a favorite amusement of the mob in the olden times (Nichol, 1795-1811):

In 1328, the new Earl of Lancaster, out of dislike of the proceedings of the king's mother and Mortimer, refused to be present at the Parliament held at Salisbury, where John of Eltham was made Earl of Cornwall, Roger Mortimer Earl of March, Edmund Boteler Earl of Ormond; all of whom, with their adherents, gathered a great army and ravished the lands of the Earl of Lancaster; and, particularly, coming to Leicester on the day before the nones of January, staid there and in the adjacent country eight days, making great havoc and spoils, destroying woods, parks, and fishpools, and carrying away all that they could

FIGURE 37: The expansive grounds located just south of the 78-foot-high great tower erected by William, Lord Hastings, at Ashby de la Zouch Castle contain a series of unusual sunken forms that are the remains of ornamental ponds containing fish.

lay their hands on.

In the petitions to the House of Commons during the year 1649, there is one from the Earl of Rutland, dated March 28, wherein he makes the complaint that a horde of riotous miners had lately entered into his lands, broke up his pleasure-grounds and destroyed his fishponds. This petition evidently referred to his lordship's seat of Nether Haddon, in Derbyshire, where he resided after Belvoir Castle had been demolished by the Cromwellian forces. It is almost needless to add that the fishponds at Belvoir shared a similar late (Nichol, 1795-1811).

In 1381, the mob, excited by Tyler and Straw, demolished John of Gaunt's house and his fine fishponds in the Savoy, London. In the reign of Edward III (1327) a mob destroyed the fishponds of the Abbey of St. Edmondsbury in Suffolk, "and took out such store of fish as they found in the same." In 1377 a dispute between the retainers of the Earl of Warwick and the tenants of the Abbot of Evesham resulted in the fishponds of the latter being demolished by the rabble.

The ponds at Croyland Abbey, Lincolnshire were frequently sacked (Hollingshead, 1577). These were amongst the oldest in the country, having been bestowed upon the monastery by Ethelbald, king of the Mercians, 716AD. They were likewise the most unfortunate, having been perpetually in hot water, either through encroachments, riots or legal squabbles. The secret of this was their extraordinary value; the fish they yielded being worth more than £5,000 per annum in modern currency. We might begin in the year 1280 and follow a multitude of legal and arbitrary cases concerning them, but suffice be it to commence with the year 1415. Thomas Wake, Lord of Laddie, wanted to have some of the Gogeslound ponds, to which he alleged a legal right. The abbot disputed his claim, whereupon the case was tried and the jury found for the plaintiff.

All the jury," said the chronicler, **"who determined the matter by a false, unjust and disinheriting (*ex hereditaria*) presentation, came to violent ends, by palsy, dropsy, phrensy [i.e., frenzy] or other misfortunes, and the foreman who returned the verdict had his tongue swollen so by it that he could not get it back into his mouth, but came to a shameful end."**

From this verdict the abbot appealed and when he won the appeal Wake was condemned in misericordia regis (i.e., the King's mercy). Still the persecution went on against the poor abbot until the 12th of May, 1432, a mob came, armed with swords, sticks, bows and arrows, and fished in the abbot's separate pond out of which they took 1,000 dentrices [pike], 1,000 tencas [tench], 1,000 rochias [roach], and 10,000 anguillas [eels], and carried off the nets and other ingenia [i.e., fish and eel traps] for catching fish, together with 600 dead geese and gulls to the amount of about $15,600 in damages. A special jury was summoned the following year, and the sheriff had orders to fine them in default of not appearing,

FIGURE 38: The Valle Crucis Abbey in Wales. The fishpond provided a ready source of food for the monks who were forbidden by their vows to eat meat. The pond is the only surviving monastic fish pond in Wales, but most monasteries without fishing rights would originally have had one or more such ponds.

and they were all sent to the Fleet Prison in London "save Hugh Cross, of Croyland, who was then with his uncle, Humfrey, Duke of Gloucester, in Picardy."

Thousands of episodes might be mentioned by which we could trace their progress and importance in those so-called dark ages. Even Chaucer tells us in his Franklin's Tale: "Many a luce [i.e., a fully grown pike] and pike had he in stew."

G3. THE MIDDLE OF THE FOURTEENTH CENTURY

Documentation for monastic fishponds declined markedly after the middle of the fourteenth century. Archaeological evidence suggests that pike consumption, reaching a modest peak after construction of the abbey ponds in the early thirteenth century, thereafter declined steadily to the Dissolution. It would be easy to dismiss the later middle ages as a time of declining interest in fish production, as monastic landholders, experiencing the same economic difficulties as lay lords, began withdrawing from direct farming, leasing out their ponds with their outlying demesnes.

A property leased out by Quarr Abbey in 1430 included a fishpond and Winchester Priory's two ponds at Fleet were also leased out by 1491, the prior agreeing to provide the timber necessary for maintenance of the intervening causeway. Whereas Ramsey Abbey continued to derive considerable income in the fifteenth century from leasing its fisheries in the rivers and natural meres of the Fenland, rents from artificial fishponds were generally low. Winchester Priory asked only $50 per annum for the Fleet ponds, little more than the value of the 100 fish which the lessee was required to send to the priory each year. Low rents probably reflected the expectation that the lessee would provide his own breeding stock, exactly as would be the case for leased pasture land.

Despite the general move towards leasing, however, fishponds within the precinct and those belonging to manors which had been retained as residences for monastic officials were usually kept in hand. At Titchfield, land abandoned after the Black Death had been utilized for a new fishpond before 1393 and both here and at Southwick archaeological evidence confirms that the ponds were not only maintained but also enlarged. New ponds were made at Eynsham before 1360, and ponds at Abingdon and Selby were still producing fish into the fifteenth century.

G4. FISHPONDS: LAYOUT AND FORM

There is little difference in characteristics of siting, construction, form or management between monastic and secular fishponds in Britain. The layout of ponds within or just outside monastic precincts depended upon a number of factors, of which the most important were the physical characteristics of the site and the amount of space available. In areas of accentuated relief, ponds were confined to chains along narrow, steep-sided valleys, where dams were easily constructed. Where the site was generally level the course of leats bringing in and removing water required more careful surveying, and more earth-moving was needed to excavate beds and provide retaining banks; but there was greater scope to create more elaborate arrangements of ponds for more convenient management. On the whole the reformed monastic orders settling in remote locations had better opportunities to lay out more extensive arrangements of fishponds, simply because they had more space, whereas the older Benedictine abbeys and the later friaries were

FIGURE 39: Manor House and fishpond, Long Clawson, Leicestershire.

more frequently in congested urban settings.

One important late medieval innovation was the introduction of carp (*Cyprinus carpio*). Carp already dominated continental fish-farming by the early fourteenth century and had been kept in Britain since the fifteenth century; yet no evidence has been found for their presence in monastic ponds before 1530 when the Prior of Llanthony by Gloucester sent a gift of carp to the king. When Prior More placed "certain carp fisshes" in his Worcestershire ponds in 1531–32, he does not seem to have regarded them as a particular success.

G5. EUROPEAN LITERATURE ON FISHPONDS

The culture of fishponds also became one of literary importance. One of earliest manuals for cultivating cyprinids in fishponds was written by the Swedish friar Peter Magni in 1520. He dealt in detail with how to keep crucian carp in ponds. However, it was never printed and therefore did not reach any audience. There are a few printed sixteenth-century treatises on freshwater aquaculture from central Europe. The first, and in point of data, the most important writer on this subject, was Scala (John) Dubravius, Bishop of Olmutz, in Moravia, early in the sixteenth century. He was born at Plitzen, in Bohemia, and died Sept. 6, 1553, having acquired the reputation of being a pious and enlightened prelate. The functions of the episcopate did not prevent him from being an ambassador in Silesia, afterwards in Bohemia and subsequently president of the tribunal touching the troubles of Smalkalde (The *Schmalkaldic* League was a military alliance of Lutheran princes within the Holy Roman Empire during the mid-16th century). He is the author of several works, the most important of these being a history of Bohemia in thirty-three books executed with fidelity and accuracy, and *De Piscinis*, a treatise on fishponds. In the latter he exhausts the entire subject, every minutiae being delineated with a master hand. Nothing escaped his powerful penetration, and parallels were drawn from the ancient authors, more distinctly illustrating any obscure definition where such arose.

But the work was only applicable, in a general sense, to the country which it so faithfully depicted The culture of ponds in Moravia, with all its ramifications, is inapplicable to England, save when such manipulations are altered and modeled to meet the requirements of a different sphere. Nevertheless, it has been the textbook to all subsequent writers on this economy, though altered to meet the several requirements which arose in different cases, which practical experience alone can truthfully indicate. As far as it concerned Moravia, Bavaria and Saxony, it was an infallible guide. One point, however, I cannot omit to mention. In his book he mentions the profits that were in those days derived from fishponds in his native country. He describes those belonging to Janus of Berenstenie, "the rich ruler and alderman of Bo-

FIGURE 40: Scala (John) Dubravius (1486-1553), Bishop of Olmutz and author of *Libellus de piscinis et piscium.*

hemia and Moravia," who he states annually derived three times the amount that Cato received from the ponds of Lucullus, which represent £9,375 per year in today's currency.

The bishop's treatise soon acquired an immense reputation, and became known in almost every country. In 1599, George Churchey, Fellow of Lincoln's Inn (one of the four Inns of Court in London to which barristers of England and Wales belong and where they are called to the Bar), published a translation of it in English, very few copies of which now remain. Dubravius's efforts were emulated by English writers, as follows. In 1590, by Leonard Mascall; in 1686, by Richard Blorne; in 1715, by the Hon. Roger North; in 1727, by Professor Bradley, F.R.S.; in 1800, by the Bight Hon. Sir Joseph Banks, Bart.; in 1804, by Sir Edward Lytton, Bart.; in 1805, by the Rev. Charles Maxwell; in 1806, by J. Loudon, F.R.S.; in 1812, by the Rev. *W*. B. Daniel, and in 1841 by Gottlieb Boccius.

The second manual was published in 1573 (second edition in 1605) by Olbrycht Strumieński (?–1609), a nobleman and manager of fishponds in the vicinity of Kraków. He wrote the book at the request of his friends, who valued his experience in aquaculture very highly. In the introduction he stated that "some respectable persons" had written works in Latin, but he did not know them. Due to the popularity of carp aquaculture, his book was plagiarized by Stanisław Stroynowski and published twice, in 1609 and 1636. These manuals give us insight into how aquaculture was conducted in early modern times.

G6. AFTER THE DISSOLUTION

Monastic fishponds after The Dissolution of the Monasteries (1536–40) was accompanied by much plundering of monastic resources. Some of the men who rose to positions of wealth and power in the wake of the Dissolution acquired former monastic premises for their private residences and redesigned their gardens and fishpond systems. Thomas Wriothesley, 1st Earl of Southampton, acquired Titchfield Abbey in 1537. Almost immediately he added four new fishponds and acquired 500 carp to stock them, hoping that future sales of carp might yield $400 or $600 a year. The ponds continued to supply carp at least up to 1741. In 1542 Wriothesley further stocked the Titchfield ponds with 1,400 fish, including bream, pike, tench and perch, supplied from Sowley Pond, formerly the property of Beaulieu Abbey.

A survey of the site of the Cistercian abbey of Old Warden recorded a substantial dam some 5m high and over 220m long, which would have retained a large lake in the valley immediately south-east of the abbey. This was equipped with a diversion channel, and probably is of medieval origin. Ridge and furrow in its bed may indicate a rotation of fish-rearing and agriculture. However, earthworks of a more intricate complex of small rectangular ponds and channels immediately south of the former cloister buildings seem not to be of monastic origin, and were more probably associated with the gardens of the great house built by Sir John Gostwick soon after he acquired the abbey site in 1537 (Baker 1982).

FIGURE 41: The actions of Henry VIII led to the dissolution of the monasteries during the 16th century and their fishponds were acquired by private estates. This is one of such examples, the fishpond of Warden Abbey in in Old Warden, Bedfordshire.

Earlier assumptions that monastic houses had played a leading role in the development of fish culture in Britain can no longer be upheld, though they undoubtedly made extensive use of methods previously shown to be effective on lay estates. Despite the efforts which went into the construction of monastic ponds, reliance upon fish foraging for their own food limited productivity. There is no evidence for supplementary feeding becoming general practice.

It has often been stated that monastic communities led the way in commercial fish farming but fish were not generally consumed by monks before the late thirteenth century. The view that monastic fishponds could have a commercial aspect is not entirely without foundation, since surviving gardener's accounts from Abingdon Abbey record receipts from sales of surplus fish on two occasions, but this seems to have been a localized and relatively late development, and there is no evidence that such practices were widespread.

H. FISHPONDS IN COLONIAL AMERICA

As mentioned in the previous section, during the seventeenth century, it was common for the estates of the great lords and of the middling gentry to include fishponds. These ponds were stocked with young fish or fry seasonally, and the fish were kept fed until they were needed for the dinner table. When English colonists came to the New World, they abandoned this practice. The development of such ponds in the American colonies during the second half of the eighteenth century marked the culmination of a long process by which British-American colonists adapted to the declining abundance of natural wildlife in long-settled regions. The development of fishponds as an increasingly important and integral component of American mixed husbandry practices in long-settled areas by the era of the Early Republic illustrates colonial American farmers' need and ability to adapt the English system of mixed husbandry to the changing environment of the New World.

In colonial America, as in early modern England, mixed husbandry as a mode of production embraced a wide array of distinct economic activities. "The chiefe and principall point of a good Countrey farme," according to the author of a seventeenth-century farmers' manual entitled the *Countrie Farme*, "is to want nothing, either needful…or available for the profit that may come thereof." Even farmers with small holdings, who could command only the labor of themselves and their families, sought to secure a competency out of their lands through a strategy of diversified production. The farmer/husbandman divided his lands between timbered areas for collecting firewood and building materials, cleared lands for raising grains and garden vegetables, orchards for growing fruit for cider, pastures for grazing livestock and meadows for growing hay. Besides properly cultivating and managing his lands, the ideal farmer also turned his improving energies to the waters within and abutting on his properties.

The *Countrie Farme* continued, "the good householder then shall not esteeme a little of Fish, seeing that of them he may make both a provision of his table, and great gaine unto his purse." Fish-

FIGURE 42: A typical Colonial farm fishpond.

ponds offered one way for the farmer, whether his lands were in England or the colonies, to help assure himself and his household of an economic competency and financial independence.

But for the greater part of the colonial period, until the latter half of the eighteenth century English settlers in North America chose to forgo the construction of fishponds, instead relying upon the bounty of nature to supply them with fish. What coolonial husbandmen of the seventeenth century actually husbanded - rather than their cows, pigs, sheep, or horses - was their labor, and with the superabundance of the natural waterways around them, colonial farmers saw little reason to waste their labor in digging a fishpond.

Early European visitors to the east coast of North America often commented on the superabundance of fish in the continent's rivers, lakes and streams. One visiting Englishmen wrote of streams choked with alewives "in such multitudes as is almost incredible, pressing up such shallow waters as will scarce permit them to swim." Thomas Morton, an English lawyer touring New England in the 1630s, claimed that in Massachusetts the river adjoining the house he was staying in stopped up with so many fish that they could have filled a ship of one-hundred tons and that "wagers have been layed that one should not throw a stone in the water but that he should hit a fish." As late as 1663, English physician John Josselyn declared the rivers and streams of New England to possess "an infinite of fish," and recorded the remarkable bounty of the many lakes and ponds that supplied the proliferating towns of English settlers.

As these examples make clear, the ponds and waterways filled with fish abounded in the areas of North America first settled by the English. But as a matter of custom, the waters of ponds and the fish they contained belonged to the commons, open to all within the community. And since these naturally occurring ponds most often served as boundaries between properties bordering on several parcels of land owned by various individuals, settlers had little incentive to conserve the fish in these communal waters.

H1. EARLY LAWS

It was only as the seventeenth century gave way to the eighteenth that the customary rights of early American settlers to fish resources yielded to the traditional practices of English mixed husbandry. By then the growing population of colonists in the areas settled earliest were beginning to place pressure on the resources of the land and water. In England, laws requiring dams and weirs to be opened to allow the passage of migratory fish dated back to the thirteenth century. Similar American laws passed during the eighteenth century may be interpreted as simply a direct expansion of English law to the new English colonies. But such laws also represent a common response to the shared dilemma of declining populations of migrating fish due to the obstruction of migration paths and to the overutilization of fish in general as a food resource.

By the early eighteenth century, colonial legislatures had begun to pass laws to protect dwindling fish populations. Among them was a 1715 act passed by the Connecticut General Assembly to prevent "stopping or obstructing the natural course of passage of fish in their season." The law prohibited the construction of all "wears [i.e., weirs], hedges, fish gears, disturbances or encumbrances" that might result in three of the colony's

FIGURE 43: A Colonial trout fishery.

largest rivers without first receiving government approval, and in later amendments fish-gates were required to be installed in all dams to allow the seasonal passage of migrating fish. This Connecticut act underwent a long series of revisions over the course of the 60 years from its passage in 1715 through the end of the colonial period. It was renewed regularly, its prohibitions expanded upon and new means of enforcement devised. Like similar legislation passed in other colonies at the same time, this act failed to have its desired effect.

Such acts represent an awareness on the part of the colonial assemblies that the migrating fish populations within its jurisdictions were under pressure and a desire to rectify the situation in order to ensure the continued availability of this resource for the inhabitants under their authority. The first response of colonial legislatures was to regulate the technologies (primarily seines and weirs) employed in harvesting river fish in order to ensure against depletion population and provide as many colonists as possible the "common privilege and benefit" of fishing.

From the 1720s onward, however, the assemblies also began to lessen the pressure on fish populations by granting exclusive rights to fishing along certain stretches of rivers and streams to private individuals. These rights were granted to individuals or partners for the construction of fish-stages [*i.e.*, wooden buildings], presumably with the intention of harvesting river fish not for personal consumption, but for sale at market. The trend towards privatization and commercialization of fishing rights, which had begun in Britain itself in the thirteenth century and which was largely complete by the end of the sixteenth, had now begun in Britain's American colonies.

H2. PONDS ON FARMS

American farmers did not rely exclusively on their representative bodies to secure their access to fish resources. Had they done so, they would have been sorely disappointed as colonial legislation failed to revitalize fish populations. As the eighteenth century progressed, more and more farmers began to construct private fishponds on their property. As wildlife resources declined, colonialists began a long but steady transition from the customary right for all colonists to exploit nature in common to private rights to own and exploit one's own land and the waterways that ran through it. Just as colonists began to feel the need to fence in and provide fodder for their terrestrial livestock as the eighteenth century progressed, they also began to dig ditches and build dams and to exert their energies in rearing fish for the table and for market.

A large farm listed for sale in Ulster County, New York by Mr. John Haskoll in 1739 included a large pasture of improved swampland that had been ditched and drained. A pond had been left in the pasture to provide Haskoll's cattle with a watering hole. Haskoll also kept the pond "well stored with a variety of fine Fish." Digging ditches and draining water represented a considerable investment of time and labor. It was this investment of labor in the improvement process, along with ownership of the property on which the efforts to improve had been expended, that granted Haskoll sole rights to the use of his pond and the harvesting of its fish.

In the seventeenth and eighteenth centuries, a working farmer had to be a jack-of-all-trades.

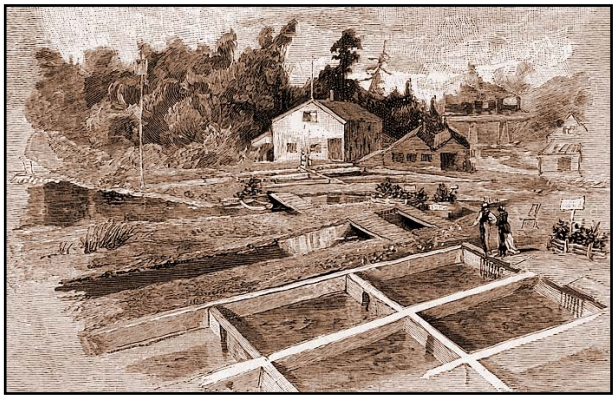

FIGURE 44: Sometimes fishponds were a significant part of farm operations in Colonial times.

Likewise, his ponds were expected to meet diverse needs. Landowners putting ponds to dual use as both fishing and watering holes followed the English example and came to be common practice among colonial husbandmen. A tract of land for sale near Peekskill, New York was advertised as possessing a pond "convenient for Cattle and for Fish." A twenty-five acre lot up for sale in Essex County, Massachusetts contained as "Part of the Premises" a "very commodious Fish Pond, and convenient for watering Cattle."

Where a naturally occurring watering hole was too shallow or otherwise unsuited for the stocking of fish, landowners raised water levels through damming. A farm for sale on Long Island in the 1760s contained a "large watering pond, which with the labor of eight or ten good hands for the space of one day, would raise the water 12 or 14 feet for a fish-pond." Taking advantage of naturally advantageous pools of standing water in the construction of his fishpond allowed the husbandmen to conserve his labor while still asserting his right to the property by improving the waterways on his land.

The ideal fishpond served as an integral part of mixed husbandry's system of diversified production. "Well Timber'd," with "large orchards of fine Fruits," and grain fields besides possessing a pond for keeping fish and watering livestock, John Haskoll's farm represented the ideal of mixed husbandry. Diversified production of fruit, grain, meat and fish provided the farmer with the economic competence that ensured independence, while also providing him with a surplus for sale at market. John Haskoll had not merely accepted the countryside as he found it, his swampland was drained and improved to provide pasture and pond. At their watering hole, cattle mingled with fish, both providing fresh protein for the farmer's table and fresh or salted fish and flesh for sale or trade to either rural neighbors or urban dwellers in nearby villages and towns.

THE DEVELOPMENT OF PRIVATE RIGHTS

By the mid-eighteenth century, the inadequacy of the natural supply of freshwater fish eventually led beyond the mere appropriation of rights to fish natural waterways by private individuals to the construction of artificial pools for first the holding and later the rearing of stocks of food-fish. Fishponds offered the advantages of smoothing out the irregular seasonal supplies presented by runs of migrating fish as well as perhaps offering the farmer the opportunity to farm more appealing species than those that inhabited his waterways naturally.

In the 1740s, a plantation was advertised near Philadelphia that included a "fine Spring where a Fish Pond might be made for little Charge." This Pennsylvania farmer obviously believed that a fishpond would represent a desirable improvement to his lands, one with the potential to help it sell. But the 152 acre lot also offered the benefit of two naturally occurring water ways, "two fine Streams running thro' said Place" with "plenty of Fish in said Runs such as Trout, Mullett, and Pike." Even without the investment of extra time and labor, this parcel offered the potential buyer ready access to food-fish. But here, as at the spring, opportunity existed for human design to improve upon the bounty of nature. "The Fish

FIGURE 45: A 1880s Carriage house barn fishpond.

might be kept in with little cost by putting a Grate" at the point where the two streams joined, creating another pond that would "afford room for the Fish to Play and Feed." As advertised, this plantation had much to recommend it to the industrious farmer.

A notice run in one of the local newspapers in 1784 by a landowner named John Harris living near Providence took a novel approach to appropriating the fishing rights to the brook that ran through his farm. For a number of years would-be fishermen had been crossing Harris' property to fish either in the brook running through his land or in the large pond on which it adjoined. Harris complained that these trespassers had been in the practice of throwing down his fences, using the fence rails and other of Harris's timber for fire, taking and destroying his hay and trampling his grain. While Harris recognized his neighbors' right to fish in the "main" brook where the road crossed over it, he denied their right to fish these public waters from his lands.

In his advertisement, Harris claimed for himself the exclusive right to fish the small brook that ran through his land, intending to offer his catch for sale at the "moderate" price of about $8 per every hundred pounds," though he also promised that "the Poor (that are really so) shall not be sent empty away." Harris justified this appropriation for himself exclusively of fishing rights that had customarily belonged to everyone within the community by pointing out the brook he meant to fish "crosses no Person's Land but my own."

As for the "main Brook" which ran clear through his property and then onto that of his neighbors, Harris promised neither to take fish from it nor to in any way obstruct their passing. Finally, Harris admonished his neighbors that if they did not find these terms satisfactory, he would dig a canal from the small brook to a natural depression on his land where the brook's waters would pool into a fishpond. If his neighbors failed to recognize his own self-declared exclusive rights to the fish swimming in the brook crossing his farm, then Harris was resolved to assert his rights through a more traditional avenue. He would build a canal to water a new fishpond, securing rights to any fish therein as the product of his labors in improving his land.

Essentially, Harris held the fish of the main brook hostage to gain the consent of his neighbors to his claims to the sole right to fish the smaller brook wholly contained within his farmlands. The reason Harris proposed terms for his neighbors' consideration is his apparent reluctance to expend the money and labor that would be necessary to dig the ditch that would water his new pond. Caught between ambiguous claims of private property and customary rights, Harris found it most expedient to compromise.

In the 1790s, an English gentleman touring America commented on a fishpond of between two and three acres in size on the land of an innkeeper named McAllister living in the countryside outside of Harrisburg, Pennsylvania. McAllister's pond sat on a farm of nearly three hundred acres, half of which was covered by woodlands, the rest encompassed by fields of rye, corn, and oats, pastures of clover and meadows of English hay for the maintenance of cattle, an orchard of peach and of apple trees, and a garden vineyard

FIGURE 46: A Colonial fishpond on an estate.

of grapes and strawberries. The farm also maintained its own cider press, a distillery for the production of rye whiskey and peach and apple brandy, a grist mill, a sawmill and an ice-house. In short, Mr. McAllister was the epitome of the gentleman farmer - an owner and improver of property engaged in a great diversity of rural production activities - and adjudged by his English guest to be the "most spirited and intelligent farmer" whom he had met during his travels. McAllister's fishpond yielded "all the kinds of fish which the river produces" presumably satisfying the hunger of the guests who frequented his public house and also possibly providing a surplus of fish for export to the nearby town, packed and preserved in ice from the store in his ice-house.

H4. POND ADVANTAGES

Whether or not McAllister used his pond to produce for the market, either for sale in Harrisburg or for sale in his own inn, he certainly made use of its waters to improve his yield of English hay. Besides yielding fish and providing watering holes for cattle, ponds also had the advantage of providing the farmer with a valuable manure for his grain fields. "The cleaning of ponds frequently is of great use," advised the *Complete Grazier*, "and it is done at no expense, because the mud, serving as manure to the lands more than pays the expense of taking it out." As the seventeenth century wore on and gave way to the eighteenth, successive generations of farming on the same plots of land made manuring as a means of restoring the nutrients to the soil became ever more important. By allowing the waste waters from his pond, rich in the detritus of decaying plant life and fish manure, to flow over his meadowlands, McAllister returned some of the nutrients to the soil that had been lost to haying.

Farmers regularly mowed their meadows annually or bi-annually, storing hay as fodder for their cattle during the winter months. Haying thus removed nutrients from the meadowlands where the grasses were grown, to the barnyard where cattle were fed when unable to be kept in the pasture. The dung collected out of the barnyard was then spread over the grain-fields in the spring, providing fertilizer for that year's crop. Chaff and loose grain, along with offal and blood from the slaughtering of livestock, made up the most common food items given to pond fish, bringing the process full circle and supplementing the nutrient load accumulated in the pond from run-off.

McAllister's pond represented the completion of America's transition from a settler colony of superabundance and common rights to fish resources to a settled nation of recognizably limited resources and private fishponds. This two-century -long process in America represented the continuation of a process towards an extinction of customary rights in favor of private property that had begun in England during the middle ages. The adoption of the rearing of fish in fishponds in concert with livestock rearing and grain cultivation by men such as McAllister by the end of the eighteenth century represented a culmination of American farmers' adaptation to self-wrought changes in the environment of North America's Atlantic seaboard.

FIGURE 47: Another typical Colonial farm fishpond.

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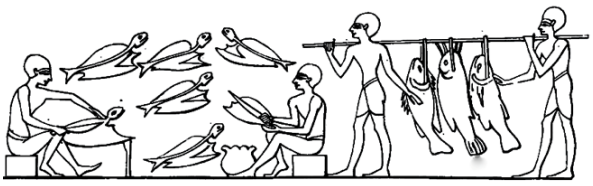
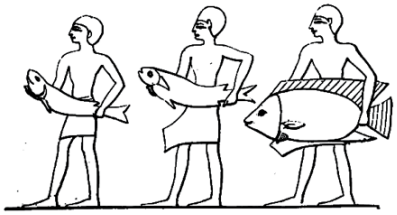


Bringing in fish and opening them, preparatory to their being salted.



Another mode of carrying large fish.

FIGURE 48: From a tomb near the pyramids.

Robert Warington (1807-1867): Professional Chemist

AJK Productions, Albert J. Klee, Editor, October 16, 2010

Editor's Note: Although I have written much about Robert Warington (Klee, 2012, 2015, 2016, 2019), it has dealt mostly with aquarium matters, although my short biography of Warington (Klee, 2015) did expand somewhat into his professional life, especially that of his association with the Society of Apothecaries. Recently, however, I have come across a detailed case study by Anna Simmons that provides an example of how chemistry in Great Britain could be commercialized outside the academic environment and how consulting merged into a broader scientific career. To do this, she based her paper on the professional career of Robert Warington (Simmons, 2020). Dr. Anna Simmons is an Honorary Research Associate in the Department of Science and Technology Studies at University College London. Her research and numerous publications explore various aspects of the history of British chemistry and pharmacy from about 1650 onwards, with a particular focus on the laboratories and pharmaceutical trade at the Society of Apothecaries (she has been associated with the Society of Apothecaries for more than twenty years) and the development of chemical careers and professional organizations.

Dr. Anna Simmons

Much of this paper is Simmons' although I have added to it and also edited it to make it more readable by American aquarists. Among other things, I have changed British spellings to U.S. and have replaced certain British terms (e.g., while for whilst). Simmons' paper is an academic one and she uses footnotes for both sources and for comments. Unfortunately, she uses a 7-point font for the footnotes and so they are not only difficult to read but they are voluminous (if they were converted to the 10-point font size of her text they would generally exceed the space taken by the text. Thus I have taken all source references from the footnotes and placed them into a Bibliography section at the end of the paper. Comments in the footnotes have been entered into the text in parentheses except for those that are of little interest to the hobbyist.

The whole point of Simmons' article involves money, money represented by the British pound symbol, £. American aquarists, however, are unlikely to know what these values mean (which change as the year changes) since she does not provide their present-day dollar equivalents. This I have remedied, thus the values given in square-brackets after their £-values are their present-day dollar-equivalents taken from Eric W. Nye's "Pounds Sterling to Dollars: Historical Conversion of Currency," accessed on October 4, 2020. All other square-bracketed text is mine.

INTRODUCTION

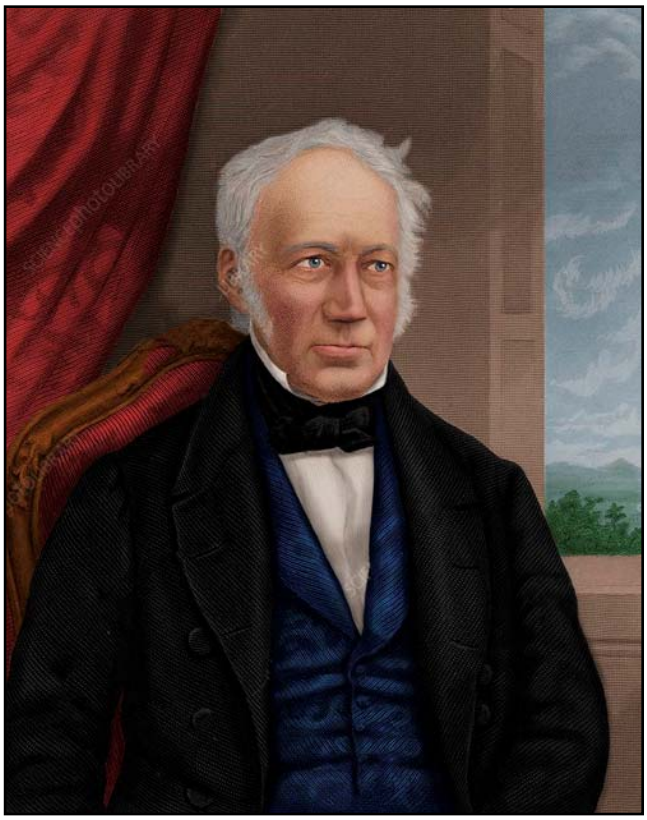
Chemistry was a saleable skill in mid-nineteenth century London and Warington was one of a number of chemists to take advantage of the opportunities available and for which data on his earnings are available. However, there are a number of other prominent chemists at the time for which earnings data is also available and I will start with short biographies of the most important of them.

The Glasgow-born chemist Dr. Andrew Ure (1778-1857) is considered to be the first chemist to earn a living primarily from consulting when, following his

controversial end to his teaching career in Glasgow, he set up in private practice as a consultant in London in 1830. He served briefly as an army surgeon before settling in Glasgow, where he became a member of the Faculty of Physicians and Surgeons in 1803.

On December 10, 1818, he read a paper to the Glasgow Literary Society on some pioneer experiments he had performed with the galvanic current on the body of Clydesdale, a murderer, and suggested that by early stimulation of the phrenic or vagus nerves or the great sympathetic in the neck, life might be restored after suffocation or drowning. These experiments caused a considerable sensation according to the Dictionary of National Biography, and found an echo in Byron's poem Don Juan. The following are some extracts from the published account of these experiments:

The murderer was a middle-sized muscular man of 30. He was suspended on the gallows for nearly an hour, and the experiments were made in the anatomy theatre within ten minutes of him being cut down. There was no dislocation of the neck. Dr. lire connected his galvanic rods firstly with the spinal marrow and the sciatic nerve through deep incisions, whereupon every muscle of the body was immediately agitated with convulsive movements resembling a violent shuddering from cold. On moving the second rod from hip to heel the knee being previously bent, the leg was thrown out with such violence as nearly to overturn one of the assistants, who in vain tried to prevent its extension. The body was also made to perform the movements of breathing, by stimulating the phrenic nerve and the diaphragm. In the judgement of many scientific gentlemen who witnessed this scene, this respiratory experiment was perhaps the most striking ever made with a philosophical apparatus.... Later every muscle of his countenance was simultaneously thrown into fearful action, rage, anguish, horror, despair, and ghastly smiles united their hideous expression in the murderer's face, surpassing far the wildest representation of a Fuseli or a Kean. At this period several of the spectators were forced to leave the apartment from terror or sickness, and one gentleman fainted.



Dr. Andrew Ure (1778-1857) is considered to be the first chemist to earn a living primarily from consulting.

1821 he published his first major book, "Dictionary of Chemistry," a replacement for William Nicholson's outdated Dictionary. It came out two years after William Brande's "Manual of Chemistry," and Ure was accused of plagiarism. Subsequently, Ure accused Dr. William Henry (an eminent vhemisdt) and Dr. Thomas Thomson of plagiarism of his own works. (Dr. Wollaston, a friend of both Ure and Henry, was asked to arbitrate, but compromised by appointing a friend unknown to either of them to do so. His report, a model of tact, proved agreeable to them both and their friendship was later renewed.)

He seems also to have obtained the unofficial offer of the Chair of Chemistry at University College, London, which was in the process of being founded by Lord Brougham, who as Lord Rector of Glasgow University and a great supporter of public education, knew and admired . Ure's pioneer work in this field.

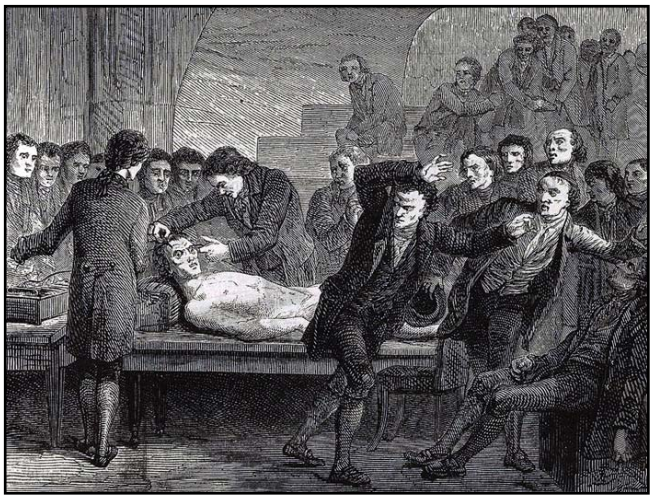
It was probably this possibility which finally decided him to move his family to London, which he did in 1830. The professorship, however, went elsewhere, as the result, it seems, of unexpected opposition fermented by Thomson, the Regius Professor of Chemistry at Glasgow, whose "First principles of Chemistry" Dr. Ure had reviewed somewhat harshly in the *Quarterly Journal of Science and Art* –"…a more arrogant and truly mischievous publication… The Regius Professor is taking Royal liberties with the labours and property of others!" In a private letter to Ure the Editor (William Thomas Brande, 1788-1866) wrote regarding another similar review "I have as usual blunted some of the shafts of your criticism ... just though they are!"

Ure set up in 1830 in private practice as a consultant in science in all its branches, and more particularly as an analytical chemist for commercial purposes. It was said of him by Sir Michael Faraday, after his death, that "his skill and accuracy were well known as well as the ingenuity of the methods employed in his researches'. . . and it has been stated that no one of his results has ever been impugned. His extensive knowledge enabled him to arrive at conclusions, and to demonstrate facts considered impossible by his compeers in science".

Some idea of the variety of his practice and "the amazing and varied fund of knowledge of applied science on which he was consulted from all over the world" (British Medical Journal) can be gained from the following brief list which has been culled from his letters or publications: The disinfecting of ships and their cargoes, bread-baking processes, distilling, a new process of amalgamating zinc and copper, analysis of a metal tool and an ointment found by Sir Gardiner Wilkinson in an Egyptian tomb, infringement of a patent concerned in piano construction, several photographic patents of his own, and the analysis of various types of coal for the Admiralty.

He also visited professionally most of the new Midland industrial areas, and some in France and Belgium, to advise upon technical improvements, chiefly in cotton manufacture, bleaching and dying processes, glass manufacture, and mining; many of the leading industrialists being old pupils of his. In 1833 he was requested by the Lords of the Committee of the Privy Council to undertake experimental researches into sugar refining, and his report was printed by order of the House of Commons, and led to the fixation of the sugar duties. He also undertook for them the investigation of methods of estimating the amount of sugar in sugar-cane juice,, for which he was paid £800 [$101,300]. In the following year he was appointed first consulting analytical chemist to the Board of Customs, a post which he held until his death. His friend Brande, who as Editor of the *Quarterly Journal of Science and Art* was relying increasingly upon his collaboration, secured him the post of Lecturer in Chemistry to the Surrey Institution, and later to the Royal Institution, where he had succeeded Sir Humphry Davy as Professor of Chemistry, and the Apothecaries' Hall.

William Thomas Brande (1788-1866) was born in Arlington Street, London, England, the youngest son of six children to Augustus Everard Brande an apothecary, originally from Hanover in Germany. He was educated first in Kensington and then in Westminster. After leaving Westminster School, he was apprenticed, in 1802, to his brother, an apothecary, with the view of adopting the profession of medicine. He studied medicine at Great Windmill Street Medical School and at St George's Hospital, before being drawn to chemistry following a meeting with Humphry Davy. He then began to lecture in chemistry, based on a sound knowledge of which he acquired in his spare time.



Le docteur Ure galvanisant le corps de l'assassin Clydesdale (Dr. Ure galvanizes the body of the murderer Clydesale).

In 1812 he was appointed professor of chemistry to the Apothecaries' Society, and delivered a course of lectures before the Board of Agriculture in place of Sir Humphry Davy, whom in the following year he succeeded in the chair of chemistry at the Royal Institution, London. In 1821 he was the first to isolate the element lithium, which he did by electrolysis of lithium oxide. From about 1823 onwards, Brande worked increasingly with the Royal Mint, eventually becoming Superintendent of the Coining and Die Department. Brande's *Manual of Chemistry*, first published in 1819, enjoyed wide popularity, and among other works he brought out a *Dictionary of Science, Literature and Art* in 1842. He was working on a new edition when he died at Tunbridge Wells.

It should be mentioned that Robert Warington became interested in what came to be known as the "balanced aquarium principle," reading the following from Brande's "A Manual of Chemistry":

In the year 1778, Dr. Priestley resumed this investigation, and verified his main conclusions by new and satisfactory experiments; he found, however, that it was necessary for their success, that the plants should be in a state of healthy and natural vegetation, and that all plants were not equally efficacious, some indeed appearing rather to deteriorate than improve the contaminated atmosphere. About this time too, Dr. Priestley made the capital discovery of the evolution of oxygen by aquatic plants, growing in water containing carbonic acid; that the presence of light was necessary to this change; that in sun-shine it was most rapid; that it was in great measure independent of warmth; and, lastly, that the bladders of some kinds of sea-weed, (*fucus vesiculosus*), often contained air purer than the atmosphere. The renovation of the air contained in water, requisite for the respiration of fishes, was thus accounted for; and the circumstance of fishes and most other aquatic animals being unable to live for any time in pure water, though exposed to air, satisfactorily explained.

John Thomas Cooper (1790–1854) was an English chemist, notable as a lecturer, chemical supplier and chemical analyst, at a time when interest was burgeoning in chemistry as a discipline of study and application. Cooper was born in Greenwich and studied and, for a short while, practiced medicine. Finding the life of general practitioner stressful and tiring, he turned instead to chemistry to which he applied himself with zeal. Until 1842 he lectured in chemistry at a number of establishments, including the Russell Institution, the Aldersgate School of Medicine, and the Webb Street School of Anatomy and Medicine in Southwark. Cooper acted as a manufacturer and supplier of chemicals, at one time the sole supplier of iodine in Britain. He devised or collaborated to produce a number of tools and techniques for which he won repute, including a hydrometer, an oxy-hydrogen microscope (the gasses providing a bright light-source), a baroscope, a refractometer; he also made improvements in electroplating, electric cell design and microscope mountings.

Cooper was employed as a chemical analyst and appeared at court as an expert witness on a number of occasions. He provided expert services to a Royal Society and Board of Longitude initiative to improve the optical qualities of glass and testimonials of the purity of a new line of brandy to its manufacturers for

Dr. William Thomas Brande (1788-1866).

use in its advertising. He discovered iodoform but did not publish, that honor falling to Georges-Simon Serullas. Cooper was vice-president of the London Chemical Society during its short incarnation. One of Cooper's students, Robert Warington founded the Chemical Society of London, and Cooper was an "energetic early Fellow." Cooper's name and excellent reputation is not entirely free from controversy, however. He is implicated in the support of a patent for the use of hyposulphite of soda to fix daguerreotype images, despite clear indications that he was aware of prior art demonstrated and published by Sir John Herschel.

Michael Faraday (1791-1867) was born in a working class south London neighborhood on September 22, 1791. Faraday was the first to produce an electric current from a magnetic field, and he discovered and named "diamagnetism", a concept that describes why some substances like copper react opposite to the magnetic force when they encounter a magnetic field. He discovered the effect of magnetism on light, and was the inventor of the electric generator and the electric motor. He is also credited with providing the scientific foundation for much of James Maxwell's groundbreaking work with electromagnetism.

Faraday's father was a blacksmith who suffered from chronic health problems that often impeded his labor. As a result, Faraday's family had little money and Faraday got only minimal formal schooling. In fact, he and his siblings sometimes had barely enough to eat. But Faraday had an active curiosity and determination to learn. While working in a London bookbindery as a teenager he was exposed to a wide range of books including textbooks and encyclopedias, and he read everything he could get his hands on. By doing extensive reading Faraday soon educated himself on a variety of scientific subjects, and his life as a scientist began.

In 1812, Faraday attended four lectures at the Royal Institution that were given by a renowned chemist named Humphrey Davy. Afterwards Faraday sent a letter to Davy, expressing a keen interest in the subjects covered in the lecture series and offering his services as an apprentice. A year later Davy accepted Faraday as his laboratory assistant. Davy also took Faraday with him on an extended tour of Europe, where Faraday met some of the most influential scientists of the day. Faraday returned to the Royal Institution in 1815 after 18 months of travel, and there he helped perform experiments with Davy and his colleagues.

Thanks to his association with Davy, the young Faraday gained a thorough scientific education. He soon began to do research and experiments with electricity, and he constructed two mechanisms to generate electromagnetic rotation, which is the force used to power electric motors. In 1821 he published an academic paper on electromagnetic rotation.

Although his time was mostly spent helping Davy, Faraday began to emerge on his own as a chemist and scientist of great importance. He began to give frequent lectures at the Royal Institution, and soon his reputation as a gifted lecturer was firmly and widely established. He published more research papers, including essays about optical illusion, the nature of gas condensation, and methods for isolating the chemical benzene, a chemical that he himself discovered. He is also credited with the discovery of other organic compounds, and he was the first scientist to liquefy a gas previously considered to exist only in a permanent gaseous state.

When his mentor Davy retired in 1827, Faraday took his place as the head of the chemistry department of

Michael Faraday (1791-1867).

the Royal Institute. Upon accepting the position he was able to focus on his own research, and Faraday's most influential and celebrated work began in the 1830s, while he concentrated on experiments with electricity.

In 1831, he discovered electromagnetic induction, a breakthrough that ushered in an entirely new era of technology. With Faraday's discovery it became possible to create such things as electrical generators and motors, and because of the practical nature of his discoveries, he was quickly awarded government grants and positions that enabled him to continue his work with electricity.

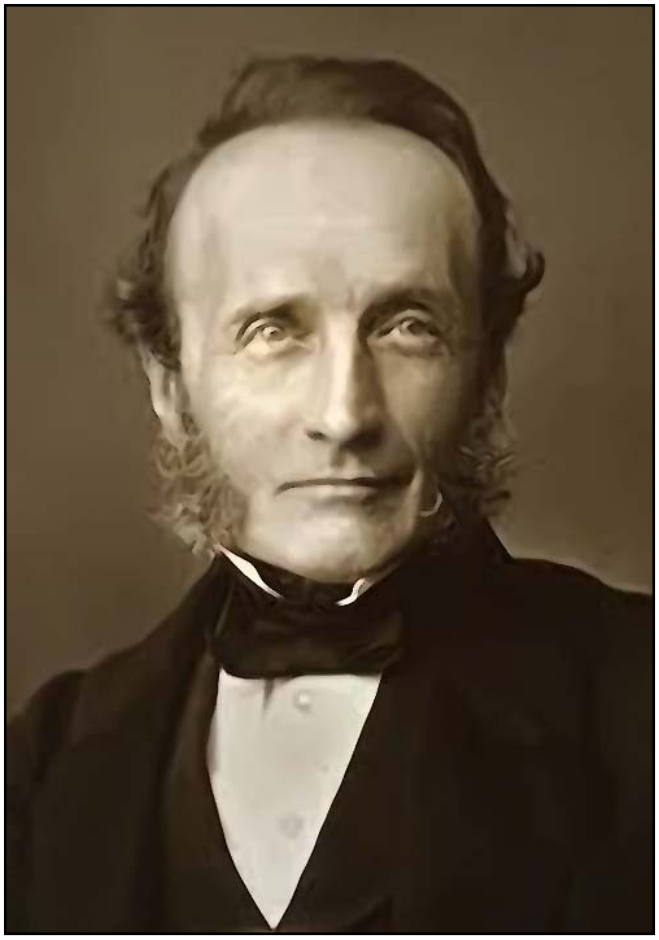
For the next eight years Faraday worked long hours in the laboratory, and the strain of his endeavor eventually took a serious toll on his health. By the end of the decade he was in such poor health that he had to take a break, and his research did not begin again in earnest until 1845. In 1846 he gave a lecture that presented important ideas about the nature of electricity, and these later inspired the historical work of James Maxwell related to electromagnetic field theory.

A number of chemists such Cooper and Brande, built careers as "professional chemists" finding multiple markets for their expertise. In the commercial section of the 1845 London Post Office Directory, Ure is the only individual to describe himself as an "analytical chemist," whilst Cooper styles himself "chemist." Five years later Cooper is one of only two chemists in the publication to use the term "consulting." The other is John Thomas Way (fl. 1820 -1883) who had been appointed Consulting Chemist to the Royal Agricultural Society of England in 1847. Use of "consulting chemist" and "analytical chemist" became more prevalent at this time, as both roles' marketability became established in the metropolis. The section category "analytical chemist" was introduced in the 1854 London Post Office Directory, with eleven listed.

ROBERT WARINGTON

Robert Warington (1807-1867) was a central figure in the mid-nineteenth century chemical community, notably through his role in the foundation of the *Chemical Society of London* in 1841. As demand for chemical services grew, Warington constructed an ultimately lucrative career in chemistry in which consulting played a major part. His formative years laid ideal foundations for establishing himself as a consultant, while his appointment as chemical operator to the Society of Apothecaries' pharmaceutical trade provided the status and infrastructure to sustain this activity.

Throughout the nineteenth century, chemists made up Britain's largest scientific community, practicing a versatile subject with wide-ranging applications. As chemists established themselves as one of the first new scientific professions, independent practice became a central element in their developing identity. When the Chemical Society of London was founded in 1841, chemical consultancy was already a significant component in the careers of many of its founder members. Later defined as "a person qualified to give professional advice or services," the consultants mentioned in this paper were practicing or analytical chemists who independently provided services for fees.



Robert Warington (1807-1867).

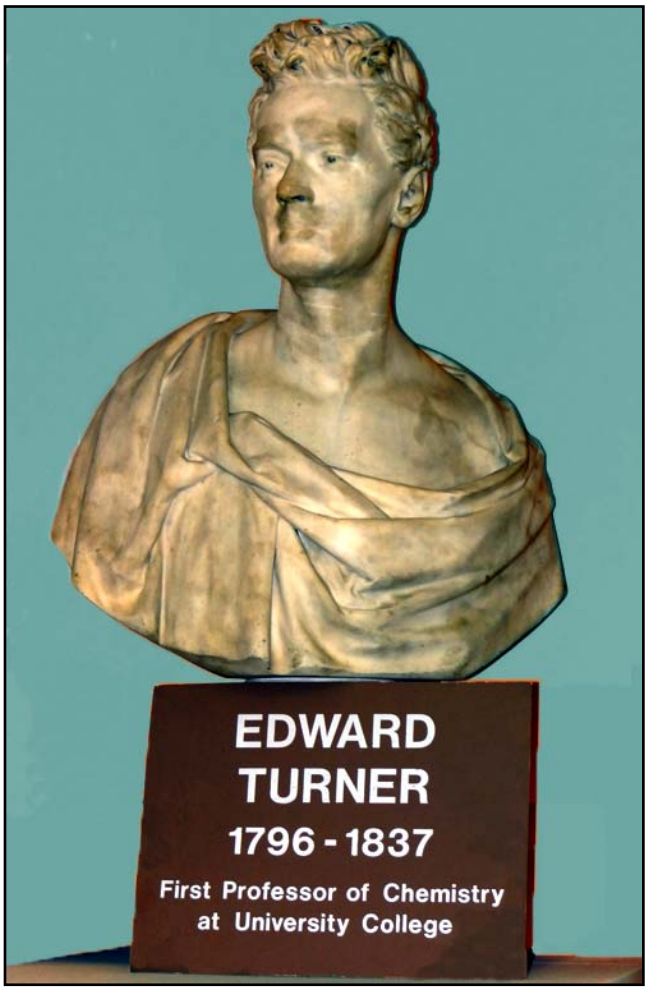
A variety of work was available to the chemist willing to advise on any scientific question. Performing process and product control, advising on chemical practice, and undertaking research were part of the services consultants performed for industrial and commercial clients, as a precursor to the employment of in-house expertise. The role of the expert witness in courts of law could also be a lucrative sideline. The versatility to perform a number of roles, whether for industry, government or private individuals was the key to sustaining work in this sector. Increasing recourse to the skills of the chemist, combined with a desire to supplement income, led to thirty percent of those who joined the three major British chemical institutions between 1881 and 1886 being employed partially in consultancy at some point in their career.

Building on the growing demand for chemical expertise from industrial and commercial clients and government bodies, Warington took on a variety of roles including analyst, chemical referee and expert witness in patent litigation cases. The notion of expertise and the appropriateness of its use has been the subject of scholarly interest in a number of disciplines, with chemical expertise in the metropolitan context in relation to environmental, public health and food quality concerns receiving particular attention. Chemistry was a saleable skill in mid-nineteenth century London and Warington was one of a number of chemists to take advantage of the opportunities available.

WARINGTON'S TRAINING AND EARLY CAREER

Born in Sheerness [a seaport in North Kent, in Southeast England on the Isle of Sheppey, at the mouth of the Thames] on September 7, 1807 to Thomas Warington (1773-1843), a victualler [a person providing or selling food or other provisions] of ships, and Esther Elizabeth Eaton (1779-1861), Robert Warington spent his early childhood moving between ports, and then studied at Merchant Taylors' School in the City of London. Intended to be a land-surveyor, he abandoned this in favor of chemistry, first as a house pupil, then from November 1822 as an articled apprentice for five years to John Thomas Cooper. Warington was to be "instructed in the said trade, science, art and occupation of an Apothecary and Chemist." Few were better placed than Cooper to prepare a student to earn a living in chemistry. Originally trained in medicine, Cooper lectured on chemistry, was a successful manufacturer of potassium, sodium and iodine, and became a widely-respected consulting chemist known for his technical expertise, particularly in the gas sector.

Having completed his apprenticeship, in 1828 Warington became an assistant to Edward Turner, Professor of Chemistry at the newly founded University College, London. Warington remained in this post for three years, took charge of the practical classes that Turner had initiated and published his first research in the *Philosophical Magazine*. Under Cooper and Turner's tuition and guidance, Warington gained experience and connections, with both men having a significant influence on the development of his career. His analytical skills were honed while tutoring students in the practical classes at University Col-



lege, while his early publications reflected Turner's interest in nomenclature. It was Turner who recommended Warington for his first industrial post, with the brewers Truman, Hanbury and Buxton. The firm desired the services of "an able young chemist" at its Black Eagle Brewery in Spitalfields [a district in the East End of London]. Warington started as an under brewer in November 1830 on a basic yearly salary of £156 [$18,900], comparable to clerks' salaries in minor posts in government, commerce and manufacturing. He acknowledged the ongoing debt to his two mentors in "A Series of Chemical Tables," published in 1833, with the following dedication:

To J. T. Cooper, Esq. and Dr. E. Turner, the following tables are respectfully inscribed as a small tribute of respect and grateful feeling for their continued kindness towards him, and the invaluable instruction which he received while under their tuition, by their late assistant and pupil. *R. Warington, 30 Church Street, Spitalfields, 1833*.

Warington's life centered on Spitalfields for most of the 1830s. Initially he resided in staff accommodation at Truman's, but soon he was living at 30 Church Street, the home of George Jackson, surgeon, instrument maker and founder member of the Microscopical Society. In 1835 Warington married Jackson's daughter, Elizabeth, at Christ Church, Spitalfields and the family set up home at 22 Princes Street. His employment in the brewing industry did not prevent his independent pursuit of chemistry and he published papers in the *Philosophical Magazine* on chemical symbols in 1832 and the action of chromic acid upon silver in 1837. Warington and a small number of others were all members of the Spitalfields Mathematical Society in the 1830s. Founded in 1717, the Society had sunk to a very low ebb but Jackson and other friends joined with the hope of raising it out of the mire. Lecture cards show that Warington spoke on lead and its combinations, while his father-in-law George Jackson discussed the construction of thermometers.

Warington's employers were initially unsatisfied with his contribution to the brewery. In 1832 the clerk's salary ledger notes that "if Mr. Warington does not very materially improve in three months we shall dismiss him." In 1836 there was "still room for further activity," with a pay rise to £300 [$35,000] offered "if he exerts himself" but set against a possible reduction to £240 [$29,200]. Although "rather improved" in 1837, Warington was not entitled to the salary increase and his employment record shows that he struggled with aspects of the role such as keeping correct accounts.

James Sumner has used Warington's career at Truman's as an example of how larger breweries were beginning to accept the value of employing "scientific gentlemen," but with mixed results. Nevertheless when Warington left Truman's in 1839 ("having an interest in a patent for making soap") his salary totaled £300 [$33,000] and the firm was "sorry to lose a person whose conduct has been so respectable." Although Warington's surviving papers include a laboratory sketch and projected profits for soap production, it is unclear what became of this proposition. In 1841 he registered a patent for "improvements in the operations of tanning," the first mention of the use of chromium chemicals in the leather trade. He had been working on chromium salts since the early 1830s and later would describe how he was "frequently called upon to examine the value of astringent substances imported into this country for the purposes of tanning."

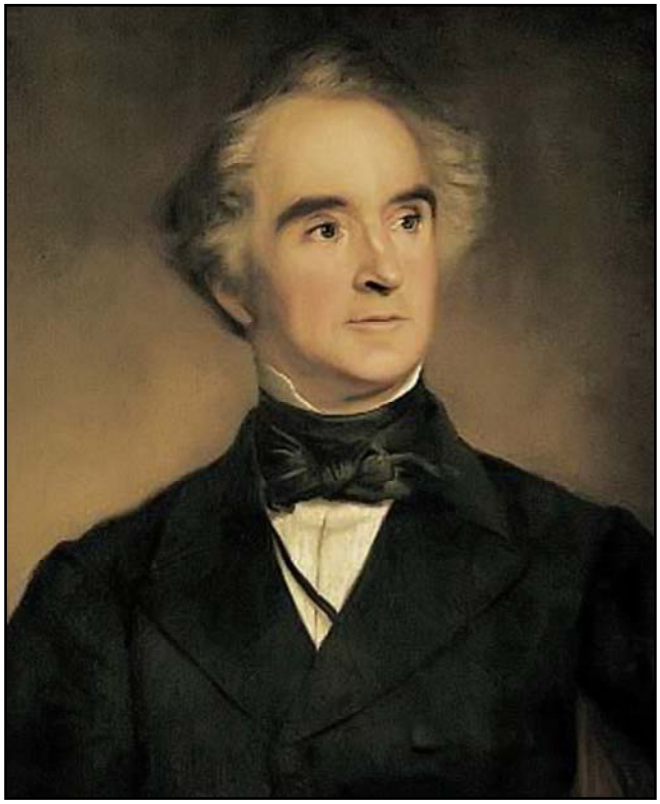
The year 1841 was part of what Robert Warington Junior (1838-1907) would later call "a short period of leisure in the life of my father." During this period Warington Senior began looking for support, ini-

"If you can't helium a sick chemist or you can't curium, you might as well barium."

tially informally then more widely, for the formation of a chemical society in London, an objective achieved in 1841. Proposed by John Thomas Cooper, Warington became Secretary, a post he held until 1851. He remained active in the Chemical Society thereafter, serving as a Council member from 1858-1861 and Vice-President twice from 1851-1854 and 1862-1865. The circumstances of the Chemical Society's foundation, the significant part played by professional chemists and Warington's aim to help unify the chemical community and integrate scientific theory and practice have been related elsewhere but key was Warington's organizational role, which indicated the central position he played in the chemical community, especially in London.

The influence of his personal connections can be seen in the twenty-five attending the Society's first meeting on February 23,1841. They included a nucleus of chemist members from the Spitalfields Mathematical Society and several linked to Warington through consulting activities. Warington's reputation for hard work and patience particularly suited him to such organizational roles. The Microscopical Society had been founded in 1839, with both Warington and his father-in-law George Jackson appointed to its first Council. Warington would later be involved in the foundation of the Royal College of Chemistry in 1845 (serving on its Provisional Committee) and the Cavendish Society, a chemical publishing subscription club, in 1846. He also had an extensive correspondence circle which included the German chemists Justus Von Liebig and Heinrich Will. Liebig and Warington had a close friendship, with Liebig sending Warington a dozen bottles of "genuine Rhein wine" and writing: "Regarding myself I like London perhaps more than any other place, I have in this town so many friends among whom, my dear Warington you are one of those I most esteem."

During this period without a formal post, it appears likely that Warington's primary income came from



Justus Freiherr von Liebig (1803-1873) was a German scientist who made major contributions to agricultural and biological chemistry, and is considered one of the principal founders of organic chemistry.

Heinrich Will (1812-1890) was a German chemist. He worked as the successor to Justus von Liebig from 1853 to 1882 as a professor at the University of Giessen. He is known for a method for the quantitative determination of nitrogen.

consultancy. In 1841 he lived with his wife, father, sister and three children at Percy Villa, South Lambeth, along with three female servants (an indicator of a certain level of prosperity). Warington's father, Thomas, had been engaged in the wine trade since the 1810s, but if his business had been successful at one point, its fortunes had severely declined. In 1841 Warington's parents were living separately and in June 1842 Thomas appeared before the Court for Relief of Insolvent Debtors and was sent to the gaol at Horsemonger's Lane in south London. These financial problems were not new; there had been judgements against Thomas in 1826 and 1832. In the same month as his father was committed to a debtor's prison, Warington returned to full-time employment, a timing which seems more than coincidental. He was appointed chemical operator to the pharmaceutical trade of the City of London livery company, the Society of Apothecaries, a post he held for the remainder of his working life.

THE SOCIETY OF APOTHECARIES AND CHEMICAL CONSULTING

The Society of Apothecaries' drug trade operated from premises surrounding its livery hall in Blackfriars, central London. Here drugs were manufactured in bulk quantities to supply customers both at home and abroad including the Navy, Army and East India Company, as well as hospitals, institutions and medical practitioners. In the year of Warington's appointment, the Society's trade employed fifty staff across manufacturing, wholesale, retail and accounts, with a turnover of £42,000 [$5,020,000]. During his tenure, driven by demand for drugs during the Crimean War, turnover would top £100,000 [$12,000,000]. As chemical operator, Warington had both practical and administrative responsibilities. He was in charge of manufacturing in the laboratories; he tested the quality of drugs produced and purchased; he liaised with the various committees of apothecaries administering the trade; and was the key source of chemical and pharmaceutical expertise

The Gallery of the Society of Apothecaries.

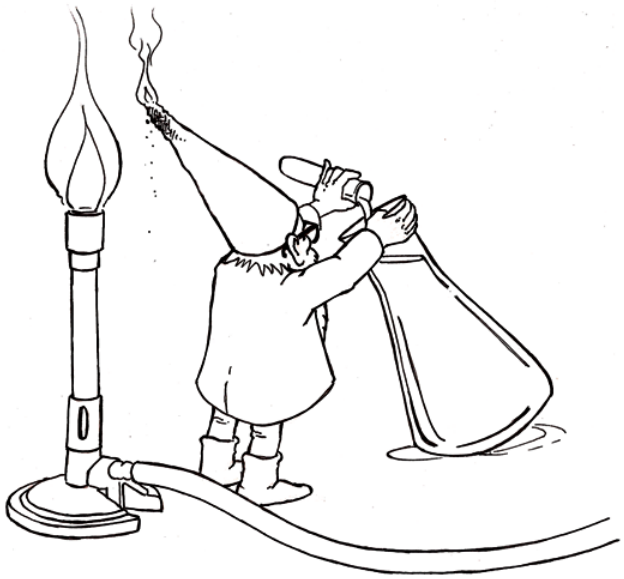
for both the Society and its customers. On September 29, 1842 Warington and his family moved into the chemical operator's house at Apothecaries' Hall. Here the Warington children, Amelia, Robert and George grew up: they were educated at home, forming societies (including a chemical society) that met in their father's laboratory early in the morning before the working day started.

Warington's appointment as chemical operator brought significant advantages, particularly in relation to developing his career as a consultant. With position came premises, while institutional employment brought affirmation and legitimation for his work, key factors in building a reputation for providing chemical services. Accounts of Warington's life emphasize this: "his professional engagements became very numerous during his connection with the Apothecaries' Society." These engagements included work as a scientific adviser in the law courts and from 1854-1861 he was especially connected with questions of water and gas supply. In 1854 four of the metropolitan gas companies, including the Surrey Consumers Gas Company, appointed him chemical referee, a post that he held for seven years. He also analyzed the water of the River Lee when its quality was under investigation in the 1850s.

Moreover, his position at the Society of Apothecaries led to work modernizing the Pharmacopoeia, particularly in regard to standardization and the introduction of chemical tests for purity. In 1851 he revised the translation of the Royal College of Physician's London Pharmacopoeia, which had been left unfinished by the chemist Richard Phillips. He was also consulting chemist to the London and Edinburgh Pharmacopoeia Committees engaged in preparing the first British Pharmacopoeia in 1864 and jointly edited the second edition of 1867, although involvement with the latter was curtailed by illness. By the autumn of 1865 Warington's lungs were seriously affected. Thereafter his presence at Apothecaries' Hall was reduced significantly. He spent the winter of 1865-1866 in Hastings [a seaside town and borough in East Sussex on the south coast of England, famous for the Battle of Hastings in 1066]. His son George (an assistant chemical operator from December 1861) took on many of his father's responsibilities regarding the pharmaceutical trade.

Warington was fortunate to benefit from the established laboratory infrastructure at the Society of Apothecaries, which provided him with well-equipped facilities for a range of chemical activities, including consulting and research. A test room – "a small laboratory fitted up with the requisite apparatus, for minute and delicate investigations and in which Chemical tests and other articles requiring peculiar attention and cleanliness are prepared" – was part of its trading premises. Apothecaries'Hall was also a location at which interested parties could call upon him with requests for advice without the need for public advertisement (Warington does not appear in the London Post Office Directory). He was ideally placed through the networks surrounding the Society's drug trade and his position in London's chemical community to link expertise across government, industry and commerce, as illustrated by the following example.

In 1844 an excise officer visited Warington at Apothecaries' Hall, bringing samples of black and green tea which had been seized in Kennington [a district in south London]. Warington examined these microscopically and "made a number of inquiries



For gnomes who love chemistry, avoiding the Bunsen burner remains a major challenge.

among the influential men in the trade and at the East India House" (one of the Society's major customers). Warington requested further information but never saw the officer again, yet his investigations continued, papers were published and evidence given to the Select Committee on the Adulteration of Food, Drink and Drugs on the subject in 1855. However, by his own admission this research came about "rather accidentally than otherwise." With versatility a key attribute for a consultant, Warington's reputation for pursuing a wide range of scientific interests was an asset. His research covered a myriad of topics, ranging from seaweed to microscopy, glass, mining and volcanoes. In 1846 he was granted a patent relating to improvements in food preservation and in 1850 he invented the balanced aquarium.

Warington could also build on a history of Apothecaries' Hall chemists providing services for clients within the institutional structure of its pharmaceutical trade. For example, through his appointment as Superintending Chemical Operator and Professor of Chemistry at the Society of Apothecaries, William Brande received significant payments for analyzing the impurities in saltpeter imported by the East India Company. Although Warington's consultancy work drew on connections generated by his employment, it extended far beyond the trade's customer base.

Given the extent of his external commitments, it is noteworthy that there is no evidence of any dissatisfaction with his services as chemical operator. When Warington resigned as chemical operator in June 1866, the Society displayed its appreciation, awarding him a pension of £150 [$16,000] per annum "in consequence of his long and able services." There is also no evidence of any financial arrangement between Warington and the Society regarding outside work. It appears that Warington was the sole recipient of any fees charged without incurring any overhead. Such advantages also benefitted many academics engaged in consulting and contributed to tensions between academic and practicing chemists that shaped professional organization in chemistry in the 1870s.

WARINGTON AS A CONSULTANT

Providing chemical services for industrial and commercial clients constituted the largest part of Warington's work as a consulting chemist. At this date few firms employed full-time chemists, so expertise was brought in as chemical answers began to be sought to commercial questions about manufacturing, waste, standards, competitors' activities and intellectual property. Warington's notes provide an insight into how firms used consultants' skills. There is evidence that Warington was approached to help undertake process and product control, analyzing both new and waste products. Such work was not regular, with samples submitted as and when required.

The explosives manufacturers, John Hall and Son of Faversham, requested analysis of a new sort of gunpowder blast, while the printers Routledge sent in alkali in waste dye, water samples and refuse soda ley. Warington's background in brewing led to clients including Beamish and Crawford of Cork, Mackeson's of Hythe, and Bridges and Cuthbert of the Falcon Brewery, Ipswich. Assessing composi-

This is the old Beamish & Crawford brewery in Cork, one of Warington's clients. Established in 1792 this was at one point the largest brewery in the country. Breweries were common clients for the professional chemists of the time.

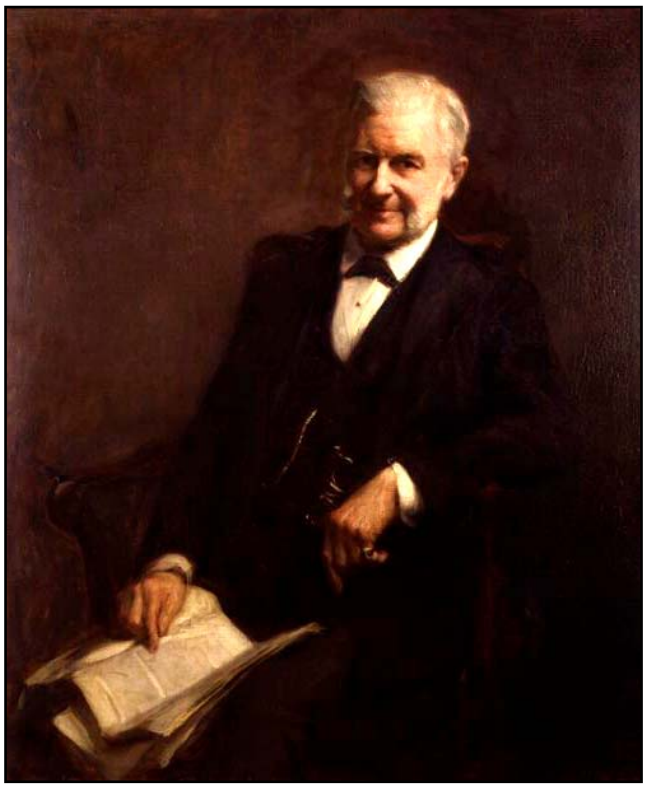
tion, quality, and purity were key concerns, with Warington's skills required to analyze raw materials, assist purchasing decisions and demonstrate the quality of products sold. The merchants Scott, Simpson and Wallis submitted sugar samples from Mauritius, St Kitts, Trinidad and Demerara [now part of Guyana] so that composition could be evaluated against the duty charged. The analysis of Ind Coope beer exported to India and returned was tested for possible contamination from proximity to turmeric.

A more detailed assessment is possible of the consulting services that Warington performed for the south London dyestuffs manufacturers, Simpson, Maule and Nicholson. The law emerged as a major patron of nineteenth-century science providing not only an additional income for many but also generating discussions about accuracy, standards and veracity, and providing a mechanism of judgment in an evolving professional and industrial arena. Simpson, Maule and Nicholson had purchased rights to Medlock's arsenic acid patent for magenta (aniline red) production in 1860. This was the most efficient process (through employing arsenic acid as an oxidant) and gave control of the route to aniline blue and violet. Such was its importance that by the beginning of 1865 the firm had spent around £30,000 [$3,360,000] fighting possible infringers of the Medlock patent. Although the firm employed several chemists in the 1860s, it relied on the consulting services of August Wilhelm Hofmann, supported by a number of members of the inner circle of the Chemical Society, including Warington.

Warington's services were initially engaged in June 1861, when he examined samples of liquid and dry magenta and prepared a report of his findings for the firm. This was shortly after Simpson, Maule and Nicholson had discovered that Wilson and Fletcher of Mile End had been manufacturing magenta using the arsenic acid process and on July 2, a Bill of Complaint was filed in the High Court of Chancery. Warington performed further experiments on samples provided by the firm as the legal process continued, with the case finally beginning in December 1862 in the Court of the Queen's Bench. Warington was amongst the eminent chemists and elite of the Chemical Society who denied that "dry" meant "anhydrous" leading to what has been called one of several "inane and newsworthy confrontations between counsel and witness." However, the chemists, including Warington, were right. When used as adjectives**,** anhydrous in chemistry means having little or no water of crystallization, i.e., water than comes from a crystal substance after heat is applied whereas dried means without water or moisture, said of something that has previously been wet or moist.

It should be noted that such statements underlined the witnesses' motives to support the legal argument rather than scientific fact. Nevertheless, the judgment in June 1863 was in favor of Simpson, Maule and Nicholson and no other firm could manufacture magenta using the arsenic acid process until the monopoly was broken in January 1865.

Warington's experimental notes from 1863 were dominated by work on magenta, blue and violet dyes



Sir Frederick Augustus Abel (1827-1902). Abel was an English chemist and explosives specialist who, with the chemist Sir James Dewar, invented cordite (1889), later adopted as the standard explosive of the British army.

and show how consultants were used by Simpson, Maule and Nicholson to monitor their competitors' activities and protect intellectual property. The firm provided samples of rivals' dyes to Warington from manufacturers including Thomas Holliday and Dan Dawson, both of Huddersfield and Levinsteins of Manchester. Warington also investigated recently patented processes. He performed, for example, a series of experiments relating to Dan Dawson's 1863 magenta patent. Late in 1863 a case began in London regarding infringement by Levinsteins of the aniline blue process of Girard and de Laire (which Simpson, Maule and Nicholson possessed an exclusive license to work in Britain). A sample of Levinstein's Bleu a la Lumiere/Night Blue and other competitors' blue and violet dyes were amongst those examined by Warington in the preceding months.

When the case was heard before the Court of the Queen's Bench in December 1864, Hofmann reported on experiments he had made with Warington, Edward Frankland, Henry Noad and Theophilus Redwood to produce aniline blue, while Warington recounted his analysis of samples of blue dyes received from the plaintiffs. Warington also carried out a series of investigations on arsenic acid in 1864. He was one of many chemists drawn into studying processes and products from a new industrial sector closely tied to metropolitan chemistry and pharmacy, with his activity in this field predating his consultancy role. Warington's work for Simpson, Maule, and Nicholson finished with the Levinstein case.

The end of the relationship was probably due to Warington's declining health (the proportion of consultancy work he undertook for industrial and commercial clients declined significantly after 1864) but also linked to broader factors affecting Simpson, Maule and Nicholson. Medlock's magenta patent was declared void in January 1865 and although Nicholson and Maule (Simpson left the partnership in 1866) tried to have the patent restored, they were unsuccessful and retired from the industry in 1868, while leadership in the British dye industry shifted to northern manufacturers.

THE CHEMICAL CONSULTANT: REMUNERATION AND ROLES IN MID-NINETEENTH-CENTURY LONDON

When Frederick A. Abel's father asked for advice regarding his son's ambition to study chemistry in the 1840s, Warington advised against "on account of the very limited prospects of advancement in the profession." When considering remuneration from institutional employment in isolation, the advice appears accurate. Warington's initial salary as chemical operator at the Society of Apothecaries was £200 [$23,900] and it was not until 1860 that his earnings from the post matched what he received in his final year at Truman, Anbury and Buxton. Warington also never achieved the status which came with an academic appointment: he unsuccessfully applied for the chemistry professorship at St. Bartholomew's Hospital in 1857.

However employment at Apothecaries' Hall was not Warington's only income. By considering how Warington self-defined his occupational status, it is clear that by the 1860s institutional employment was one aspect of his working life. Using "brewer" in the

1830s, a brief period as "gentleman" in 1839 and 1840, and then "chemist" from 1841, by the 1851 Census Warington styled himself as "Chemical Operator to the *Society of Apothecaries* and Professional Chemist." "Professional Chemist" alone is used in the 1861 census and in his will. The use of this term reflected the growing professional identity in the field; it was consulting and analytical chemists who were instrumental in the foundation of the Institute of Chemistry in 1877. The changing terminology also suggests the existence of a generational shift in consultants' roles between the 1830s and 1860s, whereby consultancy evolved from being a supplemental activity to a primary focus.

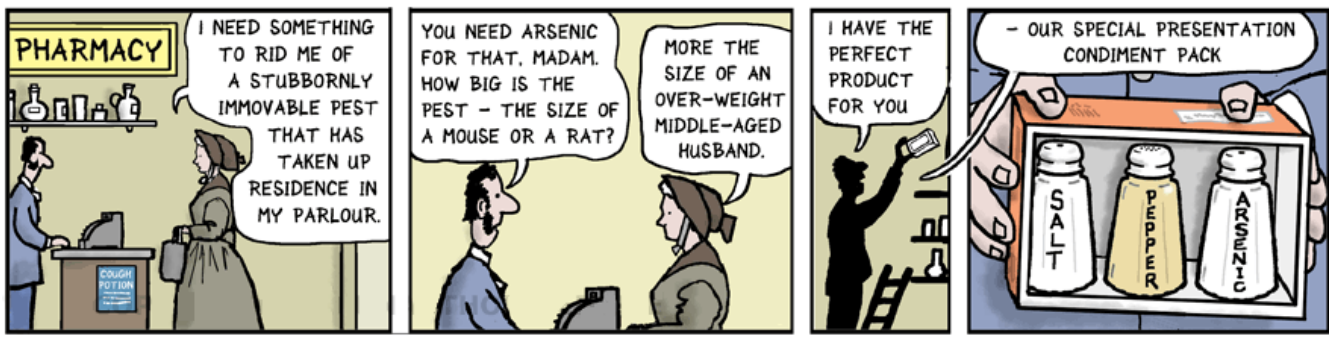
The role of "professional chemist" appears ultimately to have been very lucrative to Warington. Over the course of thirty-plus years of employment at Truman, Anbury and Buxton, and the Society of Apothecaries, Warington's remuneration totaled just over £8,500 [$906,000]. Yet his will was proved at under £16,000 [$1,650,000] on his death, a sum not only substantially more than his lifetime institutional earnings but also significantly greater than that of his contemporaries. William Brande had left £3,000 [$321,000] a year earlier, while Michael Faraday's will was proved at just under £6,000 [$643,000] in 1867, when his yearly salary never fell below £800 [$98,000] after 1836. As Warington's salary from the Society of Apothecaries reached a maximum of £305 [$32,500] in 1861, this shows the extent to which his earnings must have been augmented by other sources, even after accounting for significant variations in outgoings. The size of Warington's estate has led to it being suggested that his emolument at Apothecaries' Hall was supplemented by a private income.

However, given Warington's father's financial problems, family money seems unlikely, especially considering that his brother Thomas, a corn merchant, also faced bankruptcy proceedings in the late 1850s and early 1860s. The significant sum that Warington built up during his lifetime must have come from external engagements, of which the provision of chemical services was a major part. No details of fees charged by Warington survive, but consider those of the Glasgow-born chemist Andrew Ure. His schedule of fees ranged from £1 1s [$112] "for consultation respecting any single point or question of inquiry" to £10 10s [$1,120] for the complete analysis of any mineral water, soil, earth, metallic or other mineral indicated the sums that could be made. Engagement as an expert witness could also be extremely lucrative, as shown by "The Feast of the Blues," an extravagant dinner that Warington and other expert witnesses attended during the Levinstein case.

SUMMARY

The concluding paragraph of Warington's obituary in the Proceedings of the Royal Society begins by encapsulating the strengths he brought to consultancy work: "Mr. Warington was remarkable for his varied taste and constant activity as an observer." However, it went on:

He may be said indeed to have passed from one subject to another with too great a facility and consequently his completed investigations bear but a very small proportion to the number of subjects that he had continually under examination.



Combined with his relatively late election to the Royal Society in 1864, such comments suggest that some of Warington's contemporaries considered that his achievements were not as great as one would have expected from a man of his abilities. Yet such sentiments risk drawing attention away from the esteem in which Warington was held for his practical and organizational contributions to chemistry. His obituary in the *British Medical Journal* ends: "Few men have passed a life of more continuous and honorable usefulness. He died at Budleigh Salterton, Devon [a county in southwest England] on Nov. 12, 1867 universally respected and widely lamented."

As science-based enterprises grew in scale and scope, Warington's breadth of experience, combined with his position at the heart of London's chemical community, meant he was ideally placed to provide chemical services to a range of firms, government bodies and private individuals. Drawing on the networks generated from his training under John Thomas Cooper and Edward Turner, the period living in Spitalfields, and his key role founding the Chemical Society, and supported by the institutional status and infrastructure of his employment at Apothecaries' Hall, Warington constructed a lucrative career in chemistry in which chemical consulting played a major part. In this work, elements of his background in brewing and his experience in pharmaceutical production can be located, while for a number of years work in both water and gas analysis was key. Although many of the services Warington provided for industrial and commercial clients were on an *ad hoc* basis, such activity was a precursor to how specialist advice would be used across different sectors as consultants became a key resource in knowledge management.

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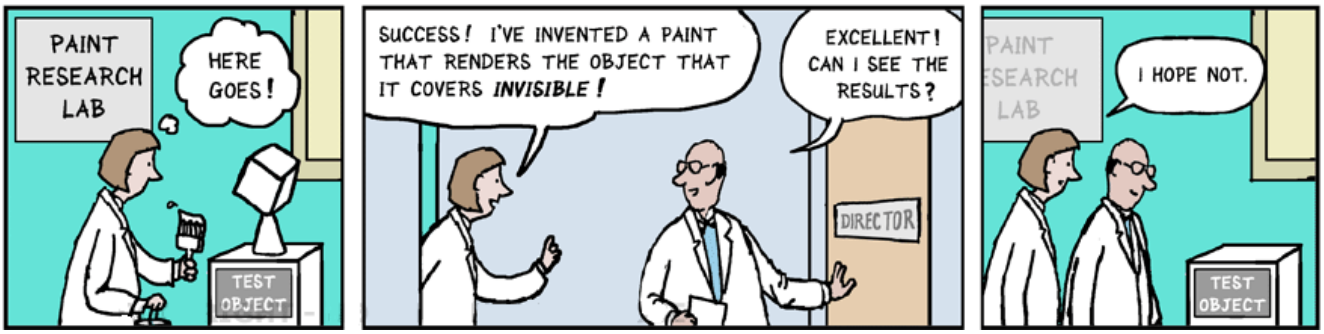

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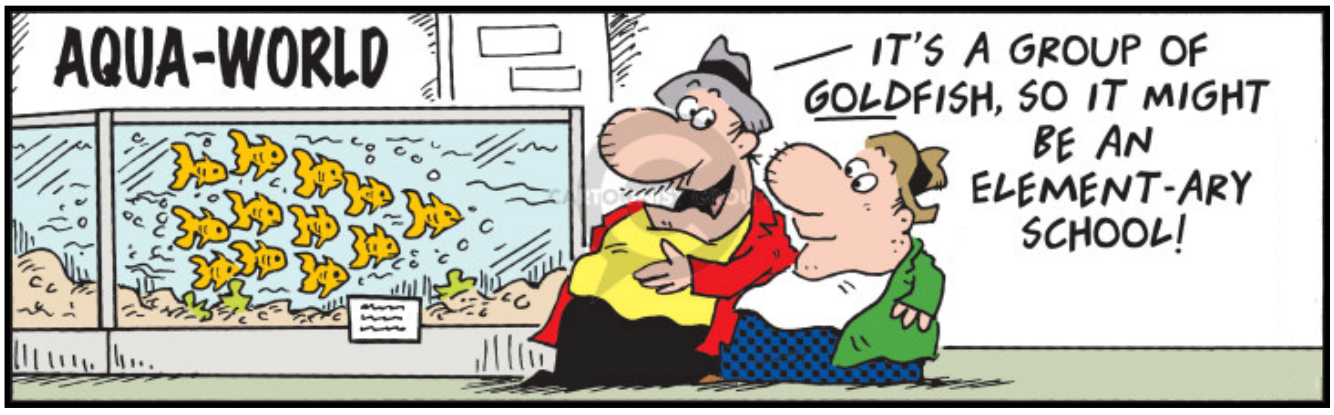

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Michael Faraday's chemical chest. The chest has two keys and contains Faraday's letters and chemical specimen bottles.

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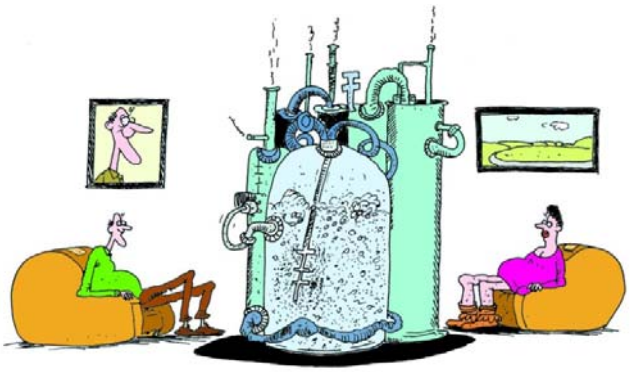


Forty years man and wife, and the chemistry was still there.

MISINFORMATION AND AQUARIUM HOBBY HISTORY

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Facebook Files, November 13, 2020)

Misinformation in aquarium hobby history is not uncommon and some of it has generated a great deal of controversy over the years. The majority of defects are often due to sheer carelessness when slipshod authors erroneously or incompletely record information and do not take the precaution, prior to publication, to proofread their work. More serious errors occur, however, when authors fail to define important terms, fail to check their sources or else rely on secondary sources that contain fallacies.

Failure to consult an original source leaves an author at the mercy of an intermediary's imperfect or biased reading. To avoid being unconsciously influenced by the second-hand user's slant, it is essential to see the full original. Moreover, original sources often reveal pertinent data unseen by and unknown to the lazy secondary borrower. Such misinformation is abundant on the Internet and include Wikipedia, You Tube, social media and other internet sites connected to the aquarium hobby. Such errors are also found in books and magazine articles not on the Web. The purpose of this essay, then, is to examine some of this misinformation and to show how I handled these problems.

THE HISTORY OF THE WORD "AQUARIUM"

The most important word in the history of the aquarium hobby is, of course, "aquarium." The word is Latin, so I'll start with the Romans (see Klee, 2015). Note that the root of aquarium is aqua, which means "water" in Latin and takes on different endings depending upon the gender, declension and whether it is singular or plural. For the neuter gender, for example, in addition to adding the ending -rium to aqua, we find the added endings -ria, riorum, riis, -rio and -rii.

Cato the Elder (234 BC-149 BC was the first author of record to use the word aquarium. Examples from his book, De agricultura ("On Farming" sometimes referred to as De re rustica), written about 160 BC include the following: **situlum aquarium** ("water bucket"), **urceum aquarium** ("water vessel") and **bonumque aquarium** ("well-watered"). Note, however, that aquarium here simply meant "water," not a container of water.

Pliny the Elder also mentioned aquarium in his Naturalis Historia, published circa AD 77–79. In Book 59, Volume 19, he talks about directions for watering certain plants:

Peculiaris medicina raphano, betae, rutae, cunilae in salsis aquis, quae et alioqui plurimum suavitati et fertilitati conferunt. Ceteris dulcium aquarum rigua prosunt. Utilissimae ex his quae frigidissimae et quae potu suavissimae. Translated, this reads,

There is a curative property especially effective for radish, beet, rue and savory in salt waters, which moreover also contributes a great deal to their sweetness and to their fertility. All other plants are benefited by being watered with fresh water, the most useful for the purpose being water from streams, which is extremely cool and very sweet to drink."

With regard to the term, "watering place," in Cicero's Three Books of Offices and Other moral Works, written in 44 BC, we find the following:

Tum Canius inquit, quæ, Pythi, quid est hoc? Hic, ne, tantum piscium, ne tantum cymbarum? Et ille inquit, quid mirum? Quidquid piscium est Syacusis est hoc poco, hic aquatio… Translated, this reads,

Then Canius says, 'What is this, pray, Pythias – so many fish – so many boats?' And he answers, 'What's the wonder? Whatever fish there are at Syracuse are taken at this place; here is their water- place…'

Cicero uses the nominative form "aquatio" here to mean "watering-place; it was not used in the sense of a container to hold fish, or anything else for that matter, although some have mistakenly translated it as being a water trough for cattle. Thus at no time did the Romans use aquarium or its cousins in the sense of a container; rather, it was either meant as water or a place (but not a vessel) that held water.

New Latin (also called Neo-Latin or Modern Latin), was a revival in the use of Latin in original, scholarly and scientific works starting circa 1375/1500 AD. For example, Mercator drew a marine chart in 1569 that portrayed the Great Lakes as accurately as could be drawn at the time. It was noted that river running into the St. Lawrence Gulf had two large branches and at the head of the northern branch was grouped three small lakes just west of which is a very large lake. Beside this lake is written, **"hic mare est dulcium aquarium, cujus terminum ignorari Canadenses ex relatu Saguenaiensium aiunt"** ("this sea is of fresh water; the Canadians do not know its bounds, according to the report of the people of Saguenay"). The "sea" that Mercator was talking about, by the way, is what is now known as Lake Huron.

János Reisinger (1784-1852) received a medical degree in 1806 and from 1810 until his retirement in 1848 he was a professor of zoology and mineralogy at the Faculty of Medicine in Pest, Hungary. In 1830 he wrote a book in New Latin titled Specimen ichthyologiæ- sistens pisces aquarium dulcium Hungariæ **(Ichthyological observations on Hungarian freshwater fish)**. Thus even in New Latin the word "aquarium" was never used in the sense of a container; rather, it simply meant water.

However, none of the foregoing gets us any closer to an explanation of how the word aquarium got into the aquarium hobby, although it had been in use among the botanists for a long time to designate the containers in which aquatic plants were reared. In my essay "The Gardener's Aquarium" (Klee, 2014a), I discussed John Loudon's "An Encyclopædia of Gardening" (Loudon,

"It's OK, everyone makes mistakes. Look at me. I hired you."

1824) in which he showed several examples of containers and artificial ponds he identified as aquaria and suggested that fish might be added to them. Since a gardener's aquarium is nothing more than a receptacle that contains water and aquatic plants, I went on a search to determine who came up with the name and who devised such a receptacle. Working backwards from 1824 down into the 1700s, I found that it was Carl Linnaeus (also known after his ennoblement as Carl von Linné). In his 1742 prologue to his Hortus Upsaliensis, he defined the following terms under the heading of "Aquaria:" **Aquarium fluviatile, Aquarium lacustre** and **Aquarium palustre**, denoting respectively a river pond aquarium, a lake pond aquarium and a marsh pond aquarium. Here is how Linnaeus described the last-named:

Aquarium palustre ad latera truncos horizontales seu parietes habet, aquam a solo separantes, inter illos vero & ipsam humum repletum est spatium humo limosa e paludibus desumta, cui insertae plantae palustres. Translated, this reads,

The marsh aquarium has horizontal sides of tree trunks or walls that separate the water from the surrounding soil; the ground between them is filled with soil from muddy swamps, into which is inserted marsh plants.

Clearly Linnaeus was describing the construction of a vessel containing water and not as a synonym for it. He was not, of course, concerned with fish but with aquatic plants but adding fish is not an alteration, only an extension of the meaning. Thus I considered Linnaeus to be the inventor of the aquarium without any further criteria and dubbed him, **PATER AUTEM AQUARIUM** or **FATHER OF THE AQUARIUM** (Klee, 2019).

At this point we can define an aquarium as a constructed vessel containing aquatic plants and/or fish. The history of the aquarium therefore takes us into pre-historic times when writing had not yet been invented. A new study led by Tsuneo Nakajima of the Lake Biwa Museum in Japan and published in Nature Ecology & Evolution (Hudson, et al., 2019), for example, suggests that the practice of rice fish aquaculture actually began thousands of years earlier than previously believed - around 6200 BC.

COMMENTS ON THE WORD "HOBBY"

Before one starts to discourse about important concepts or ideas, barring that others have already defined them to everyone's satisfaction elsewhere, one must define them. The following appears in the Revised & Expanded edition (really the Second edition) of my book, The Toy Fish (Klee, 2003):

There is also, alas, a problem with precisely what is meant by the word, "hobby." …We may ask ourselves whether Anna Thynne was

THE FOUR STAGES OF THE AQUARIUM HOBBY

STAGE I:
THE TOP-DOWN AQUARIUM
(circa 4000 BC)
Opaque-sided containers.
STAGE II:
THROUGH A GLASS CLEARLY
(late 1530's)
Glass jars: fish kept for ornamental or scientific study purposes.
STAGE III:
OCEAN AND LAKE IN GLASS
(mid 1800's)
Tanks frequently with flat glass sides; aquarium books; commercial aquarium fish and equipment suppliers; object to emulate a small portion of a natural habitat.
STAGE IV:
ASSOCIATION (circa 1900)
Aquarium societies; exhibitions; competitions; aquarium magazines.

a hobbyist, or A.A. Maconochie, or some unknown American who maintained several jars of native fishes during the Presidency of Andrew Jackson, but the answers are in no way clear.

Thus I abandoned the idea of defining "hobby" directly in favor of the concept that I developed in 2004 of the "Four Stages of the Aquarium Hobby" (see accompanying figure) that indirectly defined the hobby by describing it chronologically, a lot easier task (see accompanying image). In the fourth edition of my Toy Fish book (Klee, 2005), however, I bit the bullet and defined the aquarium hobby as: **A subject or pursuit involving fishes, undertaken primarily for pleasure during one's leisure time and to which a person is notably devoted**. This enabled me to assert that the first aquarium hobbyists were the Romans. At the very least, it enabled readers to clearly understand my assertion after reading the remainder of this section of the book. For more details on my quest for definitions, see Klee, 2014b. It is time now to discuss some significant errors in the writing of aquarium history.

JEANNE VILLEPREUX-POWER AND THE MYTH OF THE INVENTION OF THE AQUARIUM

Jeanne Villepreux-Power was a remarkable woman. With little or no formal education, she bested Giuseppe Saverio Poli, considered the "Father of Malacology"; she bested Henri de Blainville, an authoritative, well-known figure in the field; and she bested Baron Cuvier, the famous French ichthyologist. As a result of this, she revolutionized the study of marine biology, a fantastic accomplishment for any one with so little formal education and by a woman in an age where men did not take women seriously. However, over the years we have read countless times on the internet that Jeanne Villepreux- Power was the inventor of the aquarium. Ironically, she is known more for this myth than for her real and more important accomplishments. That she was the inventor of the aquarium simply is not true.

In 1832, Villepreux-Power used had four types of what she called "cages" in her research: Two were made of glass (the first of which was used at home; the second was used for smaller mollusks and was in a frame so that it could be immersed in water) and the third was a cage made out of wood designed to be immersed in water. The fourth, invented to replace the second which proved unsuccessful, was a cage made of clay for smaller mollusks and also designed to be immersed in water.

Although the two glass containers certainly were aquaria, she did not invent them. Because of the use of lead-acid batteries in use at the time, her tanks were readily available locally. She neither built them or designed them; she simply bought them and thus did not invent them (see Klee, 2019).

WHO INVENTED THE AQUARIUM?

To answer this question I needed a new definition, i.e., one for "aquarium." As Newman put it (Newman, 1873),

The birth of the aquarium is of such remote antiquity that we fail to ascertain the date with any certainty. The point at which, any

"No Martin… I make errors of judgment… you just make mistakes!"

vessel containing water and fishes becomes an aquarium is equally open to discussion.

Before one attempts to pin down a "first," one must devise a set of criteria that, like in a patent, defines the concept or idea. The following are the ones I chose (Klee, 2012):

(1) In Great Britain in the early 1850s the de facto definition of an aquarium in the sense of the whole concept, not just the container, was a vessel containing water and plants, plus aquatic animals (excluding, of course, mammals and water fowl) in which the water was not aerated nor changed. Note that fish were not necessarily included. Implicit in this definition was that basis for the aquarium was the relationship between plants and the animals, i.e., that plants absorbed the carbon dioxide that the aquatic animals generated while the animals absorbed the oxygen that the plants generated.
(2) Another part of my requirement for "first" was priority of publication, a criterion required in the 1800's and, for most things, also in the present-day.
(3) To simplify the analysis, I considered four categories for "firsts" in this monograph: freshwater aquarium sans fishes, freshwater aquarium with fishes, marine aquarium sans fishes and marine aquarium with fishes.

Using these criteria, Charles des Moulins - a man mostly overlooked in aquarium hobby history - came in first (1830) for the freshwater aquarium sans fishes, Robert Warington (1850) for the freshwater aquarium with fishes, George Johnston (1842) for the marine aquarium sans fishes and Robert Warington for the marine aquarium with fishes. If, however, we add another criterion, (4) that of the impact on the aquarium hobby in the Nineteenth Century, then Warington remains in the first place for the freshwater aquarium, with Gosse and Warington in a close tie for the marine aquarium title. It is difficult to break this tie, since Warington published first whereas Gosse had the greater impact.

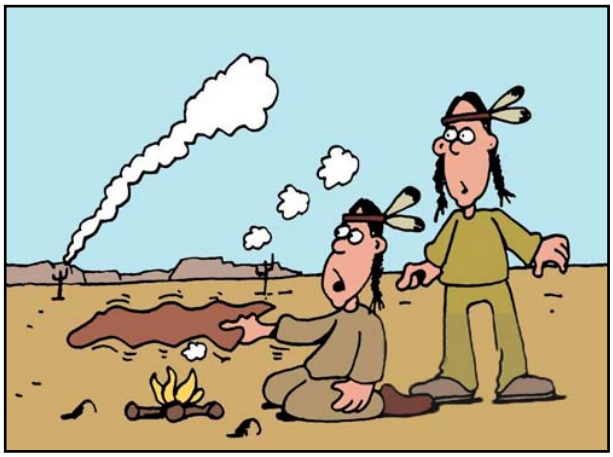
This answered, to my satisfaction at least, the question of who invented the aquarium. If others disagree then they are certainly free to construct other criteria and answer the question differently, but they are obliged to construct them, otherwise their conclusions would be meaningless.

MYTHS ABOUT ROMAN AQUARIA

There are many myths about Roman aquaria and most are due to the absence or inadequate checking of resources. Except where cited, the following is from Bernd Brunner's "The Ocean at Home" (translated from the German version, Wie das Meer nach Hause kam; Brunner, 2003):

These fish were kept in opaque tanks, often made of marble, in front of the house. The first fish to enter the interior of a house in imperial Rome was the sea barbel, a much cherished and expensive breed. Allegedly, they were kept in small tanks underneath the cushions of the guest beds. Around 50 AD, panes of glass were brought to Rome, Herculanaeum, and Pompeii, to replace one wall of the marble tanks; now it was possible to actually see the hustle and bustle of the fish without having to guess their schematic movements from above.

Brunner obtained this information from the book, "Die Arche Mostar" ("Mostar's Ark"), written by Herrmann Mostar (Mostar, 1959). Mostar (1901-



"He never has got the hang of using punctuation!"

1973) was a German writer, poet, columnist and, at times, a narrator, playwright and comedian. He also became Germany's most famous critical court reporter. This particular book deals with animals that have lived together with man, including dogs, cats, cocks, hens, doves, songbirds, fish, but also with the quite undesirable such as flies, spiders, bugs, lice, fleas, rats. Mostar provides a wealth of tales and anecdotes from politics and history, in which animals have played sensational and sometimes even decisive role. Unfortunately, Mostar provided no bibliography and several of his historical statements with regard to fish and the aquarium are questionable, to say the least. Mostar writes:

Well, all these fish [Mostar is referring here to eels, carp and bream] live in Roman water basins that were made from the most precious marble. However, they were still housed outside of the home; the eel had already made it to the fountain. Most likely the first to come into the interior of the house was - to their sorrow - the world-famous mullet. It was considered the tastiest of all fish; that's why you weighed their weight in silver at first and later in gold, but it was also the most beautiful of all fish, resplendent in glorious red, and it was a curse.

Talking now about mullets, Mostar continues:

They put a small tank for them under the cushions of the guest bed, and when it came to the fish course, the head of the house took the fish out of the tank and handed it not to the cook, but to the beautiful Lady of the house or the even more beautiful mistress, and in her slender hands the fish slowly suffocated. Because, alas, it died even more beautiful than when it was alive!

Then, about 55 AD, the first coarse glass panes came to Rome, Herculaneum and Pompeii. Now one could make one wall of the marble basin transparent so that one could see the hustle and bustle of the fish, not just shadowy sliding from above as before, but at the same height with them. And now the ladies and their lords saw the mullet during lovemaking and discovered that love bestowed the same flaming colors of beauty as did death. Where before the fish had so miserably suffocated in their delicate hands they now were in the hands of friends. It was erotic enough for spoiled Rome, eroticism and arousal without cruelty.

However, nothing claimed by Mostar is true (see Klee, 2014c):

(1) Mostar stated that Roman water basins outside the home were made from marble. Higginbotham (Higginbotham, 1997), however, states that seaside fishponds were either excavated in rock or constructed of concrete. Inland ponds were usually built of concrete walls with masonry facings.
(2) No such mention of marble tanks with glass sides were ever mentioned by Cicero, Columella, Horace, Juvenal, Martial, Pliny the Elder, Pliny the Younger, Seneca, Tiberius or Petronius, nor were the remains of such tanks ever found in the

"I realize you like to take time to polish your essay before submitting it to the AHHS, but don't you think four years is a little excessive?"

excavations of Rome, Herculaneum or Pompeii. Neither were they mentioned by Friedländer in his "Roman Life and Manners under the Early Empire" (Friedländer, 1979).

(3) The flat glass produced by the Romans could hardly have served to view fish in any detail as it was very thick, more translucent than transparent and had a distinct greenish color cast to it.

(4) Re the barbed mullets (*Mullus barbatus*) that Mostar maintained the Romans saw spawning, Columella reported that it was difficult to maintain this fish in ponds and even more difficult in an aquarium "since it is a very delicate kind of fish and most intolerant of captivity, and so only one or two out of many thousands can on rare occasions endure confinement" (Columella, De Re Rustica, VIII.17.7). They were kept successfully in salt-water lagoons constructed on the Mediterranean coast, but that is not what Mostar is talking about.

If Brunner had really checked his Mostar source, the combination of a lack of bibliography to support Mostar's claims and his assertion that the change of color in the mullet as it died in a glass was due to courtship or spawning colors would have resulted in Brunner ignoring all of Mostar's claims. One of the most perplexing things about Brunner's book is that the Mostar reference is not in his bibliography, at least not in his English version. I had to learn about Mostar from a query I made to Brunner; otherwise I would have picked up on his oversight a lot sooner.

MYTHS ABOUT ROMAN AQUATIC ENGINEERING

David W. Cheever (1831-1915) was a famous Boston surgeon who contributed essays on medical and natural history topics in the popular vein in the Atlantic Monthly and the North American Review. In an article about the aquarium that appeared in the Atlantic Monthly (Cheever, 1861), he attributed to Martial (he specifically cites Book X, Epigram XXX) the following (Klee, 2014d):

…[Roman] pisciculture was carried so far that fishponds were constructed on the roofs of houses. More practical persons conducted a stream of river-water through their dining-rooms, so that the fish swam under the table, and it was only necessary to stoop and pick them out the moment before eating them; and as they were often cooked on the table, their perfect freshness was thus insured.

Cheever, however, was way off on his translation; I read the epigram in question and I provide the original Latin and my own translation as follows:

Nec saeta longo quaerit in mari praedam, sed a cubili lectuloque iactatam spectatus alte lineam trahit piscis. Si quando Nereus sentit Aeoli regnum, ridet procellas tuta de suo mensa: piscina rhombum pascit et lupos vernas; Natat ad magistrum delicata muraena, nomenculator mugilem citat notum, et adesse iussi prodeunt senes mulli.

The line seeks not its prey in the distant sea, but the fish, caused sight of from above, draws down the line cast from bed or couch. If ever Nereus feels the power of Aeoli, the table, safe-supplied from its own store, laughs at the storm; the fishpond feeds turbot and home-reared bass; to its master's call swims the dainty lamprey; his keeper summons a favorite gurnard, and, bidden to appear, aged mullets put forth their heads.

Note: Nereus, also known as "the old man of the sea," was considered to be a gentle and trustworthy god who never lied. Aeoli (or Aeolus) was the divine keeper of the winds, releasing them only at the command of the greatest gods to wreak devastation upon the world. In some translations the line is said to be cast from a casement (window) rather than from bed or couch. Although I admit that this is a better description I felt obliged to do a more literal translation. Pliny, by the way, also described the leisure practice of fishing from one's bed just by dropping a line out the bedroom window. The proximity of living quarters to fishponds at many of the villas in Italy would have made this activity possible.

Martial therefore says nothing about fishponds on the roof of houses or fish swimming under the dining room table in a stream of water. To make sure that Cheever was not quoting from any of Martial's other epigrams I did a global find among all 1,561 of them in 12 Books using the keywords, Nereus, Aeoli and/or Latin words meaning fish; a number were found but not the one Cheever cited. Being somewhat dubious about Cheever's claim I set out to see if I could find any validation of it in the writings of the authors of the day, such as Cicero, Pliny, Varro and others. In this endeavor, I was unsuccessful.

THE HORTENSIUS MYTH

Although we cannot attribute these two myths–fishponds constructed on the roofs of houses and fish swimming under the table–to Martial, I have come across one of them made by another author, a myth that can be reliably disproved (Klee, 2014d). Quintus Hortensius Hortalis (114 BC - 50 BC), was one of Rome's foremost orators. When he retired he withdrew from politics and passed into a cultivated luxury. The vast wealth he had accumulated was spent on splendid villas, parks, fishponds and costly entertainments. Cicero puts him among the aristocrats solely concerned about their fishponds. Lucius Licinius Lucullus, well-known for having cut a channel through a mountain near Naples to allow the sea to enter his fishponds and stir the water within to prevent stagnation, was for example, a close friend. Hortensius also constructed similar fishponds at vast expense, so designed that the tide caused sea water to flow into them.

One of the references to Hortensius I came across was an 1868 translation of The Ocean World by Louis Figuier. Figuier (1819-1894) was a French chemist and writer on occult subjects. After taking his doctorate in medicine and completing his postgraduate study in chemistry, he was made professor of chemistry at the school of Pharmacy in Montpellier and later exchanged this post for a similar one in the School of Pharmacy of Paris. Many honorary degrees in science and medicine were conferred upon him by various faculties during his career. However, in his research he found himself opposed by Claude Bernard, a French physiologist whom historian I. Bernard Cohen of Harvard University called "one of the greatest of all men of science." As a result of this conflict,

Figuier abandoned his research to devote himself to popular science. Much of the scientific information in the novels of Jules Verne, by the way, was taken from his works. In any event, in The Ocean World I came across this statement in the section under mullets (Figuier, 1868a):

The great rival of Cicero, the advocate Hortensius, who attracted crowds of people to the Forum by his eloquent and elegant discourses, had an inordinate passion for this kind of enjoyment. These little inhabitants of the waters were led by a small canal which was carried under the festive table, and his great enjoyment was to witness the agonies of the unhappy fish just taken from its native element and carried to the table, palpitating with its dying convulsions, as it perished beneath his eyes, he in the meanwhile enjoying a sumptuous banquet.

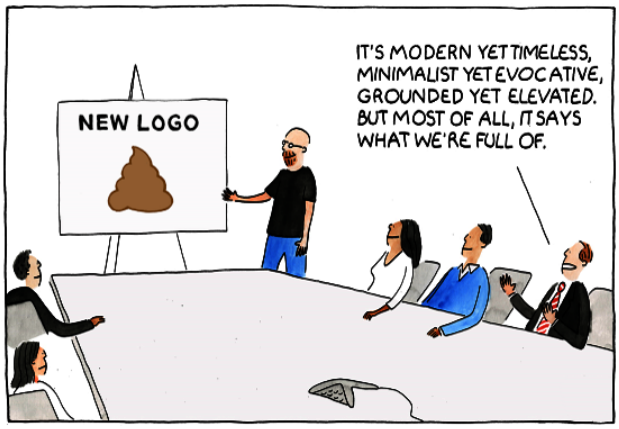
Unfortunately, Figuier provided no in-text references nor did he provide a bibliography. My next thought was that perhaps it was the translator had made an error, not Figuier, so I started a search for the original French version. Alas, there was no such version. On the Title page of The Ocean World, however, was the statement, "Chiefly translated from "La Vie et les Mœurs des Animaux," so I examined this book and found the original French that I was looking for (Figuier, 1868b):

Le rival de Ciceron, l'avocat Hortensius, qui attirait tout le peuple au forum par la beauté de ses harangues, avait une passion désordonnée pour ce petit habitant des eaux. Il faisait venir les rougets dans de petites rigoles jusque sous la table du festin; et il se délectait, assis devant un somptueux banquet, du plaisir de voir un de ces malheureux poissons retiré du bassin et apporté sur sa table, palpitant et agité des convulsions de l'agonie, périr sous ses yeux, en se colorant de mille nuances irrisées.

Keeping in mind that I needed here a more literal translation than an artistic one, I translated it as follows:

The rival of Cicero, the lawyer Hortensius, who attracted all the people in the forum by the beauty of his harangues, had a wild passion for these little inhabitants of water. The mullets were led into a small canal that was carried under the festive table, and he enjoyed sitting in front of his sumptuous banquet, the pleasure of seeing one of those unfortunate fish removed from the canal and brought to the table, and in agonizing convulsions, die before his eyes in iridescent colors of a thousand shades.

Since this didn't differ much from that of Figuier's translator, it was Figuier who was saying that Hortensius brought his fish to the dining room by some sort of water conduit connected to one of his fishponds. However, Figuier's statement could not possibly be true. For proof of this I refer to Marcus Terentius Varro (116 BC - 27 BC), Rome's greatest scholar and a satirist of stature, whose vast and varied erudition in almost every department of literature earned for him the title of the "most learned of the Romans." His only complete work extant, Rerum Rusticarum Libri Tres, has been described as " …the well digested system of an experienced and successful farmer who has seen and practiced all that he records." The following dialogue is taken from this book. Appius Claudius Pulcher was a consul of the Roman



Republic and a good friend of Varro's and this is he, talking to Varro:

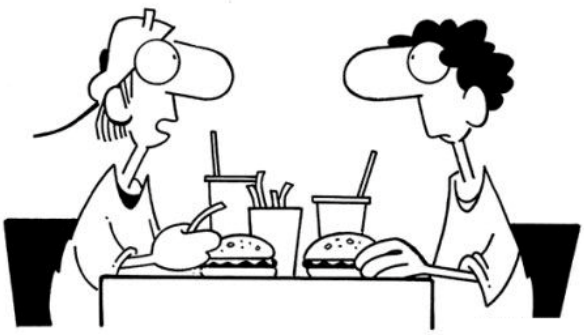
Our common friend Quintus Hortensius had fishponds near Bauli which had cost him a great sum to build, and I know, for I often used to stay with him at his country-house, that he used always to send to Puteoli to buy the fish for dinner. And it was not enough that his fish-ponds didn't feed him, but he must needs, if you please, with his own hands feed them, being more anxious lest his mullets should feel the pangs of starvation than I do lest my asses at Rosea should go hungry. He spent, too, a good deal more on the former than I do on the latter in the matter of both food and drink.

For all I need for the feeding of my costly asses is one little slave, a trifle of barley, and water found on the estate, while Hortensius in the first place kept an army of fishermen to feed the fish, who used constantly to bring him masses of tiny fishes which were destined to serve as food for the big ones. He would buy, besides, salt-fish, and throw it into his ponds, when the sea was stormy, and when, owing to the weather, the market that supplies the fish-ponds (the sea, that is) refused its food, and the live food, the fish eaten by the common people for supper, could not be got to shore with a net. You would sooner, said I, have got Hortensius's consent to your taking his carriage-mules from the stable and keeping them for your own, than a bearded mullet from his fish-pond.

This fanaticism and concern for his bearded mullets became a standing joke throughout Roman society but the point here is that Hortensius was so devoted to his fish that he could not stand to send them off to the banquet table, opting instead to purchase them from the market in Puteoli. He would not have constructed such a conduit from one of his fishponds to his dining table any more than a present-day fish fancier would serve up his pet arowanas through a 3-inch PVC pipe to his dinner guests. Thus, Figuier's account is a myth, nothing more. The coup d'etat was provided by the following review of The Ocean World that appeared in 1868 in The Contemporary Review:

…what is the book? Truly a very patchwork of compilation, utterly without authority as a work of reference! We must admit that the various compilers who have had a share in the volume, have frequently avoided misstatements, while they have popularized the history of the inhabitants of the sea from the zoophyte to the vertebrate fish. Yet we meet with random writing and vague exaggeration more frequently than we expect, even in a French compilation. Thus we are told that the little Janthina shells inhabit the deep sea, and often form banks of many leagues in extent! Another marvelous story is that of a cuttlefish 60 feet long, not counting its arms, which are represented as about 40 feet more and weighing 4,000 pounds, which encountered a French corvette. The fish, according to the illustration taken on the spot and given here, should have been more than a match for the ship. The editor, however, suggests (in, we presume, 'compilation' Latin) that this should be taken cum grano salis.

The reviewer opines, therefore, that Figuier's book is a very patchwork of compilation, utterly without authority as a work of reference, and finishes off by pointing out some errors (I smile at the statement, "…vague exaggeration more fre-



"I forgot to make a back-up copy of my brain, so everything I learned last semester was lost."

quently than we expect, even in a French compilation"). The reviewer goes on to suggest that the only value the book has is as a children's book and even there because of its pictures. Another myth bites the dust, this one by referring to the primary source, not a second one.

GROWING MARINE PLANTS IN ARTIFICIAL SEA-WATER IN A WARDIAN CASE?

The following statement by William Alford Lloyd appeared in his "Handbook to the Marine Aquarium" (Lloyd, 1876):

Mr. Ward had, however, before 1849, made sea-water by artificial means, and had grown marine plants in it.

I was interested in finding the original source for this statement and the first I found was in Shirley Hibberd's "The Book of the Fresh-Water Aquarium or Practical instructions on the Formulation, Stocking, and Management in All Seasons of River Animals and Plants" (Hibberd, 1860):

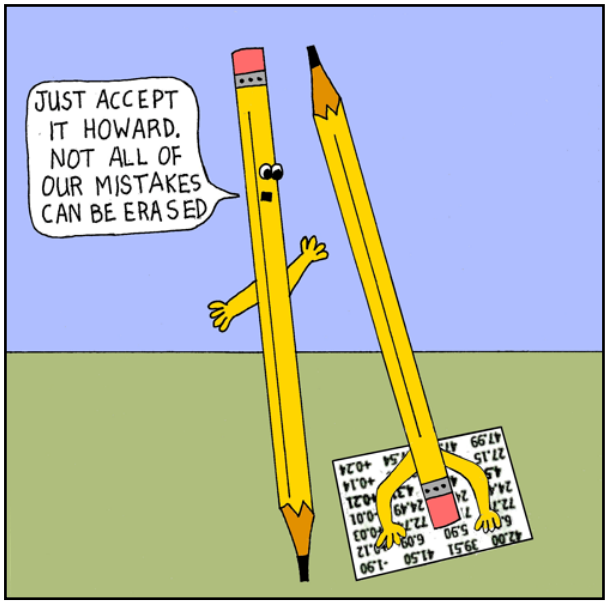
With this opinion I quite concur, and it is agreeable to have to associate Mr. Ward's name with the subject before us, for he was one of the early pioneers, and at a meeting of the British Association at Oxford, 1849, communicated an account of his success in growing marine algae in artificial sea-water.

The British Association that Hibberd referred to was the British Association for the Advancement of Science so I consulted their Annual Report for that year but was unable to find any mention of Ward mentioning artificial seawater. I had noticed that Lloyd stated that this happened BEFORE 1849 and Hibberd stated that it happened IN 1849. As it turned out, with regard to the date Lloyd was right and Hibberd was wrong. I suspected that Hibberd had the wrong date so with a set of key words and phrases I did a Google search and came up with two relevant hits, one in the *Floricultural Cabinet, Florist's Magazine* (Anon., 1847a) and *The Gardener's Chronicle and Agricultural Gazette* (Anon., 1847b). Since the reports were identical, I am reprinting the entry as found in the *Chronicle*:

BRITISH ASSOCIATION. Friday, June 25, 1847. Mr. Ward made some remarks on the results of his plan of growing plants in closed glass cases… Mr. Ward also stated, that not only could land-plants, and the higher forms of vegetation be grown in these cases, but that the various forms of marine Algae had been cultivated in artificial salt water.

This solved the problem, or so I thought at the time, since it was the 1847 meeting of the British Association, not the 1849 one as Lloyd and Hibberd had it. Now all I has to do was to obtain a copy of the 1847 Annual Report and to find Ward's comments. Unfortunately, no matter what words or terms I searched on–Ward, artificial, salt water, etc.–Ward's comments just weren't in these Reports.

I decided to find out what Stephen H. Ward, Ward's son, had to say so I read his paper titled "On Wardian Cases for Plants, and Their Applications" (Ward, 1854). In this paper a note appeared in the appendix that mentioned the idea of growing algae in Wardian cases by means of salt water that appeared in the *Athenaeum* on July 3rd, 1847.



Thus I looked for the *Athenaeum* issue (Anon., 1847c). The *Athenaeum* was large, in newspaper style, set up in three columns and had much more detail than was in the Association's Annual Report. Although the Association did not include the smaller, less important communications in its Annual Report, independent journals like the *Chronicle, Floricultural Cabinet* and *Athenaeum* did. Ward's report, however, read quite differently in the *Athenaeum* from those in the *Chronicle and Floricultural Cabinet* in 1847 (Anon., 1847c):

BRITISH ASSOCIATION.
Friday. July 3.- Section D.
Mr. Ward made a communication on the subject of Growing Plants in Closed Cases. His object was to give the results of a long experience of his plan, as well as to point out some errors with regard to the use of these cases... He also called attention to the fact that all the lower marine Algae might be grown in these cases by means of salt water artificially prepared.

Note that all these reports were written by reporters who worked for–or were paid by–the periodicals in which the reports appeared (in the case of the reports in the *Chronicle* and *Floricultural Cabinet*, it is almost certain that they were written by the same reporter). Periodicals need to publish information as soon as possible and the associations involved published their information annually. Furthermore, the associations of the day did not publish everything (group discussions, for example, were not included in their Annual Reports) so reporters would attend meetings of these individual sections and take their own notes.

Thus, a reporter for a botanical magazine would be sure to attend the meeting of the Botany part of the meeting where he would take notes of informal discussions and exchanges he thought might be of interest to his readers, Ward's comments above being an example. Different reporters, of course, would produce reports of the same exchanges that would agree roughly but not exactly.

The last line of the two reports above highlights a discrepancy between the *Athenaeum* version and the other two, the *Chronicle*, stating that "…the various forms of marine Algae **had been cultivated** in artificial salt water" and the *Athenaeum* stating that "…all the lower marine Algae **might be grown** in these cases by means of salt water artificially prepared." [the boldfacing is mine]." The difference between "had been grown" and "might be" is significant. If it is the latter, then Ward had not actually kept marine algae in artificial seawater, and even if it is the former, Ward did not claim that he had been the one who did. The best that can be said is that, on the record, Ward is the first to evince an interest in using artificial seawater in the marine aquarium, not that he himself had done it.

However, by using deductive reasoning, we can come to a more satisfying conclusion. If Ward or someone he knew had cultivated marine algae in artificial sea water, then he certainly would have mentioned it and included the answers to the usual questions of who, when and where. As he didn't, then Ward was only suggesting that it might be done and the rather lengthy material in the *Athenaeum* was the correct version of what he said at the British Association meeting of 1847 at Oxford.

It is clear that Hibberd most likely got his information from one of the gardening magazines

available in 1847, which would include the *Floricultural Cabinet and Florist's Magazine* and *The Gardeners' Chronicle and Agricultural Gazette*, but not from the *Athenaeum*. He was booby-trapped by using unreliable sources. He was correct, however, in noting that the citation did come from the meeting of the British Association at Oxford; the meeting in 1849, by the way, was at Birmingham.

CONCLUSION

I have shown a number of instances of misinformation appearing in aquarium hobby history writing falling under the headings of (1) failing to define important terms, (2) failing to check their sources and (3) relying on secondary sources that themselves contain fallacies. Unfortunately, the errors described have become widely disseminated all over the planet and into many different languages.

Admittedly these errors are not going to cause any really significant problems for society, but when it happens in other areas, such as education, it is a far more serious case. For example, in 2002, publishers submitted high school U.S. History books for State of Texas approval and the education establishment missed most factual errors. The firm, Educational Research Analysts, found 249 undetected factual errors in four high school U.S. History books after the state approval process certified them error-free. This was despite the publishers' claims to have beefed up their fact-checking, despite the Texas Education Agency's emphasis on verifying their accuracy to the State Textbook Review Panel, and despite an $80,000 Texas Tech review team backing them up. Four examples:

[William H.] Seward had some trouble persuading the House of Representatives to approve the [Alaska Purchase] treaty. (From "The Americans: Reconstruction to the 21st Century," McDougal, 2003.) The Senate, not the House, approves treaties.

1492 Columbus first reaches North America. (From "The Americans: Reconstruction to the 21st Century," McDougal, 2003.) Columbus never reached North America. He explored Caribbean islands and the northern coast of South America.

The Dred Scott case was only the second one in American history in which the Supreme Court reversed a federal legislative act. (From "The Americans: Reconstruction to the 21st Century," McDougal, 2003.) The 1857 Dred Scott decision did not reverse the Missouri Compromise, because the 1854 Kansas-Nebraska Act had already repealed it.

James Monroe was the last president to have fought in the Revolutionary War. (From "American Nation in the Modern Era," Holt, 2003.) Andrew Jackson, not James Monroe, was the last president to have fought in the American Revolution.

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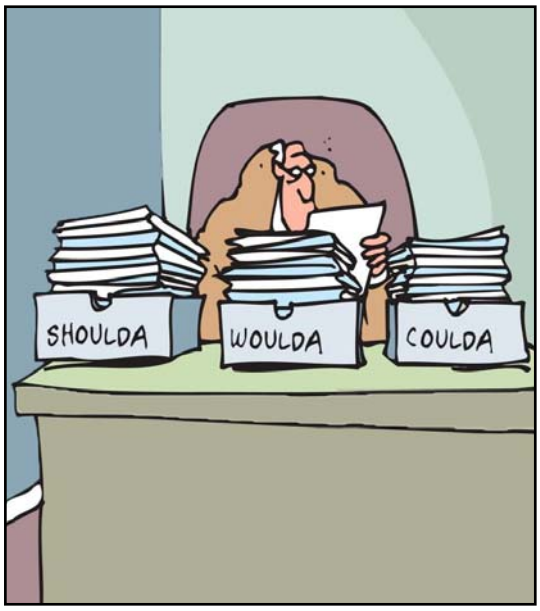

THE AQUARIUM AS A HYBRID SPACE BETWEEN ANIMAL HOBBIES AND EXPERIMENTAL ZOOLOGY

by Christian Reiß

(Aquarium Hobby Historical Society, Files Section, February 12, 2011)

This essay is part of Christian Reiß's PhD project (Friedrich-Schiller-Universität Jena) on the history of the Mexican axolotl (*Ambystoma mexicanum*) as an experimental animal in the life sciences. First I'll provide explanations of some of the terminology he used. Reiß frequently refers to the term "life sciences" in his article. Life sciences comprise the branches of science that involve the scientific study of life and organisms – such as microorganisms, plants and animals including human beings. This science is one of the two major branches of natural science, the other being physical science, which is concerned with nonliving matter. Biology is the overall natural science that studies life and living organisms, with the other life sciences its subdisciplines. However, in the context of this article is concerned only with the aquarium and its effect on zoological; research. Reiß uses the term "fancy" alone and also terms such as "animal fancying," "aquarium fancying" and similar terms. In all these instances I have used "hobby" instead.

Reiß also uses the term "hybrid spaces," which is best explained by the following example.

In 1872, August Weismann (he studied how the traits of organisms developed and evolved in a variety of organisms, mostly insects and aquatic animals, and proposed the theory of the continuity of germ-plasm, a theory of heredity) started his research project on the Mexican axolotl. He wanted to find out in the context of his experimental studies on evolution whether the irregular and rare transformation from axolotl to amblystoma August Duméril (Duméril, 1866) had observed ten years earlier in Paris (Fig. 1) was caused by environmental influences or the internal phyletic force suggested by other zoologists.

What he at first considered to be a straightforward *experimentum crucis* (crucial or critical experiment), which would ultimately show that evolution happened gradually and was driven by natural selection, turned out to be much more complicated. His first experimental attempt failed and all axolotls died. Only after he handed the project over to the naturalist Marie von Chauvin did the experiments turn out to be successful (Chauvin 1876). Her initial interest was in the natural history of insects, but she soon acquired a reputation as a talented and experienced animal breeder (Siebold, 1876).

Chauvin used the aquarium as an experimental tool, altering the environmental conditions according to the axolotls' reaction. For her experiments, she kept five axolotls in an aquarium that was set up like a lakeshore, that is, only a part was filled with water. To induce the transformation, she slowly lowered the water level so that the animals could only submerge at one spot. During the experiments, Chauvin showed great skill in observing the reaction of the axolotls to the experimental treatment, adjusting the further steps accordingly.

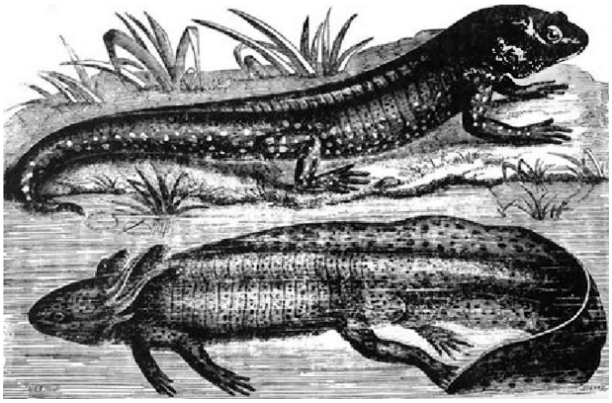

Figure 1: Bottom: Axolotl, Top: Amblystoma. As depicted in one of Auguste Duméril's publications (Duméril, 1866).

The result was the transformation of all five animals. In the course of a subsequent series of experiments she conducted over ten years, she managed to control the axolotls' transformation with the help of the aquarium to the extent that she could start it, stop it, and even reverse it up to a certain point (Chauvin 1883a, 1885). These axolotl experiments were part of a larger experimental system on amphibian metamorphosis, adaptation, and reproduction, on which she also published in the fancier journal Isis.18 While the aquarium was often just used as a gateway, which brought new species into research spaces, Chauvin took full advantage of the aquarium as an artificial environment and turned it into an instrument allowing her to manipulate ontogenetic processes (i.e., processes that are based on visible morphological characters) in several amphibian species.

The following is my translation of his own summary of Reiß's work.

Despite its widespread use in the life sciences, the aquarium has so far received little scientific and technological historical attention. This is not least due to the fact that the aquarium and its history have so far largely been viewed as non-scientific.

Contexts as diverse as acclimatization, amateur natural history and middle-class popular culture played an important role. At the same time, the development of the aquarium is also closely linked to the history of the life sciences. With a view to the second half of the 19th century, I understand the aquarium as a techno-natural assemblage in which technology, culture and nature are connected to an artificial natural space. Its history begins in British amateur natural science and the French acclimatization movement. In Germany in the late 19th century, the aquarium developed into a mass phenomenon.

At the same time it found its way into the life sciences, where it was used as a gateway, instrument and environment. As it turns out, the aquarium is a highly engineered technology that emerged from a combination of different traditions and brought life to the life sciences.

The following is the portion of his dissertation that it of most relevance to the aquarium hobby. I have edited it slightly to make it more readable for American aquarists. *Albert J. Klee, Ph.D., Editor.*

THE AQUARIUM AND THE HISTORY OF SCIENCE

Even though it was and still is an integral part of laboratory research in the biomedical sciences, the aquarium leads a shadowy existence in the history of science and technology. The rare opinions given by historians of science are short and unambiguous. For David Allen, the aquarium was a "plaything of fashion" (Allen, 1996, pg. 394) and the aquarium hobby an "extra-intellectual interest" (Allen, 1994, pg. 122) in the context of British amateur natural history. Andreas Daum describes the aquarium hobby as yet another variety of popular science in nineteenth century Germany, in which "non-professional nature lovers [aimed] for fulfilment and organization" (Daum 2002: 108). This article contributes to these and further works that focus on the aquarium's role in

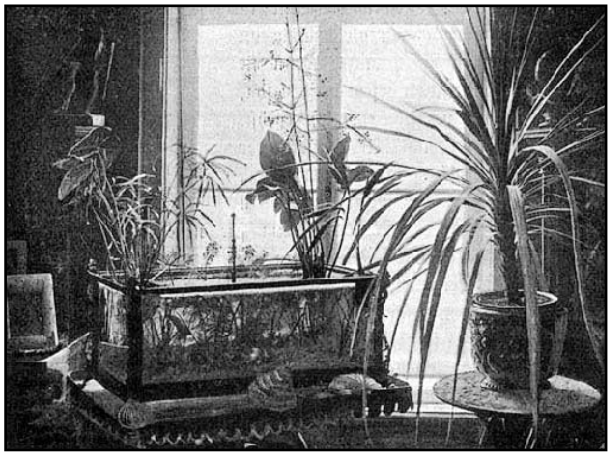

Figure 2: The aquarium as a techno-natural assemblage, integrated into the urban home (Bade 1899, pg. 72).

nineteenth and twentieth century popular culture (Schlebrügge, 2005/ Lorenzi, 2009/ Kranz, 2010/ Brunner 2011/ Hamera, 2012). At the same time it challenges the bias towards an extra-scientific history of the aquarium by emphasizing the aquarium's hybrid nature as an object in popular and laboratory culture.

The aquarium is such a functional space and a technology-in-use in twentieth and twenty-first century laboratory culture. Hence there must be a history of its emergence and stabilization and a historical link to its history in the nineteenth century. And this connection must either provide a feedback from Daum's popular science into the professional realm, or the aquarium must have been more than Allen's profane "plaything of fashion."

Closer inspection reveals that both scenarios apply and that the aquarium indeed has a history of science. It is not just exclusively a history of science, but also a history of fanciers, of animals, of industrial and urban technology and of nature constructed. It is the history of a technology that developed from a broad desire to bring nature into cities, into domestic spaces and – last but not least – into scientific spaces.

THE BRITISH AQUARIUM CRAZE AND THE SALTWATER AQUARIUM

In The Naturalist in Britain, David Allen reconstructs the history of the aquarium and the aquarium craze in Britain in the 1840s and 1850s, linking it to a number of other subfields of British amateur natural history (Allen, 1994). By way of explaining the spreading of the aquarium and the nature of the aquarium craze, he points to two central factors. First, it was the removal of the excise duties on glass (*ibid.* pg. 122) that made products of plate glass, including the aquarium, accessible to a broader audience. Second, there was a social change in the public for natural history, i.e., an emerging educated and prosperous middle class that turned enthusiasm into a craze.

The Aquarium hobby in Britain was materially and practically linked to a set of activities, which all consisted of collecting organisms or parts of them and arranging and displaying them in different kinds of boxes. While in academic natural history, these activities had a long tradition and were based on a taxonomic and classificatory epistemology, amateur crazes followed a different logic.

Driven by the writings of Philip Henry (Gosse, 1856) and following on the heels of seaweed and fern hobbyists, the aquarium offered a new opportunity for members of the emerging middle class to enjoy nature, advance their (scientific) education, and develop and display their aesthetic sensibility. The aquarium hobby originally meant to go to the coast during ebb tide – British aquarium hobby concentrated mainly on saltwater aquaria – to collect plants and animals from the tidal pools and then arrange them in aquaria. With its rising popularity and almost becoming a must-have for the salon, the aquarium became a commodity with a growing industry offering everything from fresh saltwater to fully equipped and even regularly maintained aquaria (Brunner, 2011). The most prominent aquarium trader was W. Alford Lloyd, whose Aquarium Warehouse in London had 15,000 animals in stock (Lloyd, 1858 and Alexander, 2005). To secure a steady supply of fresh water, plants and animals, traders like Lloyd took advantage of the rapidly developing railroad system in Britain, which connected the coast with inland cities like London and allowed a fast and stable transport of the sensitive freight (Schivelbusch, 1978). The rising popularity together with the new infrastructural possibilities owing to industrialization meant that soon "… great stretches of the coast were largely stripped of their attractive inhabitants" (Allen, 1994, pg. 124).

Even though the enthusiasm evaporated as fast as it had emerged, seeing most aquaria abandoned (Brunner, 2011), it left a lasting legacy by laying

the foundations of aquarium technology and practices, and thus of techno-natural assemblages. Furthermore, public aquaria made their way to the European continent as a new attraction for the masses. Following the bankruptcy of his aquarium warehouse with the end of the craze, W. Alford Lloyd became the most eminent expert for public aquaria in Europe, constructing aquaria for the *Jardin zoologique d'acclimatation* in Paris (1860), the *Zoologische Garten Hamburg* (1864), and the *Stazione Zoologica* of Naples (1874).

In addition, it sparked the proliferation of the aquarium as a research technology in the life sciences. While during the first half of the nineteenth century, scientific research with and on aquaria largely remained an isolated endeavor conducted by people like Robert Warington (Hamlin, 1986), Anna Thynne (Stott, 2003) or Jeanette Villepreux-Power (Brunner, 2011) the use of aquaria became widespread among British anatomists and zoologists (Elwick, 2007) from the 1850s onwards. Thus, not even the British aquarium tradition should be considered a purely amateur movement or as popular science. The amateur-professional dichotomy that already received substantial criticism (Daum, 2002/ Nyhart, 2009 and Phillips, 2010) does not hold for the situation in France and Germany either.

The history of the British aquarium craze and of the public aquarium reflects a specific tradition in the aquarium hobby which is intimately tied to a broad cultural (re-)discovery of the ocean at the beginning of the nineteenth century (Corbin, 1994, Rozwadowski, 2005 and Schwarz, 2005). Saltwater aquaria became the focus of this tradition, serving as imaginative spaces of the mysterious and undiscovered wonders of the ocean. In addition, the geographic specificities of Great Britain as an island with a big ratio of coastline to area and the resulting short distances between coast and inland cities simplified their set-up and maintenance.

THE CONTINENTAL COUNTERPART: ACCLIMATIZATION, AQUACULTURE AND THE FRESHWATER AQUARIUM

The situation in continental Europe differed from Great Britain in several ways. Due to the geographic differences – less coastline per area and hence long distances between coast and most inland cities – saltwater aquaria never became as popular and common as in Great Britain. Even though adept enthusiasts managed to set up and maintain saltwater aquaria for several years without changing water, the organisms populating the aquarium nevertheless eventually died and had to be replaced by new ones. As breeding turned out to be almost impossible for most marine organisms, fresh supply had to come directly from the sea.

This corresponds to the fact that, especially in France and Germany, the aquarium hobby was much more rooted in the acclimatization movement with its specific agendas among science, enthusiasm and commerce. The acclimatization movement emerged in France and Great Britain at the end of the eighteenth century (Osborne, 2000). Due to the rapidly increasing circulation of organisms along colonial networks animals, plants and humans were frequently exposed to new environments, and the influence of different environments on organisms came into focus. Acclimatization was the attempt to deal with and even to take advantage of this influence. In Great Britain this meant the transfer of organisms between similar environments, while the French approach assumed that organisms could, to a certain degree, be bred to adapt to different environments (*ibid.*).

The *Société Imperiale d'Acclimatation*, the first acclimatization society founded in Paris in 1854, set its agenda accordingly (Osborne, 1994). It announced prizes (consisting of medals and considerable sums of money) for the successful introduction and breeding of a wide range of organisms that were considered agriculturally and eco-

nomically promising in various ways. Its activities were directed both at France as well as at the colonies and included attempts to acclimatize alpacas, zebras, bustards, new silkworm species, new wax-producing insect species and quinine bark in France, edible fish in Algeria and "an animal to Martinique that could exterminate the fer-de-lance (*Bothrops lanceolatus*) living there."

These examples illustrate the Société's policy ranging from projects in France to ones in the colonies, and from agriculture to pharmacy. In parallel to stimulating acclimatization efforts by its members, the *Société* founded a zoological garden. The *Jardin Zoologique d'Acclimatation* was opened in 1860 and designed as a mix between an acclimatization laboratory and public animal display. In the *Bois de Boulogne* outside Paris, which had been landscaped under the direction of Baron Haussmann into a park in 1852, the *Société* built what was soon regarded as the ideal of a modern zoological garden. Financed by stock shares and a large network of powerful members, the *Jardin* was the manifestation of the acclimatization ideology.

The French acclimatization movement must be understood as part of a much broader regenerative movement, which Napoleon III turned into a state policy during the Second Empire. Projects ranged from Baron Haussmann's urban renewal of Paris to reforestation projects all over France, following the idea of "making facts of nature into instruments of human progress'' (Kinsey, 2006: 536). Acclimatization was a complex set of practices that linked "science to animal display, urban renewal, agricultural improvement and France's colonial mission" (Osborne, 1994, pg. 13).

One of these projects was scientific aquaculture, the attempt to "elevate the last unconquered region of the planet – its aquatic wilderness – to a level of domestication" (Kinsey, 2006: 527). The aqua-cultural revolution, like any other regenerative project at this time in France, was carried by heterogeneous interest groups "including scientists, bureaucrats, sportsmen and entrepreneurs" (*ibid*. pp. 552). State and private actors aimed for the rational and scientific reorganization of the use of aquatic species and tried to acclimatize foreign species in French waters, including salt- and freshwater "fish, mollusks, and even leeches for medical purposes" (*ibid*. pp. 528). For their Jardin, the Société commissioned W. Alford Lloyd to build an aquarium, which included both saltwater and freshwater tanks as well as facilities for fish, oyster and frog culture.

While committed to the improvement of nature in general, and human food sources in particular, the spectacle of the exotic and ornamental held a prominent place on the acclimatization agenda as well. As a result, aquaria did not only become an integral part of the *Jardin* but also objects for private homes (Lorenza, 2009). Compared to Great Britain that created a different blend of aquarium culture, the specific mixture of economic and ornamental motives, the inclusion of freshwater aquaria, and especially the close association with imperial networks and acclimatization shifted the attention away from the one-way relation between the ocean and the aquarium toward the breeding and circulation of aquarium organisms within techno-natural assemblages.

THE AQUARIUM IN GERMANY

The French acclimatization movement - and especially its *Jardin Zoologique d'Acclimatation* - soon acquired European fame, and similar societies and zoological gardens were founded across Europe. Germany was one of the countries where [French] acclimatization found a large following. Zoological gardens were opened or reorganized (Wessely, 2008), societies founded, journals published and a broad affinity to animal keeping and breeding emerged.

While acclimatization and its encompassing improvement agenda turned out to be rather short-

lived in Germany, the educational and leisure aspect of animal keeping and breeding acquired increasing prominence. This development was amplified by the particular German tradition of non-academic natural history (Nyhart, 2009). In this context, Emil Roßmäßler, the German counterpart to Philip Henry Gosse, promoted the aquarium and set the agenda for German aquarium culture (Roßmäßler, 1856, 1857 and Daum, 2002). As in Great Britain and France, aquarium enthusiasts were members of the middle class with the necessary resources in money, time and education (Daum, 2002).

After the initial boom between the 1870s and 1890s, the hobby saw another upswing in the interwar period. During these years, the aquarium found a new audience among members of the working class, and large numbers of proletarian clubs were founded (Hohl, 2001).

The rapid expansion of the field in the late nineteenth century is apparent in the growing number of increasingly specialized journals and the formation of clubs or *Vereine*. Until the 1870s, *Der Zoologische Garten, Zeitschrift für die gesamte Tiergärtnerei* (The Zoological Garden, Journal for the Entire Field of Zoo Keeping), founded in 1859, was the most important journal in the field of animal hobbyists. Originally the journal of the Frankfurt zoological society and its zoo, it soon became the central publication for zoological gardens, acclimatization and animal breeding in Germany. In 1876, *Isis, Zeitschrift für alle naturwissenschaftlichenLiebhabereien, Verkehrsblatt für naturgeschichtlichen Kauf und Tausch* (Isis, Journal for all Scientific Hobbies and Natural Historical Trade and Exchange) was launched. It specialized in the needs of the ever-growing private animal hobbyists, serving as a platform for the exchange of practical information and to connect animal buyers and sellers (Paepke, 2007a). The journal *Natur und Haus, Illustrirte Zeitschrift für alle Naturfreunde* (Nature and House, Illustrated Journal for all Friends of Nature) founded in 1892 and its follow-up *Nerthus: Illustrierte Wochenschrift für Tier- und Pflanzenfreunde, Organ für Sammler und Freunde aller naturwissenschaftlichen Zweige* (Nerthus: Illustrated Weekly for Friends of Animals and Plants, Institution for Collectors and Friends of all Scientific Branches), launched in 1899, were directed at similar audiences (Daum, 2002).

Isis was only published until 1889, but one year later, in 1890, *Blätter für Aquarien- und Terrarien-Freunde, Illustrirte Halbmonatsschrift für die Interessen der Aquarien- und Terrarienliebhabei* (Journal for Aquarium and Terrarium Enthusiasts, Illustrated Half-Monthly for the Interests of Aquarium and Terrarium Enthusiasts), was launched as the first journal exclusively for aquarium and terrarium hobbyists. This project was initiated by Bruno Dürigen, the co-founder of Isis and one of the most prolific figures in the field of German animal keeping and breeding (Paepke, 2007b), and Ernst Bade, former editor of *Nerthus* and a leading figure in the German aquarium and terrarium scene who ran his own commercial aquarium breeding business in Berlin. The journal's title points to a characteristic of German aquarium culture – the close connection between the aquarium and the terrarium, often subsumed under the umbrella term vivarium. This meant a generally more inclusive approach with a broader array of animals, ranging from fish, amphibians, and reptiles to insects and plants, as well as a more complex set of habitats, which often combined aquatic and terrestrial spaces.

In 1902 the *Blätter* was renamed *Blätter für Aquarien- und Terrarienkunde, Illustrirte Wochenschrift für die Interessen der Aquarien und Terrarienkunde* (Journal for Aquarium and Terrarium Studies, Ilustrated Weekly for the Interests of Aquarium and Terrarium Studies) and switched from bimonthly to weekly publication. While the latter indicates the growing number of authors and readership, the change in the title from Freunde (enthusiasts) to Kunde (studies) points to the effort of enthusiasts to be taken seriously in their activities, which they understood as a form of production of knowledge complementary to the

sciences (Nyhart, 2009). In 1909, *Natur und Haus* merged with *Blätter* and in 1939 *Blätter* merged with its competitor *Wochenschrift für Aquarien und Terrarienkunde* (Weekly for Aquarium and Terrarium Studies), founded in 1904.

Aquarium clubs started to appear in the late 1870s. By 1911, 284 clubs existed and could be found in every large German city (Hohl, 2001a). In the same year German aquarium and terrarium hobbyists saw a further institutionalization with the foundation of the *Verband der Aquarien und Terrarienvereine* (Association of Aquarium and Terrarium Clubs) (*ibid*., 2001b).

This continuing specialization and institutionalization of the aquarium and terrarium hobby found no complement in France and Great Britain. Aside from monographs that were regularly published in all three countries, only Germany saw the development of highly specialized, practice-oriented journals and a national network of clubs (Daum, 2002). Clubs mostly worked as local communication platforms where a common interest cultivated sociability in the exchange of practices, technologies, knowledge and organisms. Hobbyist journals fulfilled the same function at national and sometimes international level, connecting likeminded enthusiasts and the growing number of professional aquarium suppliers and acting as platforms on which knowledge and practices were further negotiated, stabilized, exchanged and archived. Especially in the second half of the nineteenth century, when the keeping and breeding of organisms in aquaria and terraria was still developing, clubs and journals were crucial in developing, stabilizing, and making accessible the necessary knowledge and technologies. The following examples demonstrate this process of tinkering and stabilizing techno-natural assemblages as well as their integration into middle-class life worlds in nineteenth-century Germany.

Water ventilation was the most crucial aspect of running an aquarium. Although hydraulic/pneumatic devices (often in combination with a fountain (Fig.3) or spring mechanisms driving a paddle wheel) had been available from early on, enthusiasts were constantly experimenting with alternative mechanisms, like small steam engines (Buck, 1875) or the growing infrastructures of urban supply. Adolf Sasse, who ran the biggest aquarium shop in Berlin, even made a trip from Berlin to Lübeck to study the apparatus constructed by Heinrich Lenz, director of the local natural history collection, who used the water pressure from the recently installed urban water supply system for ventilation (Sasse, 1878).

In Sasse's description of his own efforts to install this apparatus in his apartment, several conflicts of integrating techno-natural assemblages become visible. The new apparatus had the advantage of replacing the old pump system, which was rather bulky and used to spray water. As Sasse emphasized, "nobody was happier than my wife" (*ibid.* pg. 143) about its disappearance. Still, the new apparatus consisted of a rubber pipe, which ran through three rooms and connected the water tap in the kitchen to the aquaria. In the end it was the landlord who ended "this municipal *perpetuum*

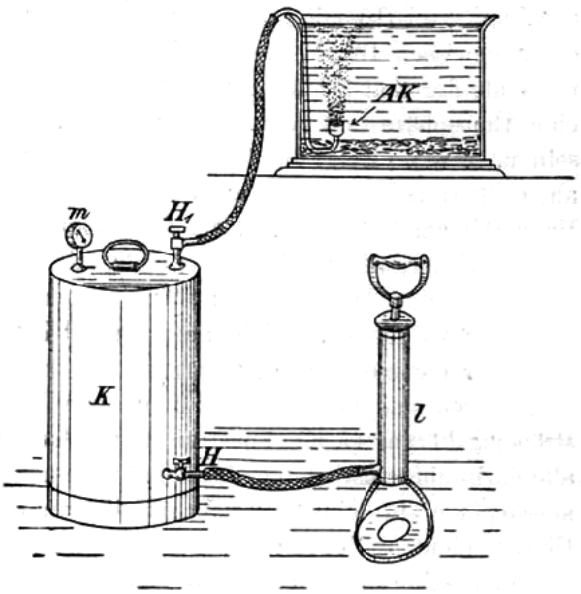

Figure 3: Construction plan for an aeration device using an air pump (Zernecke 1897, pg. 41).

mobile" (*ibid.*), complaining about the water running day and night. Sasse had to return to his old pump system. The kind of ventilation device developed by Lenz did not become commercially available until 1908 (Hohl, 2001a).

As these examples show, the process of creating a shared space for human and non-human animals went beyond mere technical feasibility and had to meet different interests. The decorative aspects of the aquarium often conflicted with the necessities of maintenance and functionality. The boundary between human and non-human subspaces turned out to be problematic in various ways. *Blätter* editor Ernst Bade (Bade 1897) brought these boundary issues to the fore when he discussed the following dilemma. If the aquarium is not filled up to the top lip, the water surface leaves a strip of dirt, which over time is more and more difficult to remove and blemishes the aquarium. Yet filling up the aquarium to the seam, one runs the danger that the fish jump out.

Last but not least, the aquarium hobby had to be integrated into family life. In a text on aquaria for children from 1899, the author discussed the question why children rarely shared their father's enthusiasm. He identified one reason in the way the aquarium was integrated (or rather, not integrated) into family life. While it often formed the center of the household, dominating the needs of wives and children, "no wife, no child is allowed in the vicinity of the aquarium, let alone to touch it" (Dankler 1899: 94).

In the course of this mediation between the diverse interests of aquarium animals, family members and landlords, the aquarium became socially and domestically integrated and the techno-natural assemblage developed into a stable and increasingly ready-made infrastructure (Fig. 2). As the aquarium hobby found a growing audience, a market developed that was served by a growing number of suppliers. To give just one example of its dimensions: between 1905 and 1912, the company A. Glaschker in Leipzig sold 100,000 aquaria (Hohl, 2001b: p. 117).

THE AQUARIUM IN THE SCIENCES

The process of integrating the aquarium did not only take place in domestic spaces. For a number of partly overlapping reasons, life scientists started to keep animals as well. While many life scientists were fanciers themselves, there were also practical and methodological reasons that created a growing demand for living animals. Even though the aquarium was likewise used in scientific institutions in France (for instance at the *Musëum d'Histoire Naturelle* in Paris) and Great Britain (Elwick, 2007), the highly diversified German aquarium culture and the development of the life sciences in Germany in the second half of the Nineteenth century (Coleman, 1971) constituted an especially fertile ground for proliferating the aquarium in the life sciences.

Physiology achieved growing institutional independence and especially experimental physiology developed a research agenda that intensified its consumption of research animals (Nyhart, 1995/ Dierig, 2006). When in 1877 Emil DuBois-Reymond had his new physiological institute built in the center of Berlin, he included a ranarium, that is, a facility to breed frogs, so as to have a steady supply of frog muscles for his electrophysiological experiments (Dierig, 2006). In turn physiologist Elie de Cyon considered the aquarium as the best way to secure this steady supply and he noted that every "experimental scientist should personally make sure that the animals are held under living conditions that fit their nature the most" (de Cyon, 1876, Pg. 29). As de Cyon emphasized, the growing urban infrastructures could be easily used for this purpose (Dierig, 2006).

In parallel, anatomy and zoology shifted from a systematic to a morphological framework (Nyhart, 1996). Instead of studying particular anatomical structures in particular species (often

using particular specimens from a collection) to comparatively understand the taxonomic relation of these species, morphology used a number of species from one group as exemplars to understand the history and thus the development of a structure in the whole group. Gradually, the scope expanded to increasingly fundamental principles and ever-larger taxonomic groups.

Since this research was based on the investigation of the successive steps of morphological development, it needed the successive developmental stages of often several animal species. Accordingly, the large collections of dead and preserved specimens gradually lost their significance in this context. Like experimental physiologists, zoologists started to rely on species that were either of great abundance locally or could be kept and bred rather easily (Hopwood, 2011). Hence availability slowly outpaced taxonomy.

In this context, experimental embryology emerged as a new field of research. It was a science of, or better, at the sea, with roots in the morphological questions of *Entwicklungsgeschichte* (developmental history). After primarily developing at marine stations that were founded on all European coasts in the 1870s and 1880s, it heavily relied on easy access to eggs and larvae of mostly marine invertebrates (Groeben, 2008). As a consequence, decades into the twentieth century, several generations of zoologists and anatomists traveled at least once a year to one of the stations, the most famous being the Stazione Zoologica of Naples (Fantini, 2000).

And finally, life history studies, though often less visible, always played an important role in zoology (Nyhart, 1996). Following the publication of Darwin's Origin of Species, the interrelations between organisms and their environment became an important area of research that was increasingly carried out in the emerging hybrid spaces of techno-natural assemblages.

Especially in the context of experimental embryology and the research style developed at the marine stations, the aquarium gained significance. But this observation should neither suggest that the aquarium was imported into science as ready-made technology, nor that there was a clear distinction between amateur and scientific uses of the aquarium. Lynn Nyhart has already brought to attention the importance of "practical naturalists" (Nyhart, 2009, pg.108) for the life sciences and the role played by the "everyday business of keeping the animals alive." Not only people generally considered as amateurs contributed to scientific knowledge; also scientists participated in activities generally considered as amateurish.

Aquarium enthusiast and scientist were often identities of the same person, sometimes being almost unconnected but sometimes being closely interwoven on the practical level. Probably one of the most (in)famous examples in this context is Paul Kammerer. He started out as an aquarium/ terrarium enthusiast in his youth, became a corresponding member of the Berlin club *Triton* (Rieck/Mau, 2008, pp. 60) and published in the *Blätter* (Kammerer, 1901). In 1902, he started to work at the *Biologische Versuchsanstalt* in Vienna, also known as the Vivarium. It is no coincidence that Kammerer, known for his special aptness for breeding and keeping amphibians (Rieck/Bischoff, 2001/ Gliboff , 2006/ Berz, 2009), worked at this institution which was in all aspects designed for keeping, breeding and experimenting with animals (Reiter, 1994/ Gliboff, 2006/ Berz, 2009). But he kept close contact to the aquarium movement, acting as editor for the *Blätter* from 1908 until 1909.

Other examples include Valentin Haecker, Professor of Zoology at the University of Halle, who had a close relationship to the *Vivarium-Halle*, one of several local clubs. Some of his doctoral students were members of this club and did their experimental research on aquarium animals (Roßmäßler-Vivarium 2006). Werner

Schnakenbeck, for example, published his breeding experiments with the Mexican axolotl in the Blätter (Schnakenbeck, 1922a), and his experimental research on the same animal in scientific journals (1922b, 1923). In Jena, Friedrich Maurer, Professor of Anatomy, Ludwig Plate (Levit/Hoßfeld, 2006), Ernst Haeckel's successor as Professor of Zoology, Karl Hobstetter, Professor of Veterinary Medicine and Julius Schaxel (Reiß 2007), Associate Professor of Zoology, were all members of the local club *Wasserrose e.V.* [e.V. under German law is a Körperschaft (corporation), which is defined as being a legal entity which is separate from its members, i.e. not a partnership], 1913, Jena. The fact that many university libraries in Germany hold a wide variety of aquarium journals further demonstrates the close ties between the academic life sciences and the intermediary realm of enthusiasm.

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Figure 4: Christian Reiß.

GOLDFISH: MUSINGS, MEMORIES AND MORSELS

by Albert J. Klee, Ph.D.

(*Aquarium Hobby Historical Society*, Facebook Files, June 10, 2021)

A1. EARLY ATTEMPTS TO DATE THE INTRODUCION OF THE GOLDFISH INTO THE U.S.

In 1836, James Ellsworth De Kay had been entrusted with the stupendous task of covering "both botany and zoology" for a Natural History survey of New York State. The years of research that followed resulted in the publication of five volumes from 1842 to 1849. In these he had described more than 1,600 species of animals, including mammals, birds, reptiles, amphibians, fishes, molluscans, and crustaceans, introducing common names as far as possible.

De Kay (his name was spelled also as DeKay, even by him at times) was born in Lisbon, Portugal in 1792. When he was two years old his family moved to New York; both his parents died, however, while he was still quite young. He attended Yale from 1807 to 1812, but was expelled before completing his degree when he threatened a college tutor with a club. Later, he studied medicine at the University of Edinburgh, receiving his MD in 1819.

De Kay returned to Oyster Bay, New York, giving up medicine for the study of natural history. On the outbreak of cholera in New York City, De Kay hastened to give his services to the afflicted, although the practice of his profession was repugnant to him. He became involved with the Geological Survey of New York, which was initiated in 1835, and as a result, from 1842 to 1844 he published the multi-volume Zoology of New York, or The New-York Fauna covering: mammals, birds, reptiles and amphibians and fish.

I mention this because when I first started my research into aquarium hobby history in 1960, one of my goals was to find out when and who brought the first goldfish to America. At the time, the earliest mention was in De Kay's "Zoology of New-York" (1842, De Kay):

The Golden Carp, or Gold-fish, as it is more generally called, was introduced from China into Europe in the early part of the seventeenth century, and probably shortly after found its way to this country. They breed freely in ponds in this and the adjoining States. They are of no use as an article of food, but are kept in glass vases as an ornament to the parlor and drawing-room. They are said to display an attachment to their owners, and a limited obedience to their commands.

This, however, was hardly a definitive statement about the first importation of the goldfish into America so I attempted to find where De Kay obtained his information. With regard to Western Europe (and I include England here) there were a

James De Kay (1792-1851).

number of dates under general consideration at the time I started my research, i.e., 1611, 1691 and 1728. My reasoning for considering the first importation into Western Europe was that when the goldish was first introduced into Western Europe it would not have been long after that it was imported into the United States. Philip Henry Gosse's book, "The Aquarium, an Unveiling of the Wonders of the Deep Sea", for example was published in London in 1855 and was reviewed in the *North American Review* three years later in the July 1858 issue. Even in the 1700s it only took the British six weeks to ferry an army across the Atlantic!

Since De Kay reported that the goldfish was introduced from China into Europe in the early part of the seventeenth century, he most likely was thinking of the 1611 date. This appeared in D. Marcus Bloch's famous book, "Oeconomische Naturgeschichte der Fische Deutschland" (Block, 1784):

At present goldfish are esteemed not only in England, Holland and Denmark, but also in different cities of Germany. They were brought to the first country in the year 1611, and in 1728 they were already widely known.

Bloch cited as his source Thomas Pennant's, "British Zoology" (Pennant, 1776) but Pennant's comments, however, were as follows:

These fish are now quite naturalized in this country, and breed as freely in the open waters as the common carp. They were first introduced into England about the year 1691, but were not generally known till 1728 when a great number were brought over, and presented first to Sir Mathew Dekker, and by him circulated round the neighborhood of London, from whence they have been distributed to most parts of the country.

However, in those days the dates of publication were always in Roman numerals and it is easier to mistake MDCXCI for MDCXI, the Roman numerals for 1691 and 1611, respectively (just remove the last C from the first date).

Therefore, Bloch's date was clearly a misprint (Hervey and Hems, 1948), although it was accepted by many authors. I was now down to only to two dates, 1691 and 1728, neither of which agreed with De Kay's assertion that the goldfish was imported into Europe in the early 1600s. At this point I put aside the problem (for about 44 years!).

A2. DE KAY'S INTERESTING COMMENT

However, De Kay was not a complete loss. I uncovered the following in the preface of his book:

In 1788, Schoepff, an army surgeon, who was in this country during the war of the revolution, published in the Transactions of the Friends of Natural History at Berlin, a memoir entitled "Descriptions of North American Fishes, chiefly from the waters of New-York." His paper is for the most part a meagre catalogue of species from New-York and the Gulf of Mexico, mostly identical with those previously described by Linnaeus. In common with many of the observers of that period, he had such a slavish deference to the great reformer of natural science,that he scarcely dared to pronounce upon the validity of a species unless it had received the Linnaean stamp of authority.

Johann Schoepff (1752-1800).

This explains why *Fundulus heteroclitus* never wound up being named *Fundulus killfish*! At this point I copied this material but never got around to publishing it until now.

B. FAST FORWARD TO 2004

On May12, 2004, Albert Pawloski, a new member to the Aquarium Hobby Historical Society of America (AHHS) hosted on the Yahoo groups, asked a question regarding Samuel Pepys. I answered the same day, remarking towards the end that the fish viewed at the house of "Lady Pen" was a goldfish. This started a controversial thread, debating whether the fish was a goldfish or a paradise fish. By this time I had added much to my knowledge of this subject and on May 13, 2004 I posted the following (Note: any personal comments I have made with regard to the posts are enclosed in SQUARE BRACKETS and in a DIFFERENT type):

Post by Albert Klee, May 13, 2004
Based on the shorthand manuscript [by Lord Braybrooke] in the Pepysian Library, Magdalene College Cambridge, transcribed in 1825 by Mynors Bright, and edited in 1893 Henry B. Wheatley, the complete quote is as follows:

Thence home and to see my Lady Pen, where my wife and I were shown a fine rarity: of fishes kept in a glass of water, that will live so forever; and finely marked they are, being foreign.--[Gold-fish introduced from China.]--So to supper at home and to bed, after many people being with me about business, among others the two Bellamys about their old debt due to them from the King for their victualling business, out of which I hope to get some money.

In his various editions of Pepys' diary, Lord Braybrooke made a large number of notes but in many instances the notes were altered and added to from later information. This is the case with regard to the goldfish note in brackets. Therefore we do not know whether to attribute this note to Braybrooke, John Holmes of the British Museum who assisted Lord Braybrooke, Henry B. Wheatley, or to one of the many authorities Wheatley consulted during his own editing.

It seems strange that, if it were a paradise fish, Pepys would have commented on either the striking coloration of the fish or its conspicuous finnage. All throughout the diary Pepys commented on both English and foreign fisheries and would have, for the day, a commanding knowledge of fish in general. On the other hand, Pepys comment that they were "finely marked" suggests a paradise fish more than a goldfish.

It should be noted that my interest in the Pepys affair was not in the first introduction of the goldfish into the Western Europe but in whether the fish Pepys saw was a goldfish or a paradise fish. However, this did prompt me to post the following.

Post by Albert Klee, May 13, 2004
Finding the date of the first importation of goldfish into the Western world is difficult, to say the least. In his "A History of British Fishes," London, 1836, William Yarrell states the following:

The date of the first introduction of the Gold-

Samuel Pepys (1633–1703).

en Carp, or Gold and Silver Fish, as they are more frequently called, is differently stated by authors: 1611, 1691, and 1728, are each recorded as the particular year in which they were first brought over. The earliest seen in France were sent there for Madame Pompadour. A correspondent in Loudon's Magazine of Natural History, vol. iii. page 478, considers "that they were probably introduced into Portugal at an early period, after the people of that country had discovered the route to the East Indies by the Cape of Good Hope, as they appear to be now completely naturalised there, and abound in many of their streams, whence they are brought to us by trading vessels from Lisbon, St. Ubes, &c. in large earthen jars, and may be had at a very easy rate before they get into other hands."

In his "Natural History of British fishes: their structure, economic uses, and capture by net and rod," London, 1880, Frank Buckland had this to say about the goldfish:

This fish originally came from some lakes near the mountains of Tchanghou-the-Kiang. It is said to have been introduced into England in 1611, in the ninth year of the reign of James I. Another story is that it was introduced from China to St. Helena, and thence brought to England in 1728, the second year of the reign of George II. I have searched in vain to find any authority for any of these statements, and should be very much obliged for the information.

Some aquarists cite Gustave Loisel (1864-1933) in his "Histoire des menageries de l'antiquite a nos jours," Paris, 1912 where he states that goldfish were introduced into England by 1611, Portugal in the 18th century, and from there through to France and other European countries. However, the Portuguese had, with the concurrence of the Chinese, established themselves in Macao in 1549 and not only started to raise birds but also "red fishes" and, by 1611, it is known that they were shipping goldfish from Macao to Portugal. Loisel, therefore, is not a reliable source.

It is of some interest to note that in 1643, that Jesuits established themselves in Hang Zhou, China, where their church was located close by a "local farm of red fishes." This took the fancy of a man known only by his last name of Martini, who took an interest in the fish and brought back 10 of them to Holland.

The 1611 date of importation into England actually was advocated by the great German ichthyologist, M. F. Bloch, and we know that the 1728 date is associated with the importation of the goldfish into France presumably as a present to Mme. de Pompadour, although the de Goncourts, the historians of the mistresses of Louis XV, have failed to trace any records of this event. The latter, therefore, may just be another aquarium myth. Sir John Hawkins, the noted editor of Izaak Walton and Charles Cotton, wrote in 1760:

There has also been lately brought hither from China those beautiful creatures, Gold and Silver Fish. These fish are usually kept in ponds, basins and small reservoirs of water,

Francis (Frank) Trevelyan Buckland (1826–1880).

to which they are a delightful ornament; and I have known a few of them kept for years in a large glass vessel like a punch-bowl.

No matter how one interprets the word "lately," Hawkins was certainly not talking about any importation earlier than the 1728 date.

Re the Paradise fish, it is known that it was introduced into Paris, France, in 1868. It was introduced in this country in 1876, long after goldfish were introduced here. In 1852, for example, a Chinese merchant named Fang Tang immigrated to the United States and opened up a teashop in San Francisco. In addition to selling silks and porcelain, he also sold goldfish that he had brought over with him.

Post by Harro Hieronimus, May 13, 2004
Sorry, but I don't believe that [here Harro is questioning the 1911 date]. That's 200 years too early for this fish. It's unlikely that fish were imported which had to be caught in the wild. Goldfish had been kept in bowls (not like that ones we know today, but larger ones like large cups to be observed from above) since then.

[Harro had to be right but I wasn't happy about it. If Bloch was wrong then the next "popular" date was 1691 and this would have placed the importation of the goldfish into Western Europe much later than Pepys' visit to Lady Pen on May 28, 1665 and I would have had to abandon my planned refutation of Pepys' fish being a goldfish. I vacillated about this a bit until I suddenly remembered my research 44 years previously when I discovered that Bloch erroneously reported Pennant's 1691 date as 1611. I was about to write a post about this when Lee Finley posted the following:]

Post by Lee Finley, May 16, 2004
The early goldfish importation topic is one dear to my heart and I am glad to see it being fleshed out on AHHS. I would like to make a couple of comments and the first one regards the oft stated import date of 1611 (as noted in Al's post).

Hervey and Hems in their book "The Goldfish" (I am working from the revised 1968 edition) offer the following (page 79): "Bloch [in his book] records that goldfish were introduced into England in 1611, and he cites Pennant's British Zoology as his authority. But, as Pennant gives the year as 1691 it is clear the Bloch's 1611 is a misprint, even if we did not know that misprints were very common in eighteenth-century books."

Hervey and Hems go on to also question the 1691 date, but this is (admitted by them) based on somewhat shakier ground involving a potential transposition of Roman numerals in a date from another source. If their thoughts on this are correct, the date should have been 1711.

But, Hervey and Hems do cover their bases somewhat by noting "That there is some indirect evidence to show that goldfish [from Macao]....reached London in 1692." And, they also wisely state that "A few isolated specimens may even have been brought to England by travelers or sailors in the middle of the seventeenth century."

**Jack Hems (?1911-1989).
In his younger days he had been friends with and worked together in London with George Bernard Shaw.**

The authors also offer some question to the exactness of the 1728 date for importation. They base this thought on a checking of the records of the ship [The Houghton] reported to have brought the goldfishes to England. According to the authors, the ship did not return to England until 1730. A small point, but it is one well worth considering for history purposes.

The main problem in trying to lock down dates for various goldfish imports, to my mind, is the paucity of (and extreme difficultness in locating) original source materials. In regards to this, I would like to make a few comments on the 1728 date (which is admittedly, to my mind, not a date of "first importation").

A couple of years ago I was fortunate to obtain an original copy of the November, 1765 "The Royal Magazine" [Great Britain]. Included in this issue is an article, as part of a natural history series, on goldfish. Unfortunately, no author is listed. The article credits the "Houghton Indiaman" as the ship bringing "...a large number of them [goldfish]..." to England in 1728. This, I must assume, is the same ship as noted by Hervey and Hems. One statement in the article stands out to me: "These fish were not generally known in England till the year 1728..." I see no interpretation for this other than they were known in England prior to 1728 (or 1730, following Hervey and Hems)...just not "generally". Although this article is not any more specific, it does keeps taking us "backwards" in the origin of goldfish imports into England. I am one who believes that there were multiple (mostly unrecorded, no doubt) shipments of goldfish to England, and elsewhere, in the seventeenth Century. Just trying to find written records of these is the challenge. (There was also a nice hand colored engraving of a goldfish accompanying the article. I have placed a scan of this in a photo album on the AHHS site for your possible interest. It is titled "Goldfish 1765").

A personal comment or two on the Hervey and Hems book: From the starting point of investigating Western goldfish history it certainly should be considered a primary source. But I will emphasize "starting point", as many problems and poor information are evident. Their section on goldfish history in America is nothing short of atrocious. And, based on the fascinating material posted on this site by Al regarding Martini taking 10 goldfish to Holland in 1643, Hervey and Hems also fall very short in this area by offering an import date of "...1753 or 1754."

Well, off for now. I will follow up in a separate post with some comments on goldfish in America.

Excerpt from a Post by Lee Finley, May 17, 2004

In a wide variety of North American literature of the 1820's and 1830's, and later, it is not difficult to find mention of goldfish. They were already living wild in many places and were also firmly established as pets (by 1833 there was a person in the environs of Boston who was producing and

Lee Finley has been an aquarium hobbyist for at least 47 years. He has regularly written on various aquarium topics over the past 40 or so years and has over 345 published articles to his credit. He is considered to be one of the most accomplished historians of the aquarium hobby.

selling a dry goldfish food made from flour and egg yolks). Prior to this time frame, finding information becomes a bit more of a challenge.

Joseph Schlagheck, a pet dealer from Toledo, Ohio, noted in a charming little 1919 book titled "Gold Fish And Their Friends And Song Birds" that goldfish were imported "In 1786, or thereabouts...." "...by some Hollanders..." Although an interesting date, this was without question late in the game. Possibly this "introduction" referred to some more "fancy" goldfish.

I recently found an interesting early reference to gold fish that has a connection to Rhode Island (where I live). It seems that one Godfrey Malbone (who is described as being either the wealthiest, or one of the wealthiest, men in town) built in the middle 1840's his Newport RI country house on a sloping 600 acre parcel at the entrance to the harbor, that was described as being "...famous as the finest residence in the colonies." Malbone, who was a strong Tory (yet had a secret tunnel built to bring in some goods, thereby avoiding having to pay duty on them), made his money from a combination of slave and molasses (to be converted into rum) trading. At the time this was known as the triangle trade....the colonies were the base and west Africa was used for gathering slaves and the West Indies for sugar. The ornamental gardens at his home are described as "elaborate" and, in addition to numerous native plants and trees, boasted much tropical vegetation (for the summer at least!) from the Caribbean islands. Artificial ponds were included in the gardens, and in these swam "...silver and gold-fish..." No hint as to the origin of these fish is given, but it does firmly place goldfish into the middle eighteenth Century of North America.

[These posts pretty well finished the Pepys discussion and that of the first goldfish introductions into Western Europe issues on the Yahoo site. In summary, two things came out of it. (1) I found a record of the first importation of the goldfish into Western Europe and (2) Lee found a record of the first importation of the Goldfish into the United States.

With regard to Godfrey Malbone, I had discovered this information independently but only published my findings in the foreword, "A Perspective on the Early Aquarium Hobby in America," in the Third Edition of my Toy Fish book, a six-year project that started in 2003 and ended in 2009. Unlike Lee's post I presented references and whittled down the date to 1747 as the earliest introduction of goldfish in America. As they took very different approaches, it is interesting to compare Lee's version with mine (which is also in the Fourth edition of "The Toy Fish."

With regard to Martini, this involved research over a period of two years. There is a detailed discussion of his life and his importation of the goldfish into Holland in 1643 in my essay, "The Mystery of Lady Pen's Fish (Klee, 2016).]

This is an oil painting by John Greenwood made between 1752-1758. It depicts a humorous scene in a tavern in Surinam, with many merchants and sea captains from enjoying themselves. The work was commissioned by the subjects while visiting the important trading ports in Surinam in the 1750s, probably for their own amusement. Two sailors are dancing, giving a dancing lesson to the young Godfrey Malbone in the brown coat.

Note: I have long considered Lee Finley and James Atz the finest aquarium hobby historians I have ever known. Over the years Lee and I have occasionally been competitive but we shared things as well. For example, as I was pursuing the holdings of the Library of Congress while these exchanges were taking place, I noticed that they held an article with goldfish in the title published in 1800. I told Lee about this and that I was ordering a hard copy of it. When I received the article, it was about goldfinches, not about goldfish! I was astonished that the Library of Congress had made a mistake like that. I was out about $11 dollars for it but both Lee and I got a big laugh about it.

Before I go on to the next section, the following is the post made by Ted that started the AHHS in style as a Yahoo Group.

Post by Ted Coletti, April 12, 2002
Welcome Charter Members and Visitors to the very first message post of the newly formed AQUARIUM HOBBY HISTORICAL SOCIETY (AHHS; pronounced "Oz," which is where many of us reside at times).

As AHHSies (pronounced "Ozzies") we have a quirky but important task ahead of us: to record and interpret the history of this North American aquarium hobby.

It has been nearly 150 years since New Yorker William Emerson Damon and his sister visited P.T. Barnum's "aquarium" in the mid-1850's and became the first known U.S. aquarium hobbyists (feel free to debate this point–that's why we exist). So much has changed since that time, but only a handful of historical narratives exist about the hobby. Almost non-existent are biographical sketches of personalities
who have developed this great pastime of the little glass box. That's where we come in.

The interest in the history of the aquarium hobby is definitely growing. Thanks to both the current "aging" demographics and subsequent "need" for nostalgia; the advent of the New Millennium, which ironically draws so many of us to the past; and the availability of vintage aquarium literature, equipment, and other memorabilia through the internet. Oh yeah...Wayne and Lee, you've helped spark this new interest too with your writings and dramatic performances (although I think the nude version of your play at one of the recent Conventions was lost on most of us).

So...Is there something you've always wanted to know about a person, place, or event in hobby lore? Do you have a question about a piece of rare aquarium literature? Maybe you want a walk-on at Wayne & Lee's next performance?

LADIES & GENTLEMEN, LET'S START THE HISTORICAL RECORD!
Ted

Ted Coletti has been a hobbyist for over 30 years. A writer and teacher by passion, Ted has penned over 200 articles and columns, and a book, and has presented programs on various topics around the country. In 2002 he founded the Aquarium Hobby Historical Society of America. The Group meets on Facebook and has close to 1,000 members. He maintains a collection of historic hobby literature and artifacts.

[Bel lavoro, Ted! Ti dobbiamo tutti un grosso debito di gratitudine per tutto quello che hai fatto per la storia dell'hobby dell'acquario].

C1. THE REPUBLIC OF LETTERS

Although it had a long history, the Republic of Letters emerged in the 17th century as a self-proclaimed community that stretched across national boundaries but respected differences in language and culture. These communities that transcended national boundaries formed the basis of a metaphysical Republic. The circulation of handwritten letters was necessary for its function because it enabled intellectuals to correspond with each other from great distances.

One person would write of a discovery to someone else, who would then pass it along to others. This network built organically over time, consisting of people from all over the continent, England, and eventually America, primarily in Philadelphia. It was not directed from a central place, and there was no inherent hierarchy. Anyone could contribute, and many ideas that might have been considered fanciful, or perhaps even crackpot, were able to make their way into the network. The filtering of these ideas for quality came in a sort of emergent democratic process; if you thought an idea was good, you passed it along to others. If it was clearly mad, you did not bother. It was by no means a perfect method, and many potentially useful notions were relegated to the wastebaskets of the elite. But, importantly, it did not rely on any centralized authority to make decisions about what was important.

The Republic consisted of scholars and scientists who worked as professors, secretaries, courtiers, physicians, lawyers or whoever was rich enough to support themselves. They formed a flexible, self-regulating and international conglomerate of networks spanning the whole of Europe. People became part of this community by the very act of writing letters: those scholars who failed or refused to establish sustained lines of communication could not be reckoned as citizens of this Republic. It was like social media today: if you are not connected, you are not part of it, however 'social' you might be as a person outside the medium of communication.

Its members shared information about work-in-progress and published books; they gossiped about colleagues and recommended students, they reflected on the politics of universities, princes, and the church, and they reported on family matters and their health. Letters were meant to be answered: reciprocity was a vital principle, and the letter writers honored the cult of communication. Idealism and pragmatism converged in the tendency of scholars and scientists to ignore political and religious differences with their correspondents. They often even avoided making explicit that they respected other people's different backgrounds, as it was wiser not to draw attention to what divided them. After all, for the exchange of texts, objects and ideas, it was more effective to seek common ground with one another than to stress differences. Thus, modesty, friendliness, openness, constancy, patience, forgiveness and industry were upheld as the moral codes of the Republic of Letters although it was not always effective; cases of insults, plagiarism and other code violations did occur at times.

C2. JAMES PETIVER

For upwards of thirty years after 1685, James Petiver (1665-1718) was the proprietor of an apothecary shop London. During these years this address became familiar to brother apothecaries, shipmasters, merchants, planters, physicians, sur-

James Petiver (1665-1718)

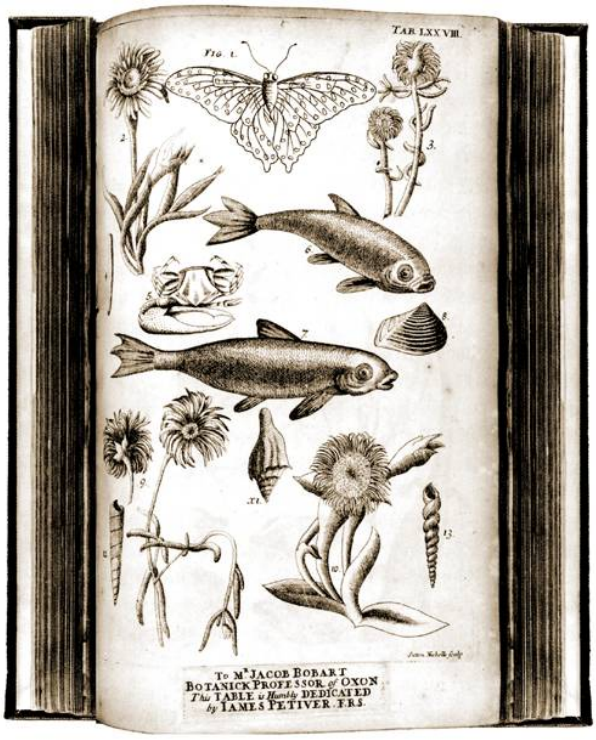
geons, ministers of the gospel, consuls, ambassadors, privy councilors, peers of the realm and foreign gentlemen of various degrees extending from Moscow to the Cape of Good Hope and from the British Colonies in the New World to the Spanish settlements in the Philippines.

From this shop were dispatched thousands of letters and queries, occasional bits of medical advice together with shipments of drugs and nostrums, newssheets, scientific pamphlets and books, frequent consignments of brown paper, wide-mouthed bottles and detailed instructions for amateur naturalists and collectors who had set forth–or were on the point of setting forth – to nearby English counties or to far-off foreign lands. To this shop were addressed other thousands of queries – most of them pertaining to the scientific identification, description, classification, use, habitat, collection, and preservation of botanical specimens and other items of natural history – and hundreds of consignments of seeds, dried plants, insects, serpents, birds, fishes, and small animals for the collections of Mr. Petiver and his friends, whose appetites for such things were insatiable. In this shop were assembled, besides the stocks of herbs and medicines common to a busy and prosperous apothecary, one of the largest and most varied collections of specimens of the natural history of the world that existed in England during the early years of the eighteenth century.

Almost no one who went abroad, especially if he were formally educated or professionally trained (whether in scientific subjects or not), was immune from Petiver's entreaties. Friends, friends of friends, customers in his shop at the Sign of the White Cross, fellow apothecaries, physicians, surgeons, ship captains, merchants, planters, and missionaries – all were asked to collect for Petiver and to enlist the services and correspondence of other persons dwelling in the lands they visited. Petiver supplied them with detailed, printed instructions as to what to collect and how to preserve and pack the specimens for shipment to England.

But not everyone was enthusiastic in their appraisal of Petiver. Their principal criticism stemmed from Petiver's practice of describing and of making illustrations of insects and other items in natural history from imperfect specimens. In his eagerness to collect rarities, Petiver had long been inclined to ignore imperfections and to be content with the most haphazard accounts of the origins and habitats of items received. In some measure, these shortcomings followed inevitably upon the dependence which Petiver and most of his fellow naturalists of that day placed upon dried specimens collected by amateurs who, in many cases, were incapable of supplying scientific data with regard to habitats, growth cycles, and the like.

Petiver was short-tempered and on at least one unhappy occasion he lost one of his best scientific correspondents because of an intemperate pen. The case was that of Samuel Brown of Fort St. George, with whom Petiver had conducted an exceptionally rich exchange since 1690. In 1698, after Petiver had angrily accused Brown of negligence and want of gratitude, as well as with tampering with one of Petiver's shipments intended for another person. Brown wrote sadly to point



From Petiver's *Gazophylacium naturae et artis* showing the silverfish and goldfish he obtained from China.

out that the ship by which he had intended to send his collections to Petiver had been "unexpectedly dispatched from Bengali (and did not return again)"; that he had inspected the shipment which had been misdirected (being intended for the Cape of Good Hope) only in the hope of speeding its delivery to the proper consignee; that "'twas the will of Providence to take from me the friendship of the only person in England whose Correspondence I coveted & on whom I could firmly confide"; and that "I intend to make a clear house and to have no more to do with Botany."' In spite of Petiver's apology for his "passionate expressions" born of disappointments "which my nature cannot easily brooke," he found his scientific correspondence with Brown to be terminated.

In 1703, Petiver had embarked upon putting together a book entitled *Gazophylacii Naturae et Artis*, *Decades Decem* with engravings of animals, insects, plants, and fossils, with short descriptions of them, and with the usual "gratefull" acknowledgments to donors. Five of these "Decades" appeared between 1702 and 1706. In 1711, Petiver stated in the second volume that he possessed "China Silver-tail" and "China gold-tail" fish "brought hence alive." John Henry Gray explained the names in his book, "China: A History of the Laws, Manners, and Customs of the People" (Gray, 1898):

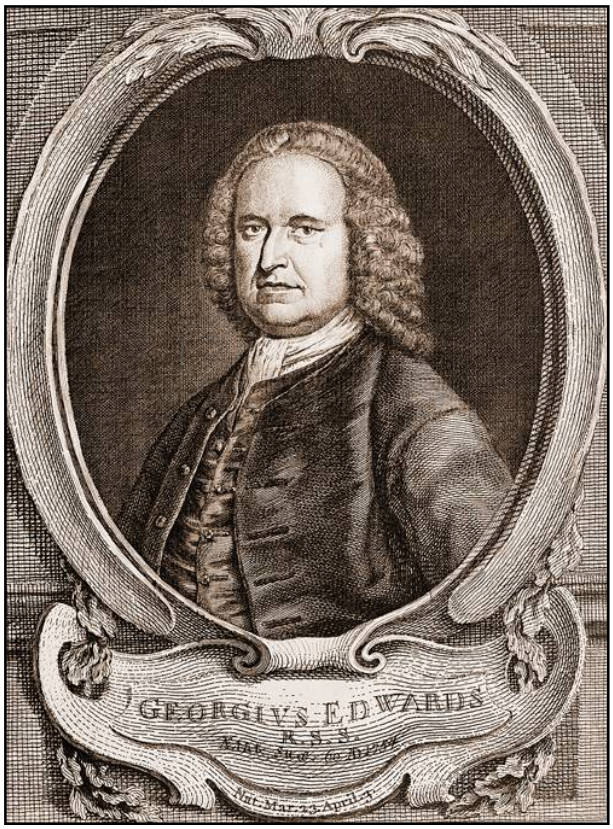
During the first four hundred days of their existence, the fish are black. For several days after this period they are marked with gold or silver spots. Eventually this speckled appearance gives place to that bright golden hue, for which the gold-fish of China are so justly celebrated.

The *Cyprinus auratus*, or gold carp, is the most beautiful gold-fish which the Chinese possess. It is indigenous to the country and, according to Pennant, was introduced into England towards the close of the seventeenth century....In China, silver-fish are of greater value than gold-fish, a circumstance which is probably due to their comparative rarity.... The Chinese do not value gold-fish which have dorsal fins. When provided with such an appendage, they are called Tsak-Yu-Chu. Those which are of greatest value in their estimation are the Chan-Chu-Tun, or pearly-scaled fish.

Therefore, this importation of live goldfish in 1711 is the first recorded for England. It is not known from whom he got his goldfish, where they came from or how they were sent to them. As Roos points out, Petiver knew James Cuninghame, an East India Company surgeon in China so is possible that the fish made their way to London with a member of this group but as it is only a surmise these questions remain unanswered (Roos, 2019).

C3. GEORGE EDWARDS

George Edwards (1694-1773) was a Fellow of the Royal Society and Fellow of the Society of Antiquaries in London who rejected his early formal training and potential career in business to pursue his passion in natural history. His publisher, describes him as follows (James Robson, 1776):



George Edwards (1694-1773).

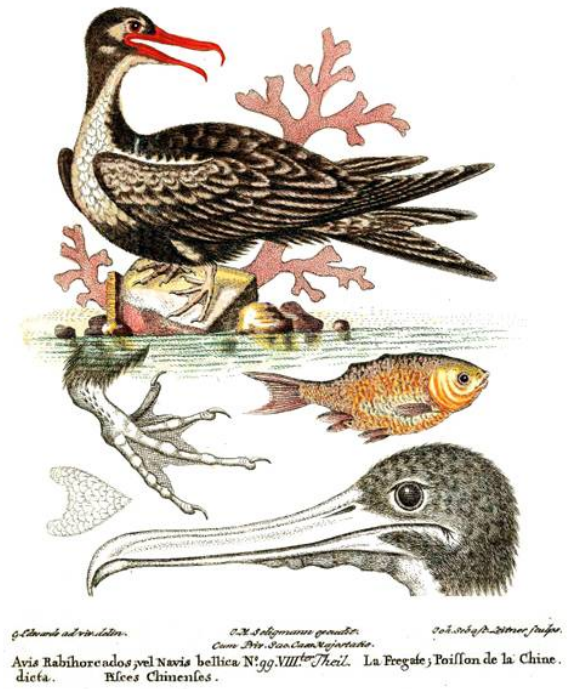
Mr. Edwards was of a middle stature, rather in-clined to corpulence: of a liberal disposition and a chearful conversation. All his acquaintance experi-enced his benevolent temper, and his poor neigh-bours frequently partook of his bounty. His diffidence and humility were always apparent, and to persons who had a taste for studies congenial to his own, he was a most entertaining as well as communicative companion.

His dedication and talent as a draftsman and naturalist was evident, thus gaining the attention of Sir Hans Sloane, President of the College of Physicians and the Royal Society. Sir Hans offered Edwards the post of Librarian of the Royal College of Physicians in London, and enlisted him to draw the natural curiosities of Sloane's private museum. This connection became the inspiration for Edward's two masterful achievements, the first being "A Natural History of Uncommon Birds," published between 1743 and 1751 (it was sold for £15,000 in 2019). This work looked not only at birds, but also at mammals, fish, reptiles and insects. However, the ornithological part of the book made up the majority and is the part for which Edwards earned his reputation. The descriptions written by Edwards were celebrated for their accuracy, so much so that Linnaeus would later use them to name around 350 bird species when preparing his *Systema Naturæ*.

His subsequent work, "Gleanings of Natural History," was produced between 1758 and 1764. These two works illustrated and documented many previously unrecorded specimens of birds, reptiles and insects held in England's private collections up to the mid eighteenth century. A monumental achievement, Edwards documented – both in English and in French – painted, engraved and hand-colored every one of the fine compositions in this Pre-Linnaean natural history opus. Such was the impact of "Natural History" and "Gleanings" that Edwards is considered to have almost single-handedly popularized the art of bird and animal illustration, and is thus known as "The Father of British Ornithology." Although not a field naturalist, Edwards placed many of his birds and animals in landscaped settings, which was unusual for the time. In other compositions birds are elegantly perched on stylized branches in a classic Georgian format, more decorative than realistic, but charming nonetheless. The following describing goldfish and providing some dates is taken from his 1751 "A Natural History of Uncommon Birds":

Out of a great number of these fishes, which were variously coloured and variegated, I have chosen the four subjects represented here of their natural bigness, tho' there are some larger, and others a good deal less. The largest I have met with measur'd eight inches in length, and near three inches in depth over the thickest part of its body; this had no fin on its back. Ii have observed many of the small ones also to be without fins on their back. These fishes are shaped pretty much like the carp, of which genus I take them to be a species; their nostrils rise out of their

Drawings of China goldfish From George Edwards' Natural History of Uncommon Birds and of Some Other Rare and Undescribed Animals (1743-1751).



A picture of George Edwards' study of a frigate bird with a Chinese goldfish below.

heads like the ends of little pipes. All that I have seen had three pair, or six fins, on their under sides; on the upper sides some are without, and others have them in various forms, as represented in these figures; some of them have angle tails, and others have them double, and joined together on the upper edge, as the third figure from the top shews. The upper figure is blue on the back, and back-fin; the rest of the fish is of a gold-colour; these colours break into each other on its sides; the tail is dark brown. The second fish is all over of a gold-colour, except a black spot on the head. The third fish hath its upper side, double tail, and lower fins of a gold-colour; the belly of silver; which two colours mix confusedly on its sides; it has some black spots on its fins and tail. The lowermost, or fourth fish, hath its upper side dusky, and its under of a silver-colour, which soften into each other on its sides; its fins and tail are dusky.

His Grace the late Duke of Richmond had a large Chinese earthen vessel full of these fish, brought alive to England. I drew some of them for his Grace, who permitted me to make draughts for myself, with leave to make them publick. The first account of these fishes being brought to England may be seen in Petiver's Works, published about Anno 1691. See his Catalogue, 186, Piscis Chin. Caudâ argenteâ, Plate 78, Fig. 6 and Catalogue 187, Piscis Chin. Caudâ aureâ , Plate 78, Fig. 7.

The second Duke of Richmond, Charles Lenox (1701-1750), was born at just the right time for someone with an enquiring mind. The Age of the Enlightenment transformed scientific thinking and dominated the eighteenth century. Richmond was part of a large circle of friends and relations whose influence can still be felt today. The Duke had a menagerie where he kept many exotic animals including a lioness, tigers, bears, monkeys, eagles and ostriches. Much of Richmond's influence was through his patronage of authors, particularly in the field of natural history. By acting as

The second Duke of Richmond, Charles Lenox (1701-1750).

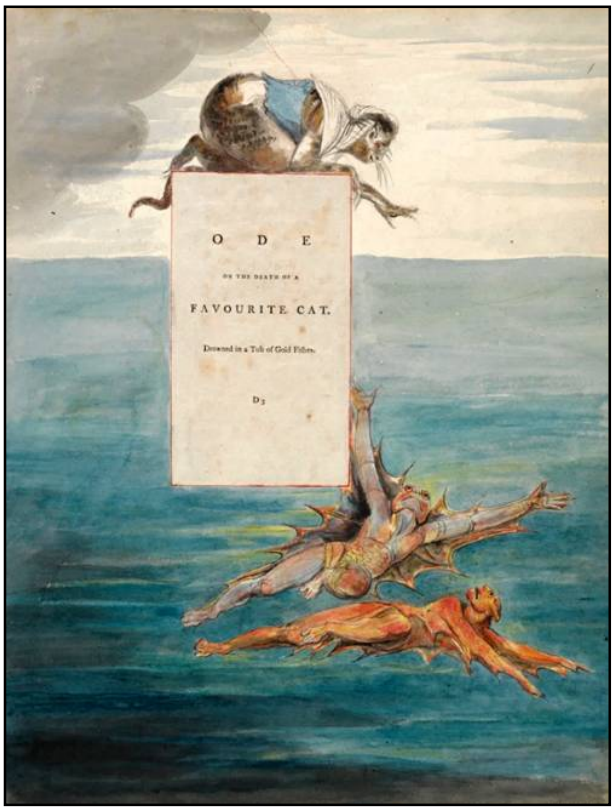
Historian and author Horace Walpole (1717-1797).

a subscriber, he was not only supporting people financially, but also encouraging and fostering talent. He was a subscriber to Mark Catesby's a *Natural History of Carolina*, published in two volumes in 1731 and 1743. This ground-breaking publication opened peoples' eyes to the beauty of American flowering trees and shrubs meticulously observed in Catesby's colored engravings. Another author Richmond supported was George Edwards whose *Natural History of Birds* was published between 1743 and 1751. As French was the international language, Edwards also published a two-volume French edition, *Histoire Naturelle de Divers Oiseaux* (*Natural History of Various Birds*), the first volume (1745) being dedicated to the duke and the second volume (1748) to the duchess.

The historian and author Horace Walpole (1717-1797) also had a large Chinese jar of goldfish located in the Great Cloister of his Strawberry Hill house. Walpole's approximately nine-acre garden at Strawberry Hill, re I) developed between 1749 and 1797, featured a collection of Gothic architectural elements, most notably a small chapel, as well as flower beds, a series of ponds, and other sculptural and decorative features. Everything that he turned his mind to in Strawberry Hill he regarded in a spirit of comic delight. He stood outside himself, like a spectator, and nothing gave him more pleasure than to figure himself as a master of the ceremonies among the bantams, and the squirrels and the goldfish. In one of his letters he describes himself and Bentley fishing in the pond for goldfish with

"nothing but a pail and a basin and a tea-strainer, which I persuade my neighbours is the Chinese method." This was in order to capture some of the fish for Bentley, who "carried a dozen to town t'other day in a decanter."

The large Chinese jar of goldfish located in the Great Cloister of Walpole's Strawberry Hill house.



William Blake, illustration for "Ode on the Death of a Favourite Cat," in 'The Poems of Thomas Gray (1797-98), watercolor with pen and black ink and graphite on paper with inlaid letterpress page.

In 1747 Thomas Gray (1716-1771) commemorated the passing of his friend Horace Walpole's cat with the tragicomic poem "Ode on the Death of a Favorite Cat Drowned in a Tub of Goldfishes." Walpole had asked Gray for an epitaph for his favorite pet and Gray responded with a poem, the first verse of which Walpole had engraved on the Chinese vase (the "tub" of the poem's title) in which the dearly departed cat met her watery end. This poem gained Gay the recognition as a poet he had long been seeking for. Edwards continued with his report in "A Natural History of Uncommon Birds":

They were not generally known in England till the Year 1728, when a large number of them were brought over in the Houghton Indiaman, Captain Philip Worth, Commander, and presented by him and Manning Lethieullier, Esq; to Sir Matthew Decker: Since which Time they have been propagated in ponds by several curious gentlemen, in the neighbourhood of London. They may be esteemed a domestick fish; they vary infinitely in their colours and marks, as do all domestick animals; they have been propagated and greatly increased in the Island of St. Helena, from whence they are now brought by all our India ships that touch there. They keep them in small ponds and basons in China, for the amusement of the Ladies, and other curious persons. Those propagated with us are generally of a deader colour than what are brought from China, or St. Helena. In a few years it is probable, we finally have them in our rivers. The last author that has mentioned this fish is Linnaeus. See his Fauna Suecica , published at Leyden, 1746. He calls it Cyprinus Pinna Ani duplici, Cauda trifurca, exoticus Piscis aureus Chinensium.

Sir Matthew Decker (1679-1749) was born in Amsterdam in 1679 and came to London in 1702 where he established himself there as a merchant. He was remarkably successful in his business life, gaining great wealth and having many honors conferred upon him. He was a director of the East India Company and ultimately its chairman, sat in parliament for four years as member for Bishops Castle, and was High Sheriff of Surrey in 1729. He was created a baronet by George I. in 1716. Decker's fame as a writer on trade rests on two tracts. He proposed to do away with customs duties and substitute a tax upon houses. He also suggested

This is the drawing of the goldfish (upper right) in Linnaeus' *Fauna Suecica* of 1746.

Sir Matthew Decker (1679-1749).

taking the duty off tea and putting instead a license duty on households wishing to consume it. The second advocated the license plan in an extended form; urged the repeal of import duties and the abolition of bounties, and, in general, showed himself such a strong supporter of the doctrine of free trade as to rank as one of the most important forerunners of Adam Smith. The Decker estate at Richmond was described as follows:

The longest, largest, and highest Hedge of Holly I ever saw, is in this garden, with several other Hedges of Ever-Greens, Visto's cut through Woods, Grotto's with Fountains, a fine Canal running up from the River. His Duckery, which is an oval Pond brick'd round, and his pretty Summer-House by it to drink a Bottle, his Stove-Houses, which are always kept in an equal heat for his Citrons, and other Indian Plants, with Gardeners brought from foreign Countries to manage them, are very curious and entertaining. The house is also very large a -la-modern, and neatly furnished after the Dutch way.

Note that Edwards refers to Petiver's publication date as being 1691 (MDCXCI in Roman numerals) but the correct date is 1711 (MDCCXI in Roman numerals). Hervey and Hems present a plausible argument for this error, i.e., that Edwards accidentally transposed the C and X when he recorded the 1691 date. In any event, we can assume that the goldfish were well established (rather than just a few) by 1728.

C4. THOMAS PENNANT

Thomas Pennant (1726 –1798) was a naturalist, writer and antiquarian well known for his published accounts of pioneering tours throughout the British Isles and one of the foremost zoologists of his time. He was educated in Wrexham and Oxford. Pennant's publications on natural history include such works as *British Zoology*, the *History of Quadrupeds*, and *Arctic Zoology*. He was a fine observer in the field, and collected specimens of plants, minerals, birds and animals. But his knowledge of the natural world also came from a wide international network of leading scientific figures of his day – his correspondents included figures such as Linnaeus, Joseph Banks

Sir Thomas Pennant (1726 –1798).

and Gilbert White of Selbourne. He was a passionate antiquarian, with an interest in the Roman remains and artefacts around Chester and a deep curiosity about the British past. An enthusiast for economic improvement and a champion of burgeoning industry (he opened a lead-mine on his own estate) Pennant was politically conservative, becoming more reactionary in the decade of unrest after the French Revolution. His writings nonetheless reveal a thoughtful and generous-spirited man with a social conscience, who was deeply moved by the conditions of poverty he encountered on his travels.

The following is taken from the goldfish section in his "British Zoology" (Pennant, 1760):

These fish are now quite naturalized in this country, and breed as freely in the open waters as the common carp.

They were first introduced into England about the year 1691, but were not generally known till 1728 when a great number were brought over, and presented first to Sir Mathew Dekker, and by him circulated round the neighborhood of London, from whence they have been distributed to most parts of the country.

In China the most beautiful kinds are taken in a small lake in the province of Che-Kyang, Every person of fashion keeps them for amusement, either in porcellane vessels, or in the small bafons that decorate the courts of the Chinese house. The beauty of their colors, and their lively motions, give great entertainment, especially to the ladies, whose pleasures, by reason of the cruel policy of that country, are extremely limited.

In form of the body they bear a great resemblance to a carp. They have been known in this island to arrive at the length of eight inches; in their native place they are said to grow to the size of our largest herring. The nostrils are tubular, and form fort of appendages above the nose: the dorsal fin and the tail vary greatly in shape: the tail is naturally bifid, but in many is trifid, and in some even quadrifid; the anal fins are the strongest characters of this species, being placed not behind one another like those of other fish, but opposite each other like the ventral fins.

The colors vary greatly; some are marked with a fine blue, with brown, with bright silver; but the general predominant color is gold of a most amazing splendor; but their colors and form need not be dwelt on, since those who want opportunity of feeing the living fish, may survey them expressed in the most animated manner, in the works of our ingenious and honest friend Mr. George Edwards.

Pennant repeated Edward's error in reporting the first goldfish importation into England as 1691 and so Pennant is not really a source. However,

Catherine Maria Fischer (1741–1767), known as "Kitty Fisher," was a prominent British courtesan. This painting was made in 1765 by Nathaniel Hone and is probably the first of these iconic goldfish bowl images.

he indirectly caused a dating problem that I will address in the next section.

C5. MARCUS BLOCH

Marcus Elieser Bloch (1723-1799) was a German physician and ichthyologist, but academic prowess was anything but inevitability in his life. His parents, being very poor, gave him hardly any education so that on arriving at manhood he was almost illiterate, and till the age of nineteen could not even read German. Some knowledge of Hebrew and rabbinical literature enabled him, however, to obtain a teacher's position in the house of a Jewish surgeon in Hamburg. Here he learned German thoroughly and mastered some Latin, taking up also the study of anatomy. Scientific enthusiasm being thus aroused, Bloch went to Berlin, where, with remarkable zeal, he devoted himself to the study of all branches of natural science and medicine, being supported by some relatives. After taking the degree of Medical Doctor at Frankfort-on-the-Oder in 1747, Bloch settled in Berlin where he subsequently worked as a physician.

Bloch was well into his fifties when his ichthyological hobby became his main academic focus. He concentrated on local fish in the beginning, publishing a couple of minor books on the subject. In about 1781-3 he began to release what would ultimately become the most important (and beautiful) study of fish published in the 18th century. It was one of the first wide-ranging ichthyology works that both provided detailed species descriptions and adhered to Linnaean principles. Although inaccuracies surfaced (particularly with non-German fish) and observations were eventually superseded, the series was generally serviceable and regarded as the standard for a century or more.

Between 1782 and 1795 he published his *Allgemeine Naturgeschichte der Fische* (General Natural History of Fishes), a 12-volume, beautifully illustrated comprehensive work on fishes. The first three volumes describe fishes in Germany and were entitled *Oeconomische Naturgeschichte der Fische Deutschlands* (Economic Natural History of Fishes in Germany); the remaining volumes dealt with fishes from other parts of the world and were entitled *Naturgeschichte der ausländischen Fische* (Natural History of Foreign Fishes). The overall series was enormously popular. Investors helped defray the publication costs of the second half of the series by sponsoring individual illustration plates which bear their names (just one of these books just sold for over $80,000 at an auction). Bloch's 432 hand-colored engravings are fair attempts at reproducing the bright natural coloring of the fish and some of the illustrations were heightened with gold, silver or bronze filings to imitate the metallic sheen of scales. Bloch published a couple of other multivolume series on fish, thereby cementing his place as one of the most important historical figures in eighteenth century ichthyology.

In Bloch's "Oeconomische Naturgeschichte der Fische Deutschlands" (Bloch, 1784), when talking about goldfish he writes:

Nach ersterem Lande ward er im Jahr 1611

Marcus Elieser Bloch (1723-1799).

gebracht, und 1728 war er daselbst schon allgemein bekannt. (It was brought to the former country in 1611, and in 1728 it was already well known there.)

He cites as the source Pennant's "British Zoology," Part III, p. 374, but as I explained in section A1, Pennant wrote 1691, not 1611 so this is either a misprint or an error. Unfortunately these two errors – 1611 and 1691 – have often been cited as the first introduction of the goldfish into England instead of the correct date of 1711.

D1. LINNAEUS AND THE GOLDFISH

Linnaeus was already interested in plants from early childhood. His father Nils Linnaeus had a lovely flower-garden with a remarkable number of plant species. However, he also kept domestic pigeons, which was still a rare habit among clergymen at that time. The young Linnaeus went as a poor student to Uppsala University in 1728 and studied medicine and natural history. As a student in Uppsala he kept many native birds, bought from local bird catchers, in his student room. A friend wrote that Linnaeus' room was "filled with branches and he kept 30 different kinds of tame birds there." Linnaeus himself wrote that he had tits, larks, sparrows, siskins and others in his chamber.

After graduating in Uppsala in 1732, Linnaeus went to Harderwijk in the Netherlands to get a doctoral level degree in medicine. This Dutch university was famous for awarding degrees very quickly and he was finished in two weeks (reminds me of our current slew of university diploma generators who grind them out for $25 each!). Instead he could focus on networking and improving his standing in the scientific world at that time. He was also employed as a curator at a private botanical garden and menagerie owned by George Clifford, director of the Dutch East India Company. The menagerie had many exotic animals, among them many birds and thus Linnaeus became well acquainted with parrots and other exotic birds. He returned to Sweden in 1738, becoming a physician in Stockholm. During his year in Stockholm he also kept birds at his home.

In 1741 the 34 year old Linnaeus was appointed Professor at Uppsala University and soon he also became responsible for the Botanical Garden (nowadays known as Linnaeus' Garden) in the city. He had to modernize the garden but also had to make a new home there where he and his wife raised a son and several daughters. He was obviously well acquainted with native birds in captivity, and in his zoological lectures he gave many interesting details about the qualities of many native birds as cage birds based on his own experiences. Starting in 1747, in his printed travelogue, Linnés föreläsningar öfver djurriket ((Linnaeus' lectures on the animal kingdom) he used several pages to describe not only these hybrids, which fascinated him, but also a kind of care-sheet for canaries (Lonnberg, 1913).

In 1750, at the age of 43 Linnaeus was appointed as Uppsala University's rector. In the 1750s Linnaeus had finally settled down. At his home near the Garden he had an extensive orangery and a large animal building. The Garden was well-established and he attracted many students not only from Sweden but also from abroad. Linnaeus had an enormous network and corresponded with everyone of importance within the scientific

Carl Linnaeus (1707-1778).

world. At the end of the 1750s he also started to acquire exotic mammals and birds to add to his menagerie. He already had peacocks in his garden and he also tried to keep a raccoon. To this he added various monkeys, lemurs, coati, agouti and other mammals, as well as parrots and other birds. Note that there is no mention of fish at this time, goldfish or otherwise).

During the summer his monkeys lived in "monkey huts." These were poles with a sort of little hut or house at the top. The monkeys were chained to the pole and could run up and rest or sleep there according to their desires. The first time I have seen a quotation from a reference incorporated into the title of the reference is in "Deras mistande rör mig så hierteligem: Linné och barns sällskapsdjur" ("Their loss touches me so dearly," *Linnaeus and his pets*), this is "This quote where Linnaeus is bemoaning the death of one of his pets reinforces the idea that he really cared for his animals (Svanberg, 2007).

D1. LINNAEUS RECEIVES PRESERVED GOLDFISH

In Sweden, the goldfish had been known since the 1740s. In 1739, Linnaeus helped found the Royal Swedish Academy of Science; he became the first Praeses (a Latin term meaning "placed before or "at the Head") of the academy by the drawing of lots. With the help of Swedish ambassador Nils Palmstierna, the Academy received a preserved goldfish that was described by Linnaeus in the *Proceedings* from the Academy in 1740. Interestingly enough, Linnaeus also published some information about its care. It was still a fish in Scandinavia kept in bowls, not in ponds, and it was recommended that it be given fresh water two or three times a week. It should be fed with biscuit, egg yolks, dried lean pork and small snails. It is however unclear if Linnaeus had any personal experience of live goldfish (which he actually might have had from his years in the Netherlands). However, the information he gives about the care of goldfish bears witness that he had at least received information from someone who knew. One of the depicted gold fish was obviously a fantail.

A close-up of one of the monkey huts.

Two of Linnaeus' "monkey huts"

Linnaeus never ceased to be fascinated by the beauty of the goldfish. In 1744, the merchant Carl Gyllenborg donated "Chinese goldfish" to Linnaeus, but they were preserved in ethanol. Linnaeus was eager to get hold of live fish. In November 1745, he wrote instructions for his pupil Christopher Tärnström that he should bring back goldfish for the Queen from his tour to East India. However, Ternström unfortunately drowned in south-east Asia and was never able to complete the task. Linnaeus's enthusiasm for the goldfish was undiminished. He received further preserved goldfish for his zoological collections from the royal court and King Adolph Fredric and his Queen probably kept goldfish in the ponds at the royal palace of Drottningholm.

D2. LINNAEUS' SECOND ATTEMPT TO OBTAIN LIVE GOLDFISH

In 1759, another opportunity arose for Linnaeus to obtain live goldfish. One of his pupils, the physician Pehr Bjerkén, was staying in London and kept up a lively correspondence with Linnaeus. He asked Bjerkén to find goldfish for him. Linnaeus became very enthusiastic when he received a letter telling him that Bjerkén had traced down a goldfish breeder, a colleague in England, Dr. Richard Guy. Guy was a physician in London known for (1) His essay on scirrhous tumors and cancers and (2) the histories of cases cured by him by means of Mr. Plunkett's medicine. The following is a review of Guy's essay that appeared in The Critical Review (Anon, 1759):

…such a precaution may be the more necessary in Mr. Guy, whose design in this essay is to recommend a nostrum for the cure of scirrhous and cancerous tumors. The bare mention of a secret remedy, or specific, is sufficient to impeach a man of ignorance and empiricism, unless he takes some such method to promulgate his knowledge. He accordingly, in the preface, gives us to understand, that he has been exposed to many invidious reflections of this nature. He tells us that as soon as he became acquainted with the surprising efficacy of Mr. Plunkett's medicine, he was seized with a desire to know the secret; which he accordingly purchased for a valuable consideration, under such restrictions as disable him from making it public, even though he should be disposed to throw away a considerable sum of money for the good of mankind. For our parts, we think he has a natural right to make the most of his own purchase; and if the medicine should be found really specific in those disorders, the legislature, upon proper application, will, no doubt, make it worth his while to discover it for the benefit of his country.

Guy charged about £50 to £100 for his cures; his medications proved quite profitable and so he was quite wealthy. At the time Sweden was experiencing quite a number of cancer cases in their population and the Swedish Health Commission was assigned the task of seeking better solutions. Bjerkén was impressed with Guy's successes:

The most important thing I can now name, and which I wish it were in my power to make public, is to sit down to cure the cancer. However, one of my neighbors in London, the surgeon Richard Guy, has made quite a reputation which deserves all possible attention. Dr. Guy bought a medication from a widower named Plunket, who inherited it from his father and grandfather, and who earned large sums of money from it in Ireland and in the surrounding country. Its reputation has increased in many different ways on a daily basis, especially since Guy improved his method of application and recently made complete cures on several persons of wealth and wealth, who have been under the care of the best doctors, as incurable. I have met several of his poorer patients, whom I never thought he would be able to help, who, however, have been

Pehr af Bjerkén, (1731-1774).

completely cured, without the slightest problems but always with the daily decrease of the cancer. The medication is applied externally to the cancer locally, as a simple vegetable in the form of a green powder, which for the sake of more convenience is applied in the form of unguent with some general digestive, and exchanged every other day or the 3rd day. It does not seem to attack the healthy part, but only the cancer itself, which gradually loosens; in fact, all its roots fall out after 4 or 6 weeks and leaves a good healthy wound behind, which is considered a general wound that needs no further need of the medication. He is a very modest and quiet man and has no natural gifts for a quack or charlatan.

Thus the Swedish Health Commission contacted Guy directly to purchase a quantity of Plunkett's medicine. This they did but he wanted £3000, which was considered a bit steep; furthermore he insisted that the medication itself was useless; it had to be applied by following Guy's methods. The biggest sticking point was that Guy would not reveal the composition of the medication. Nevertheless, he Commission agreed to these terms and the cost was paid – in public funds – by the Swedish Treasury.

When this news came out there was a public uproar about State paying so much for what some considered was nothing more than a nostrum. That Guy kept the ingredients of his powders a secret didn't help any. During this time Bjerkén acted as an intermediary between the Health Commission and Guy. By 1772 there were some cures or improvements in patient's conditions so that things quieted down except for the ingredients of the powder provided by Guy. Guy had confided in Bjerkén but swore him to secrecy. However, after Guy's death Bjerkén revealed that Plunkett's medicine consisted of *Clematis flammula*, fennel, sulfur and white arsenic, which with egg yolk was made into a sort of dough although it could also be used dry. Although physicians had long used arsenic for cancers and tumors, interesting enough, I found that *Clematis flammula* is also used today. I found several articles, including one of which was published in 2019 that I quote from here, "Overall, our data showed that *Clematis flammula* is a promising antitumor agent…," (Geusmi, 2010). Now back to Richard Guy and goldfish.

Guy had a pond at his country estate with 50 to 60 goldfish. He of course was very careful about what was then a rare fish, but Bjerkén persuaded him to donate a couple to the world-famous professor in Uppsala. Bjerkén brought them back by ship to Gothenburg. Linnaeus wrote impatiently in September 1759, "Do please send the goldfish already tomorrow with a vessel to Uppsala; they do not freeze that easily; so I will be able to once again see them, something I have dreamed of all my days but never hoped. Let the skipper ask what price he wants, only I get them alive". He finished the letter, "God give I had them alive in my orangery."

Bjerkén sent the goldfish together with detailed information about how to take care of them.

ABSTRACT, Letter 7 October 1759, Stockholm to Carl Linnaeus: Pehr af Bjerkén tells Linnaeus that he sent the goldfishes and the orang-outang with Johan Pihlström last week and that he hopes they have arrived safely. af Bjerkén tells Linnaeus in detail how to take care of the goldfishes and stresses the importance of changing the water and keeping

Horatio Henry Couldery (1832–1918)[1] was an English animal painter and illustrator noted especially for his depictions of domestic cats, kittens and dogs.

the tanks clean. af Bjerkén tells Linneaus that Richard Guy is a surgeon and a wealthy man and gives Linnaeus his address. af Bjerkén also tells Linnaeus that he has bought a secret drug against tumours for £3000 from Guy. At his estate in the country Guy has a big pond with 50 – 60 goldfishes and because of Linnaeus's good reputation he has given Linnaeus the biggest ones. af Bjerkén believes he might be able to get even more of them for Linnaeus. af Bjerkén tells Linnaeus that he corresponds with Guy and gives him Guy's address in London.

In October 1759, one fish was already dead, but the other specimen survived at least the winter and was alive the next year. Guy promised to provide Linnaeus with further specimens.

ABSTRACT, Letter 31 December 1760, Stockholm to Carl Linnaeus: Pehr af Bjerkén writes that in his latest letter Guy has promised to send new goldfishes to Linnaeus and that Daniel Solander will arrange the shipment.

The following year, Guy kindly sent new goldfish to Linnaeus, the famous naturalist Daniel Solander (botanist on Captain James Cook's first voyage and librarian for Joseph Banks, president of the Royal Society) arranging the shipment. In January 1761, Linnaeus writes to Bjerkén:

ABSTRACT: Letter 23 January 1761, Uppsala to Pehr af Bjerkén, Stockholm: Linnaeus writes to thank Pehr af Bjerkén for his letter [af Bjerkén to Linnaeus, 31 December 1760 and to tell him that he has not received a letter from Richard Guy. Linnaeus has, however, written to Guy to thank him for the goldfishes.

It is, however, unclear if Linnaeus received any more live goldfish from Guy after 1760 (Svanberg, 2007). Job Baster (1711-1775) was a Dutch physician and naturalist who devoted himself almost entirely to the study of medicine and natural history. In 1758, Baster was given a beautiful property loaded with trees and two large ponds. He called it Zonnehof (Sunshine Farms). As a new pond owner, Baster decided to try his hand at breeding Goldfish. A versatile scientist, Baster exchanged letters with the leading biologists of his time and the first twelve fish arrived thanks to a contact in England. Unfortunately, all the goldfish died. The following year, Baster got eighteen more fish. Two died, but the rest survived. Thirteen years later, Baster owned more than a thousand goldfish. He was a Linnaeus worshiper and in 1751 he wrote the following letter to Linnaeus:

Letter November 29, 1751, Zierikzee to Carl Linnaeus, Uppsala
Job Baster has for a long time wanted to establish a contact with Linnaeus, and through Ulrich Hemmingson he has got an opportunity to contact Linnaeus and to make himself known. He is very much devoted to Linnaeus's methods and very willing to do what Linnaeus may ask of him. Every now and then, Baster receives seeds or new plants from friends living in the western continents, and sometimes also from East India. If Linnaeus would be pleased to be informed of or to receive a share of those, Baster will be glad to do his best in that direction.

Statue of Job Baster (1711-1775) holding a goldfish. Baster was a Dutch physician and naturalist who devoted himself to the study of medicine and natural history.

The house where Linnaeus lived is in the garden and is now a museum. In the 1920s the garden was restored to its Linnaean character. Constructed between 1742 and 1743 the Orangery was designed (with an advanced heating system) to house plants unable to tolerate Sweden's harsh winter climate.
FOREGROUND: Lacustre or Lake pond.
MIDGROUND: Orangery attached to house.
BACKGROUND: Linnaeus' house.

Some years later Baster wrote another letter to Linnaeus, this time concerning goldfish:

ABSTRACT, Letter September 1, 1763?, Zierikzee to Carl Linnaeus, Stockholm:
Baster has a lot of goldfish in his ponds, and they have withstood the winter cold. Baster will be glad to send some to Linnaeus if he can find some means to send them quickly and safely.

This was the only letter regarding goldfish that Baster sent to Linnaeus so it is commonly assumed that he could not find a suitable way to send them. However, a more plausible reason is that by 1763, Linnaeus had already secured sufficient live goldfish, either from Richard Guy or from someone else.

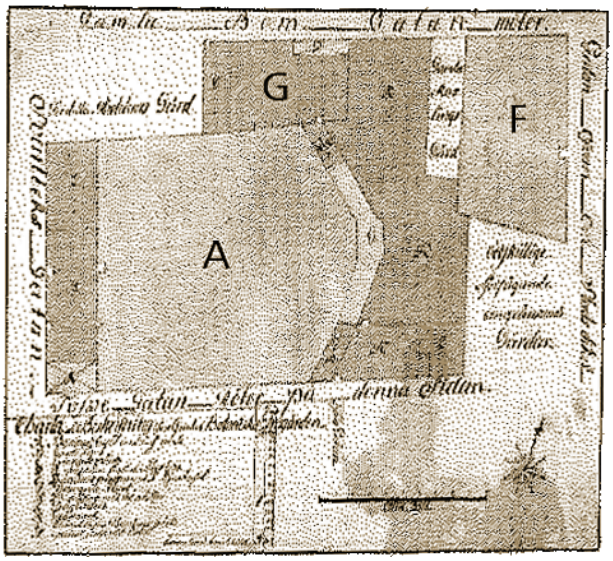
D3. GOLDFISH IN THE LINNAEUS GARDEN?

In an article on *Linné On Line*, the anonymous author states (Anon., 2008):

However, there were also animals in Linnaeus' garden. Parrots shouted here, imitating Linnaeus' voice: "Blow your nose!" Monkeys played around and a raccoon wanted to be petted. Peacocks strolled about displaying their beautiful plumage. Goldfish swam in the pond.

However, there are no written materials cited in the article that support such a claim about goldfish and I doubt very much that it is true. For one thing, if Linnaeus had live goldfish in hand he would have placed them in his orangey, not in the Botanical Garden. Linnaeus was concerned that although goldfish might be adversely affected by the cold winters in Sweden, they would be protected in the warm orangery. They also would be further protected against predators in the Garden's open ponds. Lastly, Linnaeus would have wanted the goldfish to be nearer to him where they could be more easily observed.

If Linnaeus had goldfish in the Botanical Garden in Uppsala, he would not only be the one who



A: Linnaeus' house; G: Orangery; F: Animal Quarters.
The Botanical Garden is north of the Orangery and not seen in this diagram. Linnaeus was concerned that Guy's goldfish would not survive Swedish winters and so he planned to place them in the Orangery.

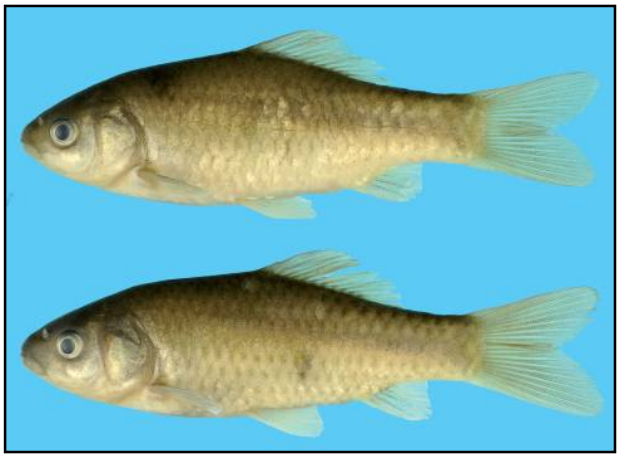
coined the defined the word "aquarium" for all posterity, he would also have been our first aquarist in the sense of keeping fish and aquatic plants together in a container of water. Incidentally, in her book on goldfish Roos refers to the *Linné On Line*: "Linnaeus kept a number of fish in the botanical gardens of Uppsala University, trading information about fishy varieties with the Dutch naturalist Job Baster who bred them [goldfish] in open air ponds," citing Baster's letter of September 1, 1763. There is nothing in this letter, however, that mentions any of this.

E. MORSELS

(1) There has been considerable confusion concerning the taxonomic status of the goldfish. Many authors have recognized two subspecies in its native range: *Carassius a. auratus* (the goldfish, Chinese goldfish, or Asian goldfish) from Asia, and *Carassius a. gibelio* (the Prussian carp, gibele carp, or European goldfish) from Eastern Europe (Raicu et al., 1981). Others have concluded that the goldfish is a subspecies of the crucian carp *Carassius carassius* (i.e., *Carassius c. auratus*). More recently, it has been reported that *C. auratus* is a tetraploid derivative of *C. carassius* (Jenkins and Burkhead, 1994). There are many mutant goldfish varieties and this exhibit a broad range of body forms and colors. Howells (1992b) reported that some exotic fish experts believe that "goldfish" typically observed in U.S. waters is actually a crucian carp x goldfish hybrid. In addition, goldfish commonly hybridizes with common carp *Cyprinus carpio*, giving rise to individuals that are intermediate in morphology between the two parent species. The goldfish has been widely and repeatedly stocked in the United States from many points of origin, including both Asia and Europe. As such, U.S. populations represent a complex of morphologically and taxonomically diverse forms.

(2) Recently, *Carassius praecipuus*, a dwarf new species, was described from a hill stream in the upper Nam Ngum watershed in Mekong drainage in central Laos. It is distinguished from all other members of the genus by the short dorsal fin, a small number of branched dorsal-fin rays, lateral line scales and gill- rakers. The largest available specimen was 62mm (about 2.5 inches standard length). This is the first species of the genus discovered outside East and North Asia and Europe. The upper Nam Ngum watershed includes a part of the Plain of Jars, which had been hypothesized to have allowed the movement of a number of fish lineages between the rivers flowing to the Gulf of Tonkin and the Mekong drainage. It gets its name from the Latin adjective praecipuus, -a, -um, meaning "which is not common," an allusion to the unexpected presence of a *Carassius* in the Mekong drainage and the very low dorsal-fin ray, lateral line scale and gill-raker counts.

(3) Following the rules of the International Commission on Zoological Nomenclature (ICZN), when a species name is combined with a generic name other than the original one, the name of the author of the species-group name, if cited, is to be enclosed in parentheses (the date, if cited, is to be enclosed within the same parentheses), i.e., *Carassius auratus* (Linnaeus, 1758). On page 91 of Roos' goldfish book she states "…those goldfish lived, immortalized by Linnaeus in his *Systema naturae* featuring his new system of binomial nomenclature to classify every living creature. Linnaeus gave them their scientific name, *Carassius auratus*." This, of course is not true. The genus *Carassius* was proposed by the Swedish ichthyologist Sven Nilsson in 1832 and Linnaeus died in 1778.



***Carassius praecipuus*, a dwarf new species of Carassius.**

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THE DAWN OF THE AQUARIUM HOBBY IN AMERICA

by Albert J. Klee, Ph.D.

(Aquarium Hobby Historical Society, Facebook Files, October 2, 2021)

Some things are difficult to define, and the aquarium hobby is one of them. For example, the aquarium hobby in England in the 1850s was not the same aquarium hobby in the United States in the 1950s. After some reflection I realized that the history of the aquarium hobby can be described in four separate and fairly distinct stages – and this solved the problem. After all, an aquarium is nothing more than a vessel that holds water and a hobby is nothing more than a pastime pursued for pleasure. Accepting these terms in their broadest interpretations, therefore, allows us to proceed in the most meaningful and useful way, i.e., by looking at the stages of the hobby as they occurred and developed over time, and this is shown on page 2 of my "Toy Fish" book (Klee, 2014). Stage Four is called "ASSOCIATION," which is characterized by the existence of aquarium societies, competitions and magazines associated with the hobby. This essay is concerned with the beginning of Stage Four in the later part of 1893 to 1914, an era I call "The Dawn of the Aquarium Hobby in America" or Dawn Era for short. This chronology is summarized in the accompanying table but added are five dates of some early introductions of fancy goldfish in the period 1872-1880. The starting date I have selected for the Dawn Era in this essay is 1892, the ending period being the end of 1914 (see the accompanying table for the timeline).

Although the common goldfish was first imported in this country in the mid-1750s, they will not be discussed in detail in this essay as they are mostly pond fish or isolated specimens in the ubiquitous goldfish bowl where, sooner or later with inattention or improper care, the crime of piscicide relegates them to a watery grave. However, a few facts about them will be helpful as fancy goldfish are bred–at considerable expense–from common goldfish, and it should be remembered that common

IMPORTANT DATES IN THE DAWN OF THE AQUARIUM HOBBY IN AMERICA	
1872	The first fancy goldfish imported into the United States were seven fantails called 'Kingiyo's.' These were brought from Japan in 1872 by Martin Gillet Gill and one of these was presented to the New York Aquarium in that year.
1876	The first official World's Fair to be held in the United States, the Centennial International Exhibition of 1876, was held in Philadelphia. Mulertt's goldfish won numerous awards here.
1877	In April of 1877 the *New York Aquarium Journal* reported that they had just imported two specimens of what they called the "Japanese Telescope fish." Although they were recently brought directly to the Aquarium from Germany, they originally came from Japan. In the following May 1877 issue, the *Journal* provided additional information about the fish.
1878	Rear Admiral Daniel Ammen made the second importation of the veiltail in 1878. These were bred on his estate at Ammendale, Maryland and fish of that lot were presented to the United States Fish Commissioner and extensively bred at the government nurseries in Washington and distributed in large numbers by them for a number of years. A few of the Ammen stock were brought to Philadelphia from Ammendale and were bred in ponds for several years, the output being sold in that city for rather high prices. Subsequently, large numbers of Japanese goldfish were brought into the United States by private fanciers and by regular dealers; other importations were made from Europe.
1880	Gill stocked the fountain that was at Baltimore's Sesqui-Centennial Celebration held October 11-19, 1880 and was bought by the City of Baltimore, through him. Henry Bishop of Baltimore got what fish were left in the fountain. The others had died for want of proper care and interest.
1892	*THE AQUARIUM*, edited by Hugo Mulertt, first published in Cincinnati in the year 1878 to 1881 or 1882 (exact year not known), and then in 1892 in Brooklyn, NY.

IMPORTANT DATES IN THE DAWN OF THE AQUARIUM HOBBY IN AMERICA Continued.	
1893	Five aquarists of New York City met on March 12, 1893 in that city and formed an aquarium society. The society was called "*Triton*" of New York. Baron von Schlichting was elected its president. This was the forerunner of the *New York Aquarium Society*.
1893	On May 31, 1883 a second aquarium society was formed in New York City. The society was called "*Salamander*." Dr. A. von Duering was elected president and Mr. H. V. Letkemann secretary.
1893	The World's Columbian Exposition (also known as the Chicago World's Fair) opened on May 1, 1893. At the close of the fair, William P. Seal returned home to Philadelphia with what was known as the "World Fair's fish." Supposedly, with this fish began the famous line of American, or "Philadelphia" Veiltail goldfish.
1894	"The Amateur Aquarist," by Mark Samuel.
1888	"The Goldfish and its Systematic Culture with a View to Profit: A Practical Treatise on the Fish, its Propagation, Enemies, Diseases, and Care of the Fish in Captivity," by Hugo Mulertt.
1897	"The Fishes of the Fresh and Brackish Waters in the Vicinity of New York City," by Eugene Smith.
1898	William Poyser stated that J. Hope was the originator of the goldfish fancy in Philadelphia and that he first introduced Japanese fish in that city in 1898 (the same year the Philadelphia Aquarium Society was established) at a price within reach of all. Poyser purchased his first goldfish from Hope about that same time. When and where Hope got his fish is not known.
1898	John Cugley and a few hobbyists started to assemble on a regular basis and one of these regulars, H. G. Burrows suggested that the group organize and conduct meetings in a regular way and so, with the aim of setting up a permanent organization, the very first meeting was held at the Colonnade Hotel in Philadelphia on May 5, 1898. Burrows, who was elected President, proposed the name by which the society was henceforth known, i.e., The Aquarium Society of Philadelphia. Other officers elected were: Harry Folwell, Vice President; George Cugley, Secretary; and E. Thalag, Treasurer. On June 14, 1898 the practice of meeting at members' homes was started.
1898	"Aquaria," by Charles N. Page.
1902	"The Goldfish and its Systematic Culture: a Thorough Guide for Goldfish Keeping and Goldfish Breeding in the House and Out-of-Doors, the Construction and Care of the Parlor Aquarium and Ponds for Breeding," by Hugo Mulertt.
1902	"The Home Aquarium…How to Care for It," by Eugene Smith.
1908	"Fresh Water and its Inhabitants," by Otto Eggeling and Frederick Ehrenberg.
1908	"Goldfish Aquaria and Ferneries," by Chester Reed.
1908	"Goldfish Breeds and other Aquarium Fishes: A Guide to Freshwater and Marine Aquaria, their Fauna, Flora and Management," by Herman T. Wolf.
1909	"The Aquarium: Devoted to Aquarium Culture and Window-gardening: Information for the Care of the Parlor Aquarium," a pamphlet by Hugo Mulertt.
1909	"Japanese Goldfish: Their Varieties and Cultivation," by Hugh M. Smith.
1911	The *Brooklyn Aquarium Society* was formed early in 1911, chiefly from the membership of the *New York Aquarium Society* residing on Long Island.
1911	The *Chicago Fish Fanciers Club* was established in 1911 but was nosed out by a few weeks by the Brooklyn club.
1911	The *BULLETIN OF THE BROOKLYN AQUARIUM SOCIETY* appeared, Editors De Voe, Lienau and Wilco, published by *The Brooklyn Aquarium Society*, Brooklyn, New York.
1911	"Aquaria Fish," by Frank Lee Tappan.

IMPORTANT DATES IN THE DAWN OF THE AQUARIUM HOBBY IN AMERICA Continued.	
1911	"Aquaria Fish," by Frank Lee Tappan.
1912	*THE AQUARIUM*, Editors: Eugene Smith and others; publishers included at the start were *The Brooklyn Aquarium Society, The Chicago Fish Fancier's Club, The New York Aquarium Society* and *The Philadelphia Aquarium Society*. Others as the time passed included the *Milwaukee Aquarium Society, Boston Aquarium Society, Philadelphia Goldfish Society, Minneapolis Aquarium Society*, and *San Francisco Aquarium* Society. However, both the San Francisco and Boston groups had undergone reorganizations before 1917 and therefore were by that date, different societies. Also, the Chicago Fish Fanciers Club had incorporated as the Chicago Aquarium Society.
1913	March 1913 the New York Aquarium Society had changed its name to "*The Aquarium Society*."
1914	"Domesticated Fish," by Walter Lannoy Brind, New York City.
1914	"The Care of Home Aquaria, by Raymond C. Osburn.

goldfish were sold in quantity in this country before and after the Dawn Era.

A1: SOMETHING ABOUT GOLDFISH

The following is taken from Charles Darwin's book, "The Variation of Animals and Plants under Domestication" (Darwin, 1868); however note that he defined monstrosities as a "considerable deviation of structure in one part, either injurious to or not useful to the species, and not generally propagated."

Gold-fish (Cyprinus auratus) were introduced into Europe only two or three centuries ago; but it is believed that they have been kept in confinement from an ancient period in China. Mr. Blyth suspects from the analogous variation of other fishes that golden-coloured fish do not occur in a state of nature. These fishes frequently live under the most unnatural conditions, and their variability in colour, size, and in some important points of structure is very great. M. Sauvigny has described and given coloured drawings of no less than eighty-nine varieties. Many of the varieties, however, such as triple tail-fins, &c., ought to be called monstrosities; but it is difficult to draw any distinct line between a variation and a monstrosity.

As gold-fish are kept for ornament or curiosity, and as "the Chinese are just the people to have secluded a chance variety of any kind, and to have matched and paired from it," we may feel nearly confident that selection has been largely practised in the formation of new breeds. It is however a singular fact that some of the monstrosities or variations are not inherited; for Sir R. Heron kept many of these fishes, and placed all the deformed fishes, namely those destitute of dorsal fins, and those furnished with a double anal fin, or triple tail, in a pond by themselves; but they did "not produce a greater proportion of deformed offspring than the perfect fishes."

This observation was important as it had a great deal to do with Darwin's belief that these abrupt changes were not inherited. Charles Lyell, important in the foundation of modern geology, influenced Darwin so deeply that Darwin envisioned evolution as a sort of biological uniformi-

Figure 1: Genetic deformity in a bubble-eye goldfish.

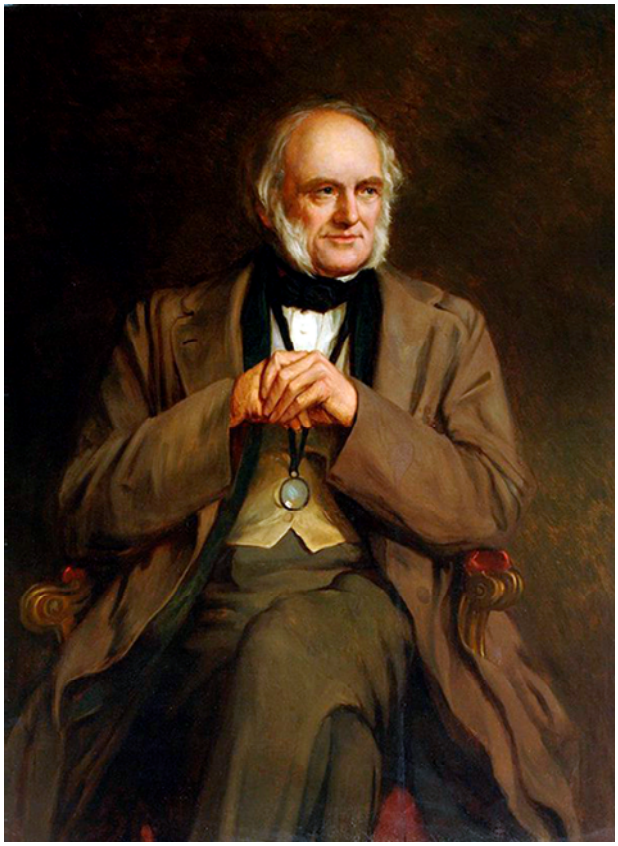


Figure 2: Charles Lyell (1797-1875). Lyell helped to arrange the simultaneous publication in 1858 of papers by Darwin and Alfred Russel Wallace on natural selection, despite his personal religious qualms about the theory.

tarianism, the theory that changes in the earth's crust during geological history have resulted from the action of continuous and uniform processes. Darwin argued that evolution took place from one generation to the next before our very eyes, but it worked too slowly for us to perceive. In a letter Darwin sent to Lyell dated February 23, 1860 (Anon., 2002) he stated that in the case of goldfish it is not a case of abrupt origin of new forms. "On the whole, I still feel excessively doubtful whether such abrupt changes have more than very rarely taken place."

It is known that, if left untended, in a few generations goldfish revert to their wild type. However, within the same generation of fancy goldfish this reversion can be seen starting; typically, 90% of a new brood of fancy goldfish must be culled and discarded. This is expensive for breeders since the newly-hatched first must be fed foods like brine shrimp and then brought to a size where they can be evaluated. To continue with Darwin's comments:

Passing over an almost infinite diversity of colour, we meet with the most extraordinary modifications of structure. Thus, out of about two dozen specimens bought in London, Mr. Yarrell observed some with the dorsal fin extending along more than half the length of the back; others with this fin reduced to only five or six rays; and one with no dorsal fin. The anal fins are sometimes double, and the tail is often triple. This latter deviation of structure seems generally to occur "at the expense of the whole or part of some other fin;" but Bory de Saint Vincent saw at Madrid gold-fish furnished with a dorsal fin and a triple tail. One variety is characterized by a hump on its back near the head; and the Rev. L. Jenyns has described a most singular variety, imported from China, almost globular in form like a Diodon, with "the fleshy part of

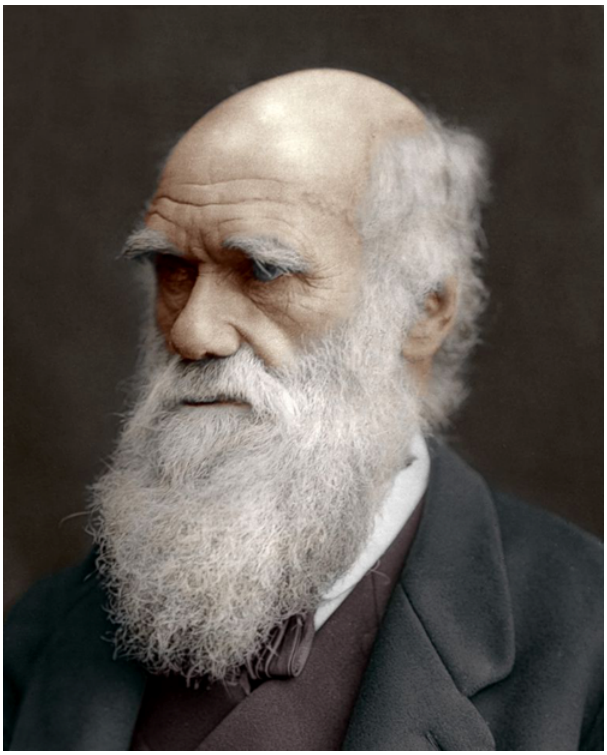


Figure 3: Charles Darwin (1809–1882).

the tail as if entirely cut away; the caudal fin being set on a little behind the dorsal and immediately above the anal." In this fish the anal and caudal fins were double; the anal fin being attached to the body in a vertical line: the eyes also were enormously large and protuberant.

Darwin's comment that "Passing over an almost infinite diversity of color, we meet with the most extraordinary modifications of structure," suggested that goldfish provided a rich resource for investigating the genetics of diverse morphological features. The study of variation under domestication in goldfish supplied Darwin with the idea of selection, whether natural or artificial, as the driving force behind evolution.

A2. SCIENCE AND THE GOLDFISH MARCH ON

Goldfish have been subjected to over 1,000 years of intensive domestication and selective breeding. A recent article (Chen, et. al., 2020) resequencing 185 representative goldfish variants and 16 wild crucian carp revealed the origin of goldfish and identified genomic regions (*i.e.*, regions of genes) that have been shaped by selective sweeps linked to its domestication. Comprehensive collection of goldfish varieties enabled the researchers to associate genetic variations with a number of well-known anatomical features, including features that distinguish traditional goldfish clades. Additionally, they identified a candidate causal gene for the first well-known case of Mendelian inheritance in goldfish–the transparent mutant. The datasets that were generated may help to elucidate the evolution of goldfish and goldfish varieties and may provide a resource for a wide range of studies with important implications for the use of goldfish as a model for vertebrate and fish genetics.

A SNP (snip) is a DNA sequence variation that occurs when a single nucleotide (adenine, thymine, cytosine, or guanine) in the genome sequence is altered and the particular alteration is present in at least 1% of the population. An example of a SNP is the substitution of a C for a G in the nucleotide sequence AACGAT, thereby producing the sequence AACCAT. Fish have many SNPs; for example, a total of 8.4 million candidate SNPs were identified in the channel catfish (*Ictalurus punctatus*).

Modern datasets often have a very large number of variables. This makes it difficult to inspect each of the variables individually, due to the practical fact that the human mind cannot easily digest data on such a large scale. When a dataset contains a large number of variables, there is often a serious amount of overlap between those variables. Principal component analysis (PCA) is a statistical method that allows one to "regroup" the variables into a smaller number of variables, called components. The goal of PCA is to regroup these variables in such a way that the first (newly created) component contains a maximum of variation. The second component contains the sec--largest amount of variation, etc. The last component then contains the smallest amount of variation. Thanks to this ordering of components, it is possible to retain only a few of the newly created components while still retaining a maximum amount of variation. We can then use the components rather than the original variables for data exploration.

Using the principal components of SNP variation, seven different types of goldfish were found to be clustered, i.e., common goldfish, Wenyu-Oranda, Telescope, Wen-pompon, Eggfish-Lionhead, Egg -pompon and Chinese-ranchu (Chen et al., 2020). Using the first two components, Figure 4 shows

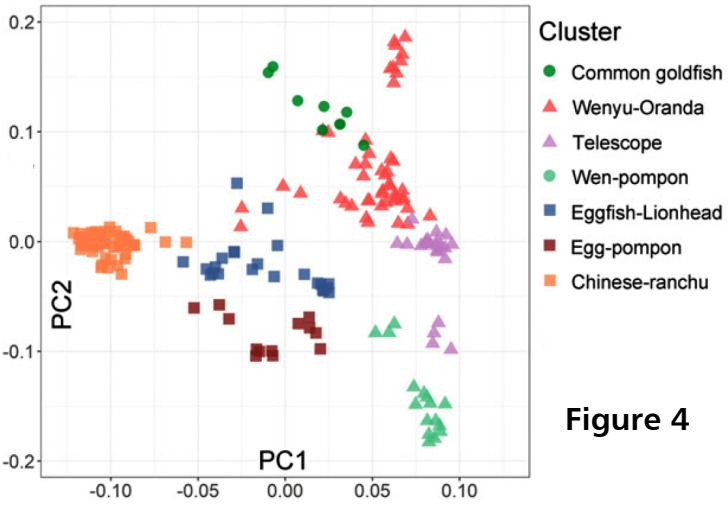


Figure 4

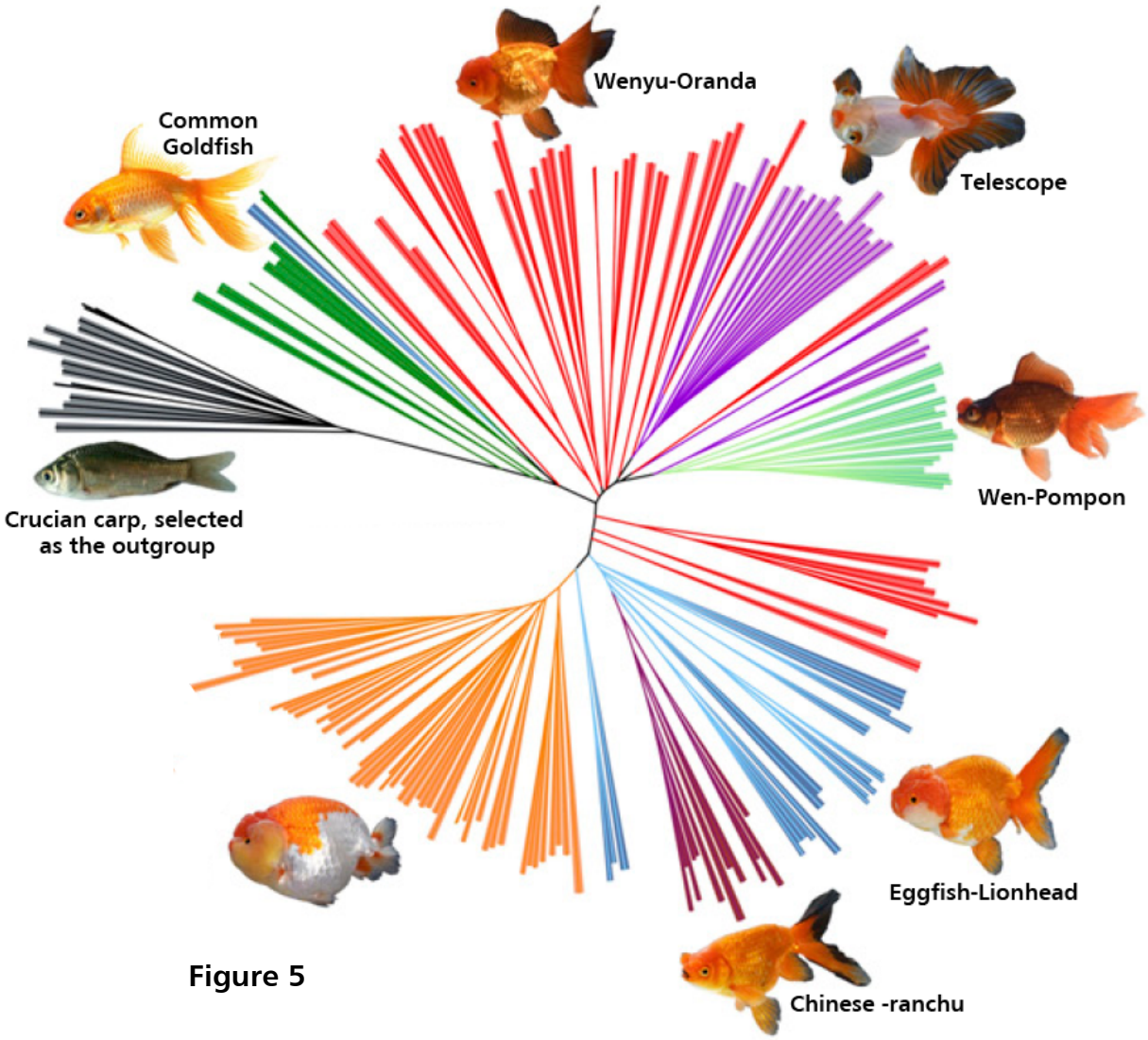


Figure 5

these seven clusters. A different technique, based on the genetic distance calculated from the SNPs, shows the clustering more clearly and also shows images of each type (Figure 5). The branch color indicates membership in one of the eight classified goldfish populations, eight because it also contains the crucian carp, used as an outgroup, which was not used in the principal components figure.

B1. THE FIRST VEILTAIL GOLDFISH OF RECORD

The tea importing firm of Martin Gillet & Co. was founded in Baltimore, Maryland by Martin Gillet in 1811, just 35 years after the Declaration of Independence (Anon., 1912). A gentleman of the old school, the founder of the venerable firm felt that the importing of tea would be not only lucrative, but would bring much honor from the housewives of the young republic. The War of 1812 afforded the opportunity of selling teas to the Government, and thus the business prospered from the very start. In 1822 Mr. Gillet's daughter, Miss Elina Adams Gillet, married Owen A. Gill, who was taken into partnership. Martin Gillet, the founder, died in 1814, and Gill carried on the business alone until his sons became of age and took their places in the business world with him (Phillips, 1979).

In 1862 the first to be admitted was Martin Gillet Gill. As a youth of 18, Gill first traveled to Paris and England aboard the ship of a tobacco trader, subsequently undertaking three round-the-world trips over the course of his 69 years. Gill rose

Figure 6: Martin Gillet Gill.

through the ranks of his grand-father's tea importing firm and as a representative of the company, he went to China and Japan in the capacity of tea-taster and remained in the Orient for seven years. During his stay in Japan it was reported that Martin traded arms to the Mikado in his struggle with the Tycoon government, and amidst this turmoil he conceived the idea of the teabag, a product later sold as "He-No tea."

The first fancy goldfish imported into the United States were seven fantails called 'Kingiyo's.' These were brought from Japan in 1872 by Gill and one of these was presented to the New York Aquarium located at 5th St. and Broadway, established by W. C. Coup and Reiche and Brothers in 1876 (Anon., 1876). The fish more properly were called "Kingyos," but the Germans called them "Schleirschwanze" (Veiltails in English).

Starting from Japan in 1875 with eighty-eight fish, the captain of the steamer took great interest in his efforts to introduce the fish to America and built a tank on the steamer to accommodate them. He took in a supply of river water but it was soon found that the motion of the ship dashed the fish against the sides of the tank and many were lost. To obviate this, a smaller tank was built and suspended like a compass, thus counteracting the motion of the ship. However, notwithstanding all the care bestowed on them, only fifteen arrived in San Francisco, all in a very weak condition. Of these, eight subsequently died.

There were also numerous troubles in bringing the fish across the continent. At one place in Nebraska the train was stalled in the snow for several days and Gill had the fish packed in snow to keep them to show the people at home, but to his surprise seven of them survived this hard treatment and lived to breed in ponds he had in his yard in the city. He afterward stocked the fountain that was bought by the City of Baltimore for the Sesqui-Centennial Celebration held October 11-19, 1880. After the celebration was over, many of the fish had died for want of proper care and interest. However, Henry Bishop of Baltimore got what fish were left alive in the fountain.

B2. HENRY BISHOP

Henry Bishop was born Hanover, Germany in June 1846 and in boyhood, he had made birds and fish a study. In 1862, at the age of 16, he came to the United States and in 1869 married his wife, Mary,

Figure 7: Image of the Kingyo in the *New York Aquarium Journal* of November 1876.

who had emigrated from Germany in 1866. They had a son, Henry Bishop, Jr. and two daughters, Hermina and Marie.

Bishop landed in New York City and I will let him tell what happened next (Bishop, 1886):

Although of German birth, I say "We Americans," for I landed on these shores when scarcely sixteen years old, and five months after went on American vessels, where I served in the capacity of cabin boy, and later as carver and steward, and took the greatest pains in mastering the English language and adopting the ways of the American people in general. This I have brought to such perfection that on Election Day I vote twice unless it can be plainly seen that my man will have an overwhelming majority. Of this voting as often as you can I sing in my song, in another part of this book, entitled "Rock, Cradle, Rock," the third verse of which is as follows:

"When twenty-one then you are a man,
Vote soon and often as you can
For the party which pays the best–
Be easy, let your conscience rest."

I won't take Bishop to task for this since in those days there was no difference between Baltimore's political structure and that of New York City's Tammany Hall (and I was also laughing a lot when I read it!). Actually, this work has been selected by scholars as being culturally important, and is part of the knowledge base of civilization as we know it. Since it is in the public domain, the book is readily available as a reprint.

It is not known why Bishop moved from New York to Baltimore but in 1880, Germans made up the majority of the foreign-born population of Baltimore at 58% of all foreign born residents. 16.9% (56,354) of Baltimore were foreign born, 32,685 of them Germans. The German-born immigrant population in Baltimore peaked in 1890, when German-born Baltimoreans numbered 41,930 out of the total population of 365,863. We don't know when Bishop arrived in Baltimore, Maryland, but the following is taken from his book (Bishop, 1886):

It is but twelve years ago, June 17,1874, when I opened the little Bird Store No 49 East Baltimore street, with but little cash, no credit and no more knowledge of the business other than that of an *enthusiastic* private bird fancier. During my occupation as hotel clerk and steward in previous years, I had as much as two hundred dollars' worth of birds and aquariums at one time, just for my private amusement, and to parents I would say this, should your son have a natural fancy for such household pets, let him have full sway, as it will keep him out of mischief. Nothing adds so much to making a house cheerful and the inmates happy–especially ladies and children– as a song-bird, a talking parrot or a choice aquarium, and any of these can always be had at my store, or from my agents In other

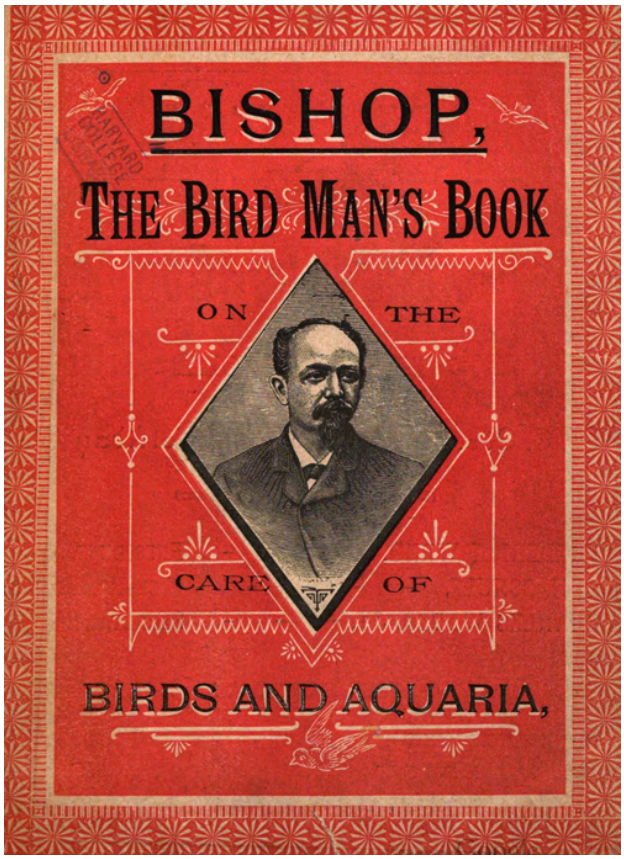


Figure 8: Henry Bishop's 1886 book.

cities, in the most approved styles and at prices so low as to surprise every visitor.

Susan G. Pearl, on the Board of Directors of Prince George's County Historical Society as Historian, discovered that in 1890, Edwin A. Newman of Washington, D.C., purchased approximately 80 acres of land that lay to the east of the Maryland Agricultural College, separated from the college by the Washington-Baltimore Road (Pearl 2018). It was well watered by the Paint Branch, a tributary of the Eastern Branch of the Potomac. The construction of the Baltimore & Ohio Railroad some 50 years earlier had caused this wetland area to form ponds and a small lake in this area. Newman envisioned the development on his new property of a resort community which he named Lakeland, with the lake (a triangular body of water of approximately 5 acres as a community amenity. He called this amenity Lake Artemesia, after his wife, Clara Artemesia Newman. He had the area platted and subdivided, laying out streets, installing gas lights, curbs and gutters, and began to sell lots. The five-acre Lake Artemisia was stocked with bass, but later her father rented the lake to a family that used it for raising goldfish..

Part of a 1903 lease among the Prince George's County land records was from the Aquarium Fisheries Company of Prince George's County, Inc. (Edwin Newman, president) to Henry Bishop, for 26 ½ acres of land and water - "for the purpose only of a goldfish farm or hatchery… all lands, ponds, lakes or bodies of water now existing or hereafter to be constructed in the subdivision of Lakeland, with rights of ingress and egress to and from…" Bishop had the right to use "water of the Paint Branch and to conduct it to and from said ponds, lakes and bodies of water." The owner of the land, Aquarium Fisheries Company, retained the right to collect ice from the ponds.

The lease was to extend for 10 years, from 1 May 1903 to 30 April 1913. Three years later, in June 1906, another document was filed in the Prince George's County land records, this one dealing with Lake (or Pond) #5 which Bishop had constructed on the west side of the tracks, south of the train station in an area which had not been developed with housing. This document permitted Bishop to construct two more lakes adjacent to one of the Lakes within the next seven years (i.e., up to the end of the original 1903 lease). Henry Bishop was not able to carry out the larger plans for his fisheries project; he died in 1907, and the obituary from the *New York Times* credits him with having developed

…the largest goldfish industry in the country. His breeding lakes at Lakeland cover acres. From them he supplied parks in New York, Detroit, Washington, and other cities with specimens. He also shipped these fish to New York and other places to be used for destroying the larvae of mosquitos."

After Henry Bishop died, Henry Bishop, Jr. had no interest in maintaining the bird and aquarium business. However, within a fairly short time the United States government was operating the fisheries at Lakeland (Kelly, 2017). There is a government report from 1915 reporting the success of

Figure 9: An interior image in Bishop's book.

Figure 10: Henry Bishop (1846-1907).

fish breeding in the Lakeland ponds. And there are several interesting reports from the *Washington Post* (1924) that indicate that the government was still running a productive fishery there at that time. One 1924 article informed fishermen that Uncle Sam was going to keep all streams within 100 miles of Washington well stocked with favorite fish.

On the road to Baltimore, near the Maryland Agricultural College (sic), the government has leased a tract of land which will be used for the breeding of fish for use in stocking the streams throughout a large part of the East. Utilizing a pond system that had been used for raising goldfish, the bureau of fisheries has 23 acres…under water for breeding purposes. The millions of crappie, bluegill, bream, and large-mouthed black bass…will be distributed in the creeks and rivers of Maryland, Virginia, West Virginia, North Carolina, Delaware, New Jersey, Pennsylvania and New York. The bureau stocked the 23 acres of ponds with 105 black bass, 8 crappie, and 12 catfish. Six months later, exactly 34,255 crappie, 2945 catfish, and 37,085 black bass had put in appearance…"

In the same year, the *Washington Post* recorded the visit by Herbert Hoover, then Secretary of Commerce, to the Lakeland fisheries (The Bureau of Fisheries operated under the Department of Commerce from 1913-1939):

The secretary visited each of the half dozen ponds. He helped draw in seines of small bass . . . part of the supply of 200,000 fish . . . which have been hatched at Lakeland from 250 large-mouthed bass with which the ponds were stocked.

As the 20th century reached its midpoint, Lakeland had become a comfortable black residential suburb, and the lakes and ponds were becoming overgrown, but they had clearly been an exceptional source of fish during the first part of the century due to Henry Bishop. In the 1907 Report of the Director of the Aquarium to the Board of Managers, under Acknowledgments" was the following statement (Townsend, 1908):

The late Henry Bishop, of Baltimore [Bishop died on November 3, 1907]**, presented fifteen Japa-nese goldfish of the large and handsome varieties so successfully bred by himself.**

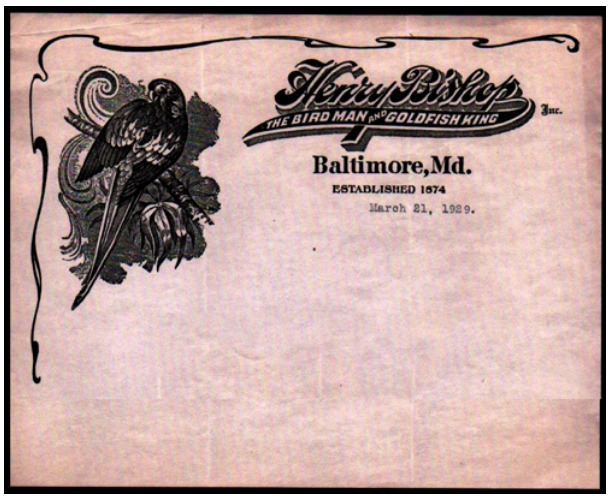


Figure 11: The Henry Bishop letterhead.

Bishop, therefore, bred more than one variety of fancy goldfish–probably veiltails and telescopes. It is possible–but hardly likely–that some of these fish might have even been bred from the veiltails he rescued from Baltimore's 1880 Sesqui-Centennial Celebration, but they probably were responsible for his early interest in fancy goldfish.

B.3 THE FIRST TELESCOPE EYE GOLDFISH OF RECORD

In April of 1877 the *New York Aquarium Journal*, under "Recent Additions," reported that they had just imported two specimens of what they called the "Japanese Telescope fish." Although they were recently brought directly to the Aquarium from Germany, they originally came from Japan (Anon., 1877a):

Like the Kingiyo they are a species of carp, the name being given to them on account of the peculiar form of the eye. On examination it will be seen that these organs, instead of occupying a cavity, are placed at the extremity of two abnormal protuberances. It is a well-known fact that certain insects are endowed with the same peculiarity, and can simply by the turning backward of these projections see behind them. In addition to this peculiarity of eye structure these fish have also the "three tails," similar in general form, though less marked, than in the Kingiyo.

In the following May 1877 issue the *Journal* provided the following additional information (Anon., 1877b):

LING-TSING-YU

A glimpse at the new arrival, Ling-Tsing-Yu, is all that is needed to inform the visitor of its origin. None but the Japs could raise such a grotesque looking beauty, and, having raised it, none but a Jap could christen it with such a name. Those familiar with the graceful beauty, the Kingiyo … will note the resemblance in many particulars between it and its rival, the Ling-Tsing-Yu. Whether these mystical three syllables, when interpreted, mean the "big-eyed-fish," we will not venture to affirm. Certain it is, however, that in addition to the long wavy tail which is the special adornment of the Kingiyo, we have the extra wonder of the projecting eyes, which have caused this fish to be called in plain English the Telescope Fish. The Ling-Tsing-Yu is a species of Golden carp. Its body has all the bright colors of the gold-fish, and adds to this the wonder of the triple tail, and the still greater wonder of the eyes. These latter are mounted on stalks projecting from the sockets, as shown in Figure 12, and are the result of breeding and culture. Although the Kingiyo was our first love, the still greater wonder now on view is a sign that the manager of the Aquarium means that each succeeding conquest in the realm of Neptune shall be greater than the last.

Figure 12: The LING-TSING-YU bubble-eye goldfish at the New York Aquarium in 1877.

B4. THE VEILTAIL IMPORTATIONS CONTINUE

When Ulysses S. Grant was a little boy, he almost drowned. His best friend, Danny Ammen, saved his life. In a very real sense, then, we have Daniel Ammen to thank for the preservation of the Union, the destruction of slavery and the accomplishments of a president. (Or, as Grant joked in a letter to Ammen fifty years after being rescued, "You are responsible for the many trials and difficulties I have passed through in the last half century. But I am of a forgiving nature and I do forgive you.")

Rear Admiral Daniel Ammen, U. S. N., had a varied career. In May 1864, while in charge of some 220 conscripted seamen sailing from New York to Aspinwall on the California passenger steamer Ocean Queen, he suppressed an open mutiny. Most of the draft were miserable creatures, raked up from the shipping agencies, and the time being at the height of the war, such a set of people were much more dangerous on board a passenger ship with ladies and children on board than tons of dynamite would have been. A mutiny occurred within thirty-six hours after the vessel sailed from New York, and some of the mutineers actually had the captain and chief engineer by the throat when Am-mon shot the ringleader dead in his tracks. The officers of the ship then fired, killing another prominent muti-neer. The dangerous mutiny was quelled.

During his career and after retirement, he was involved with designing a number of crafts and weapons for the Navy, including the ram Katahdin for harbor defense and a cask life raft that became standard design for life boats in the naval service.

Ammen made the second importation of the veiltail in 1878 on a Pacific Mail Line Steamer from Japan. These were bred on his estate at Ammendale, Maryland and fish of that lot were presented to the United States Fish Commissioner and extensively bred at the government nurseries in Washington and distributed in large numbers by them for a number of years. A few of the Ammen stock were brought to Philadelphia from Ammendale and were bred in ponds for several years, the output being sold in that city for rather fine prices. Subsequently, large numbers of Japanese goldfish were brought into the United States by private fanciers and by regular dealers; other importations were made from Europe.

B.5 VEILTALE FABLES AND THE "WORLD FAIR'S FISH"

The Veiltail goldfish has several stories about its origins in America. One of these tales talks about Imperial Goldfish being sent to Chicago from Japan to be exhibited at the World's Columbian Exposition (also known as the Chicago World's Fair), which opened May 1, 1893. It was told that these fish became sick, with most of them dying. A few were rescued by William P. Seal (Seal, 1915), who was placed in charge of the construction of the aquarium before the Fair was opened in 1893, but resigned his position as special agent in charge of the aquarium on December 31, 1892. At the close of the fair, Seal returned home to

Figure 13: Rear Admiral Daniel Ammen (1820-1898).

Philadelphia with what was known as the "World Fair's fish" and later sold it to Franklin Barrett. Supposedly, with this fish Barrett began the famous line of American or "Philadelphia" Veils. Actually, however, the Barrett Veiltail strain was produced from a Japanese Fringetail and a Chinese Telescope Eye with a short but very square tail. John Cugley of Philadelphia had imported these Telescope Eye fish and shared them with Barrett to establish a very good line of American veiltails.

The true facts are as follows: The Wisconsin Fish Commission bought two hundred imported Japanese Fantail goldfish for their exhibit at the Columbian Exposition. Unfortunately, these were infected by the disease commonly known as tail- or fin-rot and died off very rapidly. When all were dead but seven they were given to Seal to experiment with by James Nevin, Superintendent of the Wisconsin Commission. This was before the opening of the Exposition. Seal succeeded in saving three or four of them which he brought to Philadelphia. Two of them, a male and a female, one the pure pearl fish (it was white) subsequently exploited as the "World's Fair Fish" and pictured as red in color, were sold to a Philadelphia fancier for fifteen dollars. However; this fish at that time had not attained anything like the later development of its fins. In fact, at that time it was no better than thousands of others that were imported every year and sold at low prices. At the time, fish like this cost 13 dollars a hundred at San Francisco. Thus although this particular fish began its career in the United States with a value of thirteen cents, with its owner spreading a tale of its cost it finally attained a mythical newspaper value of five thousand dollars. It was not exhibited at the World's Fair, and would only have attracted attention as one of a tankful if they had lived.

B.6 THE BREEDING OF FANCY GOLDFISH

Regarding the breeding of fancy goldfish, I'll refer to Al Foster, one of the most recognized specialists of this century (Radford, 2004). First he advises the beginner who just wants to maintain a strain (it should be mentioned that I have done some minor editing of the text):

To keep a strain of goldfish, you should keep at least a couple of dozen fish all the time. These fish should be old enough to breed, i.e., 2- and 3-year old fish. Most peo-ple, however, don't have enough water space to keep a strain go-ing [a common suggestion is for the first fish, 20 gallons of water and for each one afterwards, 12 gallons]**. Also, most are too soft-hearted to do all the culling. If you don't cull, then you end up crowding the fish and they just don't develop. If you can get to a store that has adult fish you can usually pick out a pair by standing and watching the way that they act for a while. Once you have a pair, the breeding takes care of itself. If the water is clean, they will lay eggs by themselves. You can read in any book how to do it. That means changing water sometimes on a daily basis for the first couple of weeks.**

He then describes his own set-up and methods:

Figure 14: Al Foster, one of our expert fancy guppy breeders in the United States.

I have 2 fish rooms in the house and a building outside where I keep my fish over winter. I also have about 20 ponds. Most of the fish that I breed in the house are in 200 gallon tanks containing 10 or 12 adult fish. There will be several Ranchu in them, but usually a few small Ryukin also, maybe even a few single tailed males. The big males, Veils especially but Ranchu also, don't chase the females very well. However, the younger males chase like crazy. When I walk into the fish room in the morning, I know immediately if any of the females have eggs because the smaller males are chasing them all over. The big males on the other hand are waiting to see if I will feed them.

When I see that there are fish with eggs, then I will take the female and the desired male and hand strip the eggs. I hatch out the eggs and raise them for a month, feeding them all the brine shrimp that they can eat. In fact, I keep live brine shrimp in the tank with them all the time regardless of whether this means feeding them three times a day, twice a day or whatever. Al-most daily before I feed them, I siphon out two-thirds of the water, including anything that they haven't eaten and any fish waste. I then fill it back up and feed them again.

A vital part of Foster's operation is culling:

When they are about a month old, I cull them using big white porcelain bowls just like they have in China. I first put these fish in about an inch of water. Next I take a 100-watt bulb with a little reflector and place it about a foot over the water. Then I pick out all the fish that have double tails that match. (These are the fancies that I am talking about, i.e., anything with a double tail.) You usually find out that this takes about 90% of the fish out of the batch right away, no matter what variety of goldfish. If you are breeding Veils, you only take the ones that have perfect matching tails. If you are breeding Ranchus, you get a lot of tripod tails so you get rid of all of these fish. When finished all the selected fish are put back in the same aquar-ium. There may have been 40 gallons of water with 2000 fish at the start. Now, after 10 minutes, there are 40 gallons of water with 200 fish. I feed the same amount that I was feeding the day before. Don't worry; they eat it.

I have found that even with all the water that I have, I end up with a lot of fish that no one wants. I learned to be real ruthless right away. If they don't have a double tail, then you don't want to raise them. It doesn't mat-

Figure 15: Foster recommended culling with a vengeance. Center: Fry with faulty tail fin; Center: Right with good tail fin shape but it is divided; Right: Fry with fins fully divided.

ter how good they look from the side. You've got fish that are just going to foul up your whole set-up. What do I do with the 90% I cull? I dump them right back in the big 200 gallon aquarium with all the adult fish. Within 10 minutes, they are gone. It is the best natural food for the adults. On the bad side, I figure that by culling time, I have probably fed them about $25 of newly hatched brine shrimp.

The fish double in size almost twice a week. They grow so fast I usually go through them a second time. Now no matter what variety of goldfish it is, I usually raise only about 1% of the fry. People are under the illusion that I have thousands and thousands of Veils. If you count all the ones that hatch out of the eggs, I do. However, when you count the ones that people see in a book, this narrows it down to that 1%.

This section shows that the breeding of fancy goldfish had little to do with the Dawn Era of the aquarium hobby in America. It was just too expensive and time-consuming to compete with the introduction of tropical fish. Veiltails were never produced by a large number of individuals; the centers of veiltail breeding were Philadelphia and New York where it appears that many fancy goldfish hobbyists were for the most part well-off financially, very competitive in their shows, and did not readily share information with potential show competitors. When tropical fish became available to the general public, the goldfish hobby did not have a large healthy hobbyist base with which to compete and goldfish quickly became secondary to tropical fish in popularity.

In the 1920's, the veiltail goldfish abounded in both the US and Britain. There is no certainty as to how precisely the veiltail got to England but it flourished there in the hands of breeders like Captain Betts, Frank Close, Joe Linnale and George Fern. Barrett shipped his fish to others and without doubt some of these shipments were International. Two articles in 1950 about Charles Whitehead, in the *Portsmouth Evening News* and the *London Evening Standard*, indicate that he was either a source or the origin of the English veiltails. Whitehead likely obtained his first veiltails from the US just prior to WWI. By comparison, in the United States the veiltail was almost lost until the 1970's. The recovery of the Veiltail in the US brings to mind the names of John Anderson and Al Thomma as key proponents of the resurgence of the variety. Al Thomma was able to obtain stock from John (Andy) W. Anderson of Philadelphia who possessed fish from the original Barrett line. Anderson worked for Innes Publishing as advertising editor and publisher of Innes' *The Aquarium*.

C.1 THE PHILADELPHIANS

Hugo Mulertt became an increasingly popular presence in the Philadelphia aquarium scene at the end of the nineteenth century. The Centennial International Exhibition of 1876, the first official

Figure 16: A page from Cassel's catalog.

Figure 17: The Mulertt Aquarium details.

World's Fair to be held in the United States, was held in Philadelphia, Pennsylvania, from May 10 to November 10, 1876, to celebrate the 100th anniversary of the signing of the Declaration of Independence in Philadelphia. Officially named the International Exhibition of Arts, Manufactures, and Products of the Soil and Mines, it was held in Fairmount Park along the Schuylkill River on its fairgrounds. Nearly 10 million visitors attended the exposition, and 37 countries participated in it. Mulertt's goldfish had won numerous awards at the Centennial exhibition and at Philadelphia Aquarium Society fancy goldfish competitions. However, to complete this discussion of Mulertt it is necessary to explore the activities of Jacob Cassell.

Cassel was born into a family of farmers in Montgomery County, Pennsylvania sometime around 1849. In 1873, he married Harriett Pattern and the couple moved to Philadelphia where Cassel opened the Fair-Hill Terra Cotta works. In Cassel's time there were about six such works operating in the southeast Pennsylvania region. Four of those six were producing utilitarian objects, primarily sewer pipes, and one was producing some utilitarian wares as well as some garden equipment. Cassel, the sixth, was producing primarily floral and garden equipment and, uniquely, aquaria.

Cassel was primarily a garden supplier. About 70% of his twenty-five different forms advertised in the 1877 Fair-Hill trade catalog were garden related; only 25% were related to the aquarium trade. In the 1870s, 1880s and 1890s, the census and city directories list "terra cotta" or "florist" as Cassel's occupation. Similarly, most of his advertisements appeared in garden catalogs or garden sections of newspapers. By 1898 he still retained a show room in Philadelphia but began listing his occupation as "aquarist" or "aquariums." He developed what he called the "Mulertt Aquarium, the basic frame of which was not, as was most common in those days with rectangular aquaria, composed of metals. Instead it was made of an earthenware ceramic like terra cotta. Rather than being cut, folded and soldered like the metals, therefore, the earthenware was poured into a design mold, dried, fired and painted.

For decoration, the earthenware frame of the Mulertt aquarium was covered in artificial logs, stacked in a half-moon shape to cover the frame of the aquarium. This was painted to simulate moss. The rectangular pedestal was similarly constructed using two artificial logs, one on either side of the base. Two flat, semi-circular pieces of glass were inserted in the frame on either of the round sides. The artificial logs were set outside of the aquarium frame so as not to obscure viewing the fish. Overall, the tank could only hold about 1.5 gallons of water but as it was extremely decorative, it proved to be a best-seller for Cassell.

Cassel most likely broke into the aquarium industry because of the products he was already creating. His terra cotta forms were created from molds of a particular shape that could be used for any number of forms. In the case of the Mulertt Aquarium, Cassel used the same mold to create a nearly identical flower vase. The Mulertt Vase was featured in the same 1877 trade catalog, but in the garden department section. It featured the same half- moon shape constructed from stacked faux logs and a faux log pedestal. It varied in that instead of glass viewing portals on either side, the

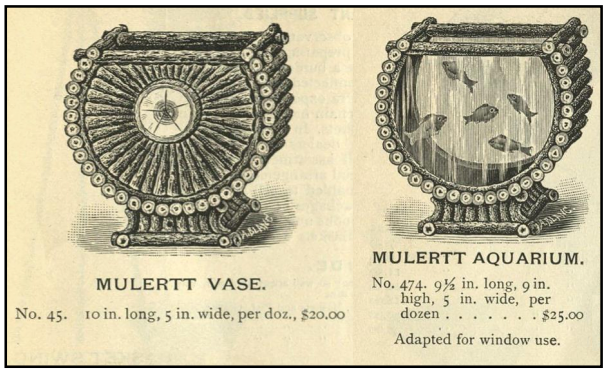


Figure 18:
The Mulertt Aquarium and Vase compared.

space was filled with rustic style logs radiating outward from a central star. Otherwise, the products are identical. It is likely the design for the aquarium preceded the vase because the name of the design referenced Hugo Mulertt, who was the most famous living aquarist at the time. Mulertt, however, most likely was not happy with Cassel's design as he was a champion of the much larger flat-sided aquariums that became the standard in the aquarium hobby. Despite beginning as a florist and garden supplier, as the Philadelphia Aquarium Society emerged Cassel became more deeply engaged with aquarists, and his aquarium designs became the icon of the flourishing aquarium district in the city.

In the March 1913, William Poyser wrote:

J. Hope was the originator of the goldfish fancy in Philadelphia. He first introduced Japanese fish in that city, some twenty years ago, at a price within reach of all. The Editor purchased his first goldfish from Mr. Hope about that same time [i.e., 1893, the same year the Philadelphia Aquarium Society was established].

Hope advertised in 1913 that he was a **"herpetologist, an Importer of rare Reptiles and Batrachians, Natural History Objects, etc. Also all varieties of curio fish on hand and supplied. Dealer in Birds, curious animals, dogs and Angora Cats and kittens–Pets of every kind."**

At least seven aquarium operations were located within a three block radius of Arch and 10th streets by 1910 including: Jacob C. Cassel, Fair-Hill Terra Cotta Works Showroom (Arch and 7th), William T. Innes, aquarium publisher (Cherry and 10th), Cugley and Mellon, fancy fish purveyor (Arch and 12th), and the Philadelphia Aquarium Society Headquarters (Arch and 13th). Thirty years earlier when Cassel had just opened his showroom, none of the others surrounded him. As time moved on, other important firms were established in the city, such as those operated by Harry P. Peters, William L. Paullin, Franklin Barrett and the General Aquarium Company of America.

Cugley and his partner, George Mullen, operated primarily as bird dealers but like Cassel, became increasingly involved in the fancy fish trade. Over the course of the first decade of the twentieth century, they advertised their Telescopic varieties and fancy aquaria in nearly every issue of the Philadelphia Inquirer. In 1897, Cugley imported a paradise goldfish from Japan that had the body and fin development of the Telescope, with the large tubular eyes pointed forward, a shortened head and long snout, moderately large paired fins and a double tail. The skin was covered with wart-like growths or papillae, which caused the thin scales to curve and stand from the sides as though they were ruffled, thus giving to the fish somewhat the appearance of being covered with barnacles, hence it was called the "Barnacled Paradise goldfish." Its scales were unevenly overlapped so that they appeared somewhat scattered, like those of the mirror carp, although they entirely covered the body of the fish. The singular appearance of these fishes led American breeders at first to suppose them to be diseased, but later they were recognized as a variety of the Japanese Telescope, the distinctive peculiarity being the scale formation. Other paradise gold-

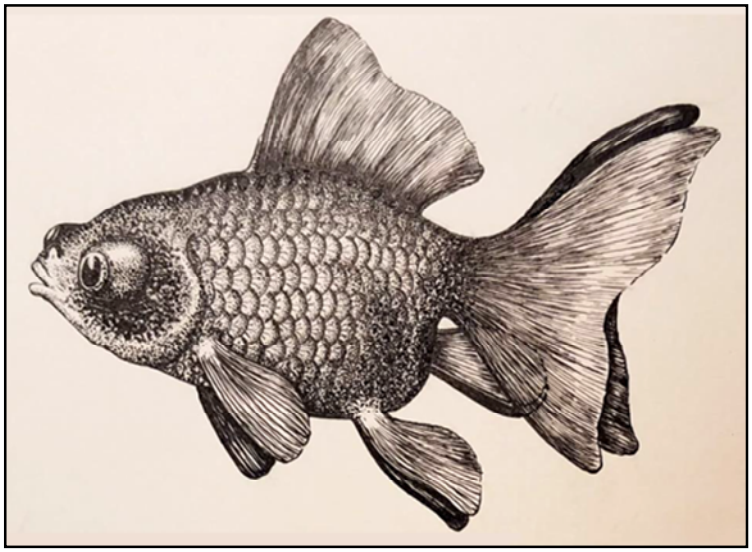


Figure 19: George Cugley's Japanese Barnacled Paradise Goldfish, drawn by Herman T. Wolf, February 6, 1902.

fish had been imported before, but they were exceedingly rare and challenging to bring home successfully.

These dealers provided impetus and equipment to the burgeoning aquarium hobby in Philadelphia. Harry P. Peters, member of the Philadelphia Aquarium Society, auctioneer, exhibitor and contestant in goldfish competitions, and Master of Ceremonies at aquarium events was William T. Innes' favorite among the dealers and he once described him thusly:

Now if there is any one large bouquet to be awarded, let us give credit where credit is due. Every organized effort has a leader. Without his energy and personal self-sacrifice nothing much would be accomplished. Since the inception of these shows fourteen years ago Harry P. Peters has been right there with his shoulder to the wheel and his hand in his pocket. Some years it seemed there would be no show until Harry got out his big whip and commenced to crack it. This was one of those years. He organized us this year and put the show across big without as much help as he should have had, and so, Mr. Harry Peters, we make a low bow and hand you the big bouquet with one hand and a cake with the other.

One thing that Philadelphia did not have, however, was a public aquarium, whereas many of the early aquarium societies did have one. That these were tremendous attractions and started many a visitor to start keeping aquarium fishes is exemplified by the following that appeared in the *Scientific American*:

ASTONISHINGLY GREAT INTEREST IN AQUARIUM.

The New York Aquarium had a greater number of visitors during the year 1909 than ever before, the attendance being 3,803,501, an average of 10,417 a day. These figures show that the Aquarium has a greater patronage by the public than all the other museums of the city, including the Zoological Park, combined, and 1,800,000 more, for the same period, than the New York Hippodrome, which has probably the largest attendance of any theatre in the city. These figures are unequaled by those of any other museum in the world for which statistics are available.

I can understand how the New York Aquarium was responsible for introducing many people to the aquarium hobby in that city since that is how I myself started. Eighty years ago, as a youngster living there, I made many trips on the subway from my home in the Bronx to the Battery (the southern tip of Manhattan Island) where the aquarium was situated.

C.2 THE PHILADELPHIA AQUARIUM SOCIETY

In the small pet shop on Ninth Street operated by John Cugley, who was the first to import calico telescope goldfish from Japan, a few hobbyists started to assemble on a regular basis to discuss the problems of this new hobby since detailed information was lacking, information that only experienced aquarists could answer. One of these regulars, H. G. Burrows, suggested that the group organize and conduct meetings in a regular way and so, with the aim of setting up a permanent organization, the very first meeting was held at the Colonnade Hotel in Philadelphia on May 5, 1898. Burrows, who was elected President, proposed the name by which the society was henceforth known, i.e., The Aquarium Society of Philadelphia. Other officers elected were: Harry Fol-

Figure 20: New York Aquarium Staff , 1909.

well, Vice President; George Cugley, Secretary; and E. Thalag, Treasurer. The object of the society was simply, "The scientific management of the aquarium and the amateur breeding of aquarium fish." In that the breeding of goldfish was stressed, the Philadelphia group set goals quite different from those of The Aquarium Society of New York established two years earlier. Active membership in the Society cost $6.00 per year (equal to about $160 today!) and Associate membership cost $3.00 (equal to about $80 today). For the first three meetings the average attendance was ten and by the end of the year, the total membership stood at eighteen.

On June 14, 1898 the practice of meeting at members' homes was started. In August of 1898 the Society was visited by Max G. Hammerschlag of The Aquarium Society of New York and thus, inter-society contacts were started. One interesting observation was that, independent of the New York group, the Philadelphia society also wrestled with the problem of commercialism. Their By-laws, however, stated explicitly: "It must be definitely understood that no member shall use the Society as an advertising medium." By the end of 1899 the Philadelphia group, perhaps influenced by the New York club, realized that its dues were too high. In order that the charter members not lose their initial investment, the Society disbanded on January 10, 1900, dividing the $20.40 cash on hand among fifteen members.

All but two members immediately reorganized as a new association, adopting the old constitution and bylaws as a whole but reducing the dues to $1.20 per year. However, since one of the problems in acquiring new members was that the old constitution and bylaws had been based upon those of academic or more erudite associations such as the Philadelphia Academy of Natural Sciences; this was no way to attract new members who were only interested in keeping and breeding the colorful new tropical fish that were being introduced into the aquarium hobby, so the new constitution and bylaws were modified to reflect this.

These changes were successful. In March of 1900 the Philadelphia club held the first competitive aquarium exhibition in America. It was held in the home of one of its members, Mr. E. Hoffman of 1813 South Third Street. The fish, goldfish only, were divided into three classes: under one year, one to three years and over three years. Ribbons were awarded by popular vote, not by judges selected for that purpose. By January of 1908 it had 128 active members (exceeding that of the New York club), a number of whom resided in neighboring cities. Its purpose at this time was the propagation of the finer breeds of the goldfish and the keeping of freshwater aquaria. Set topics of interest were discussed, exhibitions took place, prizes were awarded and inquiries from any source were invited and answered." Its meetings were held monthly, except June, July and August.

However, there was in no way a similarity between The Aquarium Society of New York and the Aquarium Society of Philadelphia. The former was an organization whose interest encom-

Figure 21: Therese Krones (1801-1830 was an Austrian actress of much ability and grace in comic parts. The portrait here showing the iconic goldfish bowl with a women was painted in 1824 by Ferdinand Georg Waldmüller.

Figure 22: Franklyn Barrett's Scaled Fringetail, Columbian World's Fair Prize Fish, Herman T. Wolf, February 6, 1902.

passed all aquarium fishes; the latter focused mainly on goldfish.

Because the number of aquarists interested in the new fishes started to significantly outnumber the goldfish fanciers, The Philadelphia Goldfish Society had broken off from the *Philadelphia Aquarium Society* in May of 1913, although the break was friendly and many kept memberships in both clubs. The new association was to specialize in goldfish, leaving all the other fish to the older organization.

In January 1914 the Philadelphia Aquarium Society started publication of a quarterly publication known as *Aquarium News and Notes*. It was a quarterly publication with its officers 1913-14 as follows: H. R. Lippincott, President; Charles Paxson, Vice-President; Hiram Parker, Treasurer; L. M. Dorsey, Jr., Secretary; Board of Governors: Hiram Parker, Geo. W. Price, C. Abram Provost, Wm. L. Paullin, and Wm. T. Innes, Jr. Publication Committee: Horace E. Thompson and Walter Lee Rosenberger (Chairman and Editor. I do not know how long it was published but the last issue I have in hand is the October 1915 issue which was Volume II, No. 8.

As time passed on, both the Philadelphia Aquarium Society and the Philadelphia Goldfish Society had disappeared. I

There are many reasons why the goldfish fad was passing. An article in the March 1911 issue of the *Guide to Nature* by Innes tells the story but as it is long, I'll summarize it here and include the complete article in the Appendix. I should explain that by "fringetail" Innes means what he later coined as a "veiltail." Innes also mentions "scaleless" goldfish; these are thin or transparently scaled fish.

He starts by observing that The Chinese are a people fond of the grotesque, i.e., a kind of beauty in ugliness. He goes into some detail talking about the telescope varieties of the goldfish where the idea is one of the grotesque kind of hideous urchin of the aquarium, beautiful in its ugliness, if you are trained to see it in that way. He notes that nine people out of ten on first seeing telescopes are horrified.

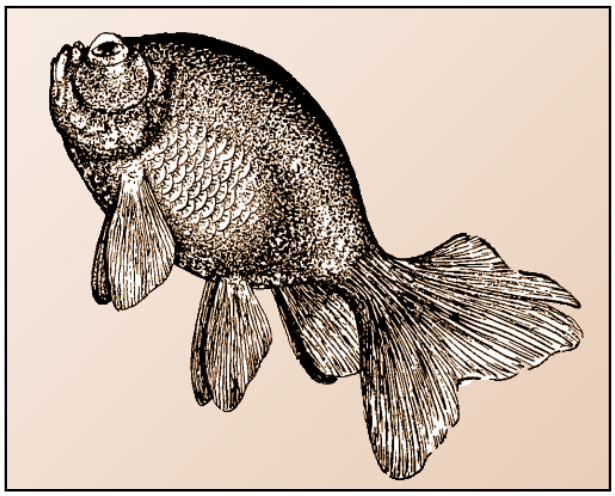


Figure 23: The Chinese Celestial Telescope goldfish, an example of an ugly Chinese breed. Herman T. Wolf, February 6, 1902.

There had been a breeding change of the telescope over time for large fin development and short body–two points clearly belonging to the ideas of grace and beauty. However, in working for these points, eyes and particularly color had fallen by the wayside. This had also produced a fish that had everything against it physically. The Chinese telescope with its great, bulging, near-sighted eyes, combined with the weakening influence of inbreeding, had trouble enough to keep alive. But combine with these disadvantages those of over-development of fins, together with the air-bladder, spawning and intestinal difficulties that go with short-bodied fish and you have a creature weighted down with handicaps. The short life and early loss of reproduc-tive power on the part of the males accounted in large measure for the difficulty in breeding large quantities of young from which to make selections, thus giving aquarists less and less opportunity to make experimental combinations.

The fish that was truly and legitimately graceful and elegant was the Japanese fringetail. The Japanese were among the most artistic people in the world and it was they who realized the possibilities of the beauty of a short-bodied fish with flowing and graceful fin development. With this fish too goldfish breeders had recently fallen behind, partly because more attention had been given to telescopes and partly because the scaled fish had gone out of fashion.

However one might very much enjoy seeing a good scaleless fringetail, it was not a practical fish. The scaleless fish had fins so weak that the dorsal could not be held erect after it had reached first-class development, and the long tail usually hung in a string instead of gracefully flowing be-hind the fish. Usually the fin develop-ment during the first year was not suffi-cient to be considered handsome. In the second year the fish looked its best, for the fins had become larger and in some cases were not yet broken. In the third and fourth years, when the fins should have been at their best, they were in the scaleless fish almost invariably dragged and broken. With the scaled fish this was not so apt to be the case. The fins were much more strongly ribbed and were carried in good form for several years. It is a fact that aquarists did not now see the very high, sail-like dorsals and the extremely long and good-conditioned tails of a few years back.

The best fin development was acquired at from three to four years of age, but if the fins at this age were not sufficiently firm to maintain their form, it hardly seemed to be worthwhile. Furthermore the scaleless fish was weaker and more sensitive to cold, and by breeding the scaleless fringetails together the depth of color was gradually lost. The fish with scales mottled red and white or solid red was very pleasing in color and possessed so many advantages over the scaleless variety that it should have been rescued from the inattention into which it had recently fallen.

Figure 24: William T. Innes attending to his goldfish, September/October issue of *The Guide to Nature*.

This ends my short version of Innes' article. Therefore, although it cannot be denied that the advent of tropicals put a serious dent in the goldfish hobby, the goldfish hobbyists themselves have to shoulder a good portion of the responsibility.

The following data summarizes the demise of the interest in goldfish over the early years of the aquarium hobby:

GOLDFISH ARTICLES		
PUBLICATION	PERCENAGE	YEAR
Guide to Nature	50%	1911
The Aquarium	31%	1913
The Fish Culturist	8%	1929

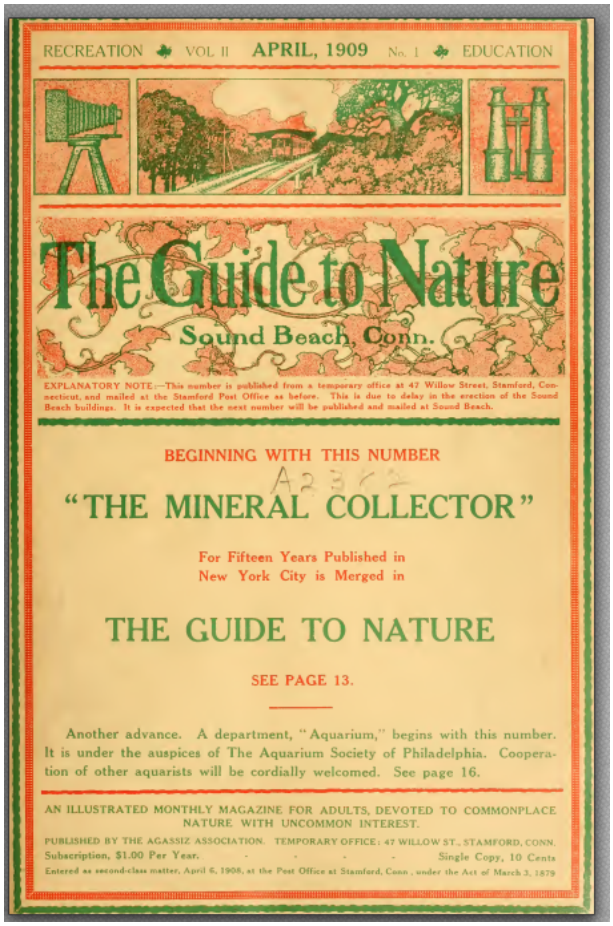
C.3 THE GUIDE TO NATURE

In April 1908, the *Guide to Nature*, published by the Agassiz Association as its official journal, appeared on the scene. A year later the publication was divided into different departments, such The Outdoor World, Popular Astronomy, Mineralogy, Correspondence and Information, The Agassiz Association, Literary and Biographical and The La Rue Holmes Nature Lovers League.

In the April 1909, *The Mineral Collector*, for fifteen years published in New York City, merged in *The Guide to Nature* as a new department but of far greater interest to aquarists was that another new department, the Aquarium, began. The cooperation of other aquarists was cordially welcomed. It was sub-listed as being under the auspices of The Aquarium Society of Philadelphia with Herman T. Wolf as its Editor. Wolf wrote the first piece, "The eyes of Chinese Goldfish" and M. R. Lippincott of Collenswood, N.J. wrote the second one titled "Wooden-Framed Household Aquaria."

Herman Theodore Wolf was born on October 13 1855 in Philadelphia, PA, to Carl Christian Wolf and Elizabeth Wolf (nee Weislogel). Both his father and his mother were born in Germany. On May 16 1883, at age 27, Herman married Louise Wolf (nee Kohler), also born in Pennsylvania. They had one daughter, Helen Emilie Wolf, born in 1887. By profession Wolf was a jeweler and jewelry salesman. On November 2, 1924 at age 69, Herman died in Lower Merion Township in Montgomery County, Pennsylvania, a suburb of Philadelphia and part of the Philadelphia Main Line ("Main Line" refers to the Pennsylvania Railroad train line that was built in the area beginning around the 1850s).

In 1901, Herman T. Wolf was an officer of the Philadelphia Society and a brother of Rudolf Wolf who, by his extensive importations, was largely responsible for establishing Philadelphia as the center of the fancy goldfish hobby in America. He had suggested a series of topics on goldfish and allied subjects that the Philadelphia Aquarium Society might entertain in discussions. As Secretary of the club, Wolf took detailed notes and these led to the writing of a manuscript. Wolf tried to get the work published but to no avail and


RECREATION VOL II APRIL, 1909 No. 1 EDUCATION

The Guide to Nature

Sound Beach, Conn.

EXPLANATORY NOTE.—This number is published from a temporary office at 47 Willow Street, Stamford, Connecticut, and mailed at the Stamford Post Office as before. This is due to delay in the erection of the Sound Beach buildings. It is expected that the next number will be published and mailed at Sound Beach.

BEGINNING WITH THIS NUMBER

"THE MINERAL COLLECTOR"

For Fifteen Years Published in New York City is Merged in

THE GUIDE TO NATURE

SEE PAGE 13.

Another advance. A department, "Aquarium," begins with this number. It is under the auspices of The Aquarium Society of Philadelphia. Cooperation of other aquarists will be cordially welcomed. See page 16.

AN ILLUSTRATED MONTHLY MAGAZINE FOR ADULTS, DEVOTED TO COMMONPLACE NATURE WITH UNCOMMON INTEREST.

PUBLISHED BY THE AGASSIZ ASSOCIATION. TEMPORARY OFFICE: 47 WILLOW ST., STAMFORD, CONN.
Subscription, $1.00 Per Year. Single Copy, 10 Cents
Entered as second-class matter, April 6, 1908, at the Post Office at Stamford, Conn., under the Act of March 3, 1879

Figure 25: The April 1909 issue of *The Guide to Nature* .

was at the point of burning the whole thing when he mentioned the fact to Innes in 1906. After reading the manuscript, Innes offered to publish it. Innes' father typeset the entire 385-page book by hand and Innes himself printed it on a small job press. The work took almost two years, appearing finally in 1908 as *Goldfish Breeds and Other Aquarium Fishes*. It was well written and beautifully illustrated. Wolf was an excellent artist and, for many years, several of his large drawings of goldfish types hung on the walls of the meeting room of the Philadelphia Society until 1909 when they were stolen. To the author's credit, the book was a masterpiece and it would not be an overstatement to say that Wolf's book was one of the great aquarium works of all time. But apart from this, it must be said that Innes' contribution was also a masterpiece. It was set in type and printed as was no aquarium book before it. It, of course, established Innes' reputation in the aquarium hobby as a publisher of aquarium literature and started his ascendancy to prominence within his own Society and in the hobby in general.

In the March 1909 issue the following review of the book appeared in the Literary and Biographical Department:

Goldfish Breeds and Other Aquarium Fishes. Their Care and Propagation. By Herman T. Wolf. Philadelphia, Pennsylvania: Innes & Sons.

This is a new and thoroughly up-to-date book on the aquarium and its inhabitants. It represents the total experience of the aquarium enthusiasts comprising the Aquarium Society of Philadelphia and the scientific knowledge of a number of members of the famous Academy of Natural Sciences. The author is an active member of both organizations and as secretary of The Aquarium Society for a number of years had ideal opportunities for writing just such a complete and practical book. In addition, Mr. Wolf is an artist of unusual ability. His illustrations of aquarium life are extremely natural and beautiful. Altogether this is far the best aquarium book that has ever appeared in any language and should be owned by every aquarist and naturalist. Every point mentioned is taken up thoroughly and practically. The book is 7 x 10y2 inches, fine paper, gilt top, 390 pages and contains 280 life- size illustrations, including a frontispiece in colors. The illustrations alone are worth the price of the book, $3.00.

An article in the May 1909 issue of *The Guide to Nature*–"The Propagation of Aquarium Fishes"–shows the types of fish being kept and/or bred in Philadelphia at the time:

The constantly growing demand for the highly developed breeds of Chinese and Japanese goldfishes, as well as the paradise fish, gourami, chanchito, climbing perch, archer perch, fighting fish and other labyrinthine or air-breathing fishes ; and the golden ide, green and golden tench, bitterling, carausche [i.e., the crucian carp]**, zebra fish and other beautiful indigenous, exotic and tropical forms, that**

Figure 26: Herman Burgin, President of The Philadelphia Aquarium Society in 1910.

may be domesticated and kept in household aquaria, has opened a field of industry in the United States which promises profitable returns to the culturist, who, with an understanding of needs and requirements and adequate facilities, will devote himself to their propagation.

The Aquarium Department was edited by Wolf in 1909 in the April, May, June, July, September/ October and November issues. The Department was missing from the magazine until the April 1910 issue when it appeared in the September/ October issue edited by Herman Burgin, President of The Philadelphia Aquarium Society. In the June 1910 issue it appeared but without mention of who edited it; the material in it, however, was by Innes. The Aquarium Department then was missing for the remainder of 1910. It was mentioned twice more, in the March 1911 issue and in the April 1913 issue, both times written by Innes, again without mention of editorship. In summary, the Aquarium Department was mentioned in 10 issues of *The Guide to Nature* during this time, 6(2) from Wolf, 1(1) from Burgin and 3 (2) from Innes, the numbers in parenthesis referring to the number of times goldfish articles appeared first. Thus in these 10 issues, five of them led off with goldfish articles and five led off with non-goldfish articles.

D.1 THE AQUARIUM MAGAZINE (Mulertt), 1892-1897

This section concerns Hugo Mulertt and the commercial aquarium hobby magazine he published while in Brooklyn, New York City. Because there was another aquarium magazine published during the dawn Era timeline with the same title, I have placed his name in parenthesis after the title. Since I have written much material about Mulertt, I summarize his activities here on the following page.

It is astonishing that after he settled in Brooklyn, Mulertt was successful in balancing all of these activities simultaneously. However, the main point here is that Hugo Mulertt was most certainly part of the dawn of the aquarium hobby in America. His was the first commercial aquarium magazine published during this period and it was excellent for its day.

The magazine itself had colored front and back covers (unfortunately the colors were drab and usually of an ugly green or mustard hue) made from a thin cardboard material that did not stand the test of time although the interiors pages were, as the Bard said," made of sterner stuff." The topics covered included native fishes, aquatic plants, aquariums, types of aquariums, fish physiology and aquatic invertebrates. Imported tropical fishes were scarce except for one about the Betta and another about the Brazilian Zebra Fish (called *Heros fasciatus* by Mulertt but *Cichlasoma facetum* in later aquarium books).

Mulertt wrote the following interesting account of his experiences in setting up exhibition aqua**The two main points to be kept in view when**

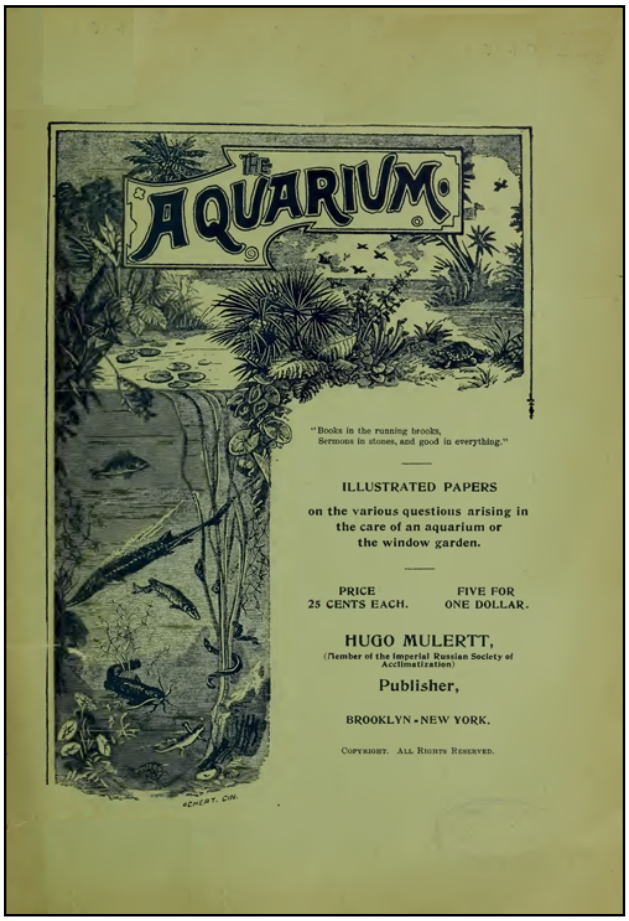


Figure 27: Mulertt's *The Aquarium* magazine.

HUGO MULERTT TIMELINE	
1848	Mulertt is born in in the town of Delitzsch, near Leipzig, Germany.
1863	He spends this year in England.
1864	He emigrates to the United States and finds employment in a commercial nursery in New Jersey.
1865	The civil war was at its height and Mulertt enlists in the cavalry and fights under Generals Sheridan and Grant for the cause of the Union.
1865	Mulertt works on Southern plantations where during that time he supplies many plant and animal specimens to the institutions of learning in Europe.
1872	He leaves his position as horticulturist at the Bellevue High School in Virginia and spends nearly two years in foreign traveling, visiting nearly every point of interest in Europe.
1874	Returning to the United States he settles in Cincinnati, Ohio where he was in business for fifteen years at 502 Race Street as a florist and aquarist.
1876	Mulertt's goldfish won numerous awards at the first official World's Fair to be held in the United States, the Centennial International Exhibition of 1876 held in Philadelphia.
1877	The Cassel Fair-Hill Terra Cotta Works produces the "Mulertt Aquarium."
1878	The first issue of his magazine, *The Aquarium,* was published.
1883	His primary work, "The Goldfish and its Culture," is published, for which he was acknowledged as an authority on four continents.
1885	The "Imperial Russian Society for the Acclimatization of Animals and Plants" elects him a corresponding member.
1876	The same Society awarded him their Great Silver Medal, a distinction which had in their days been bestowed upon Alexander von Humboldt and Philipp Franz von Siebold.
1888	This was the last year he spent in Cincinnati, leaving his store near the end of the year for Brooklyn, New York City where he started an aquarium business from his home.
1889	Mulertt obtains the position of Curator at the Harriet L. Packer Institute, a school for the education of girls.
1892	Mulertt renews the publication of his magazine, *The Aquarium*.
1894	He starts writing a monthly column called "The Aquarium" in the "*American Gardening, A Journal of Horticulture*."
1895	This was the first issue where advertising appeared in Mulertt's magazine.
1897	In this year the last issue of *The Aquarium* was published.

constructing a series of tanks for public use, aside from the proper location of them of course, are: (1st) to secure proper protection to the collection against injury by spectators, caused either through ignorance or by an inborn inclination for destructiveness; and (2nd) to allow ample elbow-room behind the tanks ("behind the scene" would be quite proper here) for the aquarist, that he may be able to work about and arrange the tanks, and wait upon his charge at any time undisturbed.

We experienced sad losses when, many years ago, we first began to display collections of aquatic life to the public. At first, when we innocently displayed our collection entirely unprotected, we mourned the loss of choice specimens that had been stolen. The water was frequently spoiled by people feeding the animals with almost anything possible and impossible, including preserved fruits and ice cream; even the small boy with the proverbial "pin-hook" fastened to a thread was represented. At one time a boy attracted quite a

crowd around one of the aquariums, because he used a certain kind of bait that hooked nearly any fish he desired, and the policeman in charge of that part of the hall–why, he enjoyed it as much as the rest of them, and declared that the next time he would go out fishing, he would use that same kind of bait.

We knew, at least we thought so then, how to stop fishing and feeding our specimens. All that was required was a wire netting over the tanks. So we had these made with dispatch, and when we covered our collection with them we felt that their safety was secured. But little did we know inquisitive man (we do not say woman). To look at an animal in captivity, no matter what element it is in, without at least trying to poke it seems to be impossible for a great many people. The spectators would now poke their parasols or fan-handles through the screens, and when the mesh of the screens proved too small for these, some did not find it too much trouble to use their hat-pins for the purpose. It gave them so much pleasure when they hit them "right close to the eye."

The feeding-fiend misunderstood the meaning of the screens entirely. Of course, no one but "city folks" could think of preventing these dear little fishes from partaking of their luncheon–consisting principally of home-made pie. They would go to the trouble of breaking it into sufficiently small pieces and force it through the meshes. Two young ladies we will never forget, as we caught them in the act, busily engaged, both on the same tank, feeding the fish with sponge cake using the protective (?) screen for a grater.

Good-natured and polite, we stopped their proceedings, and were informed by them that we need not fear any bad effects, because they had baked the cake themselves, it being no "bought stuff". We had no doubt as to the quality of the cake, for the fish had literally filled themselves up with it and we were compelled to renew the water of this tank at once. If we inform you that the tank held a barrelful, you can measure our appreciation of home-made Kentucky sponge cake. These few examples were caused by sweet innocence; but when one drops a box of sulphur matches, chewing tobacco, and, in one case, a chunk of unslaked lime (which he had to bring from outside the exposition grounds), into a tank, or cuts the glass with the diamond of a ring, we think it is done with bad intent.

On another occasion we had our display guarded by iron railings, made of gas pipe. It is true this kept the observer at a safer distance, but it likewise made the display less interesting, especially to the younger generation. On succeeding occasions we displayed our collection in show-window fashion. This arrangement guarantees entire satisfaction, both to the exhibitor and the observer. We used this method first in 1879, and it has shown that it covers all wants.

Figure 28: A girl looking into a goldfish bowl by Carl von Bergen (1853-1933).

In order to obtain the most striking effects, the tanks should be in convenient height to the eyes of the observer; the shape of the tanks should be long, rather than high, with sufficient depth (toward the rear) to admit the formation of a proper background.

The all-important light is controlled by adjustable screens. Very beautiful effects can thus be secured with either daylight or artificial light. For lighting up the tanks at dark, the light should enter the water from above the surface of the water, and as much from the front as possible, keeping it (the light itself) out of the spectator's view. The outside space, the walk or passage in which the observer is, should be but dimly lighted, if lighted at all. The effect that is produced in this way is somewhat similar to that produced by a small bull's-eye lantern fastened in front of your hat. There will be no shadow between you and the object you desire to observe.

The accompanying sketch (Figure 29) of one of Mulertt's aquatic displays will give the reader a pretty clear illustration of an example of his work. The tanks are set flush behind a wall and in the middle is a pond with a fountain open to visitors (unfortunately making it possible for them to toss food into it and for small boys to fish in it!).

Mulertt occasionally provided short stories, often unusual, related to fish; the following is an example.

One of the supplying pipes of the city water works in a city in Germany needed frequent cleaning of the rapid growing water weeds. Several efforts to give the pipe a thorough cleaning failed until a man was struck with the capital idea to use a fish to make a connection between the two tanks. A carp was put into a small vessel and on his dorsal fin a thin but strong line, which was varnished to prevent the water from soaking into it and thus making it too heavy for the fish, was fastened. The vessel was now held close to the pipe and the fish entered it. The distance he had to travel was six hundred feet. He had to go straight forward, as his size prevented him to turn himself around. Several times it was noticed, by the line, that he stopped, but when he had reached the second half of the distance he had to travel, the water had a stronger fall and he did not try to

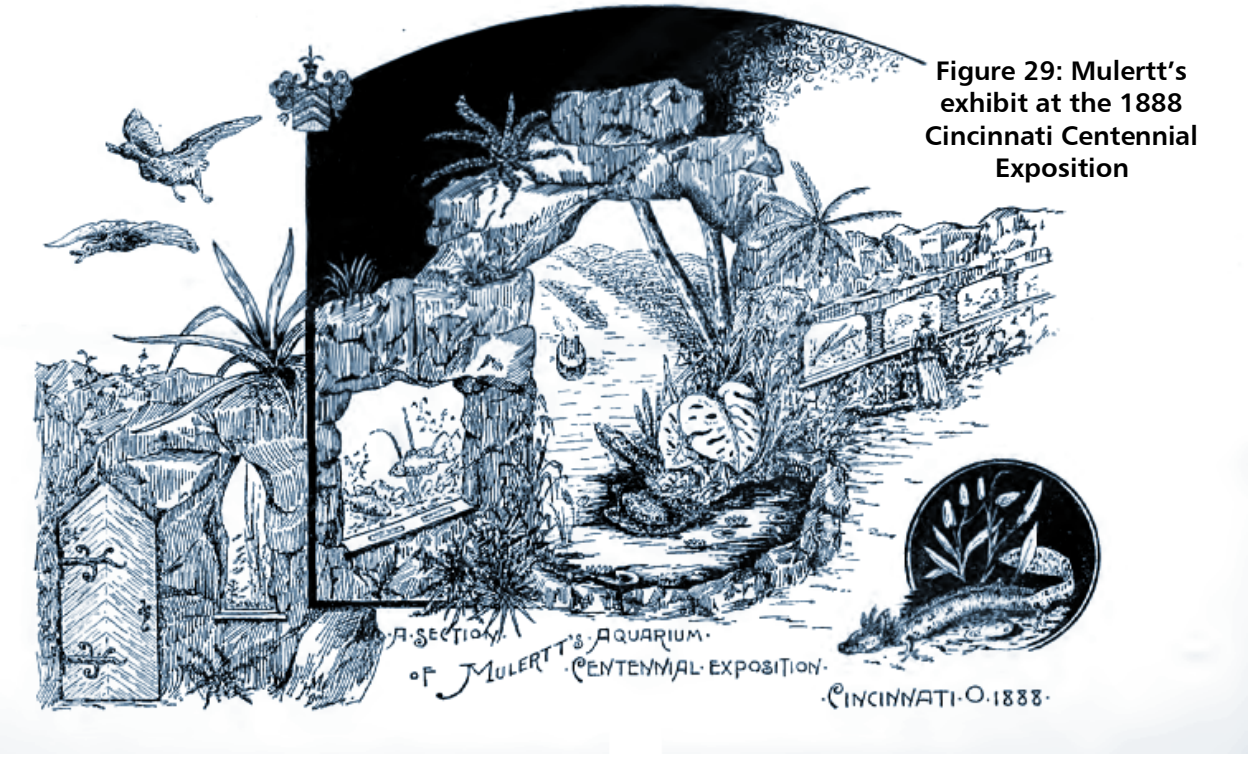


Figure 29: Mulertt's exhibit at the 1888 Cincinnati Centennial Exposition

stop any more. He arrived at the other end after two hours with the line still attached to his dorsal fin. He was very weak from his work and was easily caught. A stronger rope was now pulled through the pipe and with this, a wire cable was put there stationary on which brushes could be run through when necessary. The poor carp did not live long enough to be used as the customary Christmas dish, but had to be killed soon after he had performed his valuable service.

D.2 THE NEW YORK AQUARIUM SOCIETY

Early in 1893, five persons who had by chance become acquainted founded a small society, and although by 1896 was no longer in existence, was the mother of first aquarium society in the country. Its members had two things in common: (1) a love of aquarium fishes and (2) they all spoke German. Because the new organization was the only aquarium society at that time it was called simply, "The Aquarium Society." Only some years later, when other societies had formed throughout the country, was its name changed to "The New York Aquarium Society."

The New York Aquarium Society originally embraced a membership from the five New York boroughs as well as from the adjacent part of New Jersey; Eugene Smith was its Founder and first President. The New York Aquarium Society is thus the oldest in the field and experienced the usual vicissitudes of all pioneer organizations. The Philadelphia Society, numerically the strongest, was formed independently of New York in 1898; however, even up to 1912 it devoted its energies mainly to goldfish culture. Other early aquarium societies included the Brooklyn Aquarium Society, formed early in 1911 chiefly from the membership of the New York Society residing on Long Island. It was very successful and had established a small monthly bulletin in its own interests. The Chicago Fish Fanciers Club also was established in 1911 but was nosed out by a few weeks by the Brooklyn club.

D.3. THE AQUARIUM MAGAZINE, 1912-1914

In April of 1912, Volume I, No. 1 of *The Aquarium* appeared on the scene. As Eugene Smith put it,

Keenly realizing the benefits of association, it was felt that closer touch with the work of others was needed and mutual help could not be better obtained than by creating an organ of intercommunication. This not only would assist the several societies but would also serve to bring into touch many distant but nevertheless interested persons not connected with any society. The Brooklyn Society very wisely and generously took this larger view of the matter and agreed to merge their bulletin with the present magazine.

The societies in this consortium at the time consisted of The New York Aquarium (President, Isaac Buchanan), The Philadelphia Aquarium Society (President and Local Editor, Wm. T.

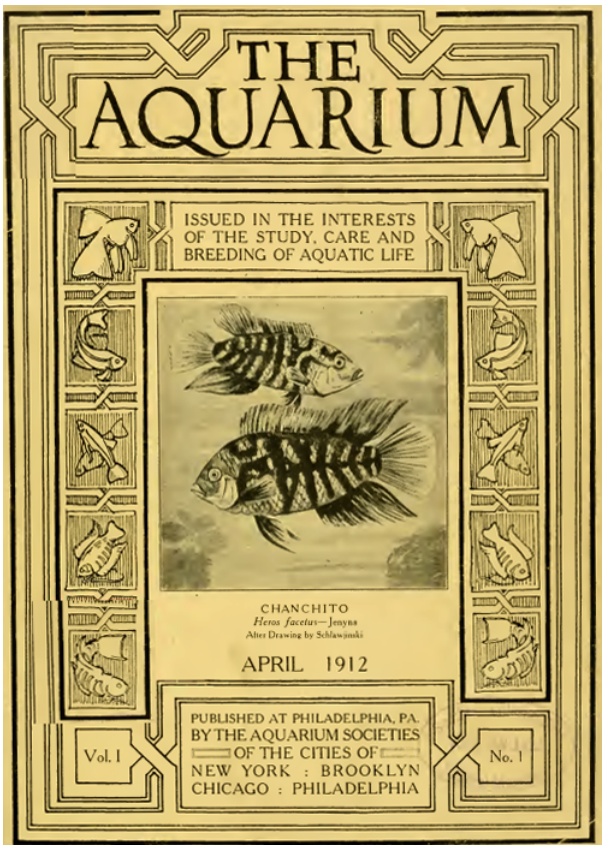


Figure 30: The first issue of The Aquarium magazine (1912-1914).

Innes, Jr.), The Brooklyn Aquarium Society (President, W.F. DeVoe) and the Chicago Fish Fanciers Club (President, F.S. Young); in June 1912 the Milwaukee Aquarium Society (President C.G.B. Schenck) joined the consortium.

Because of his illness, William T. Innes edited the September 1912 issue; the last issue Smith edited was November 1912. In January 1913, William Poyser took over as Editor due to Smith's death and for the first time, the editorship fell to the Midwest (Poyser was from Hammond, Indiana).

The consortium membership was augmented by The Minneapolis Aquarium Society (November 1912), the Boston Aquarium Society (November 1912) and The Philadelphia Goldfish Society (December 1913). It should be noted that on March 1913 the New York Aquarium Society had changed its name to "The Aquarium Society."

In September 1913, Will S. Hilpert (Chicago Fish Fanciers' Club) had taken over as editor of *The Aquarium* from Poyser. The onus of publishing had fallen to the Chicago group and the difficulties of publishing the magazine were summarized by the editor, J.W. Gage in December 1913:

LABOR WITHOUT REWARD

There has been more or less criticism regarding the magazine which would not be so prevalent if subscribers and advertisers took into consideration the fact that the entire labor of getting out the magazine is purely a labor of love. No one connected with the publication is paid a penny, yet the work involved in getting suitable articles, editing them, soliciting advertisements and keeping the accounts is no small task. It means work and time, both of which are cheer fully given by those in charge - still most of us feel a certain pride and satisfaction for honors bestowed upon us, even though the honors are mere titles of office.

As *The Aquarium* aged, many drawings and photographs were employed and the covers were in color. Yearly subscriptions were one dollar and single issue 10 cents. The Aquarium was an excellent magazine and many famous aquarists contributed to it, including Eugene Smith, R.W. Schufeldt, William T. Innes, Frank Tappan, S. Chichester Lloyd, Fred G. Orsinger, C.H. Heede, W.F. DeVoe, W.A. Poyser, John Treadwell Nichols, Frederick Schneider, C.G.B. Schenck, Harry Peters, William A. Paullin, L.M. Dorsey and Floyd S. Young. It was truly a remarkable endeavor by these aquarium societies.

E.1 AQUARIUM EQUIPMENT AND SUPPLIES

Although there were many patents awarded during the Dawn Era of 1892 to 1914, they overwhelmingly involved the design of aquaria. There were a few that dealt with filtration, heating or aeration but none of them were ever marketed. This is unfortunate since patents show how they work and provide drawings that facilitate understanding. Why weren't there more such patents? The answer is that the equipment need for aquarium application were already invented and you can't get a patent on someone's previous work. The best we can do is to scan the advertisements of this period to see if they provide more information or, if one is lucky, examine some of these antique apparatus that still exist.

E.2 WATER-DRIVEN AIR PUMPS

Walter Brind of New York City advertised the German K.D.A. air pump for $9 in the January 1913 issue of The Aquarium and the General Aquarium Company of Philadelphia did the same in the June 19, 1913 issue. An explanation of how the K.D.A. pump works can be found in my article on the early history of aquarium aeration (Klee, 2013).

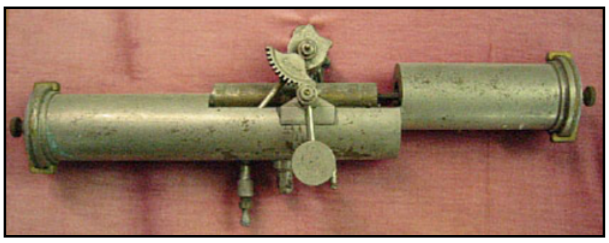


Figure 31: The K.D.A. water-driven air pump.

Figure 32: The "Little Wonder" was a water-driven air pump like the K.D.A. pump but it was based upon a different mechanism.

In addition to the K.D.A. air pump, the General Aquarium Company was in addition the selling agents for the US-made "Little Wonder" pump ($17.50) that also was water-powered. This was made by the Bishop-Babcock-Becker Company of Cleveland, Ohio who advertised the pump in the December 1913 issue of The Aquarium (Figure 32). The pump used a method that started with a chamber with a float inside (Figure 33).

Figure 34: An old aquarium air pump showing the armature (i.e., the coil below the rotor which is a permanent magnet.

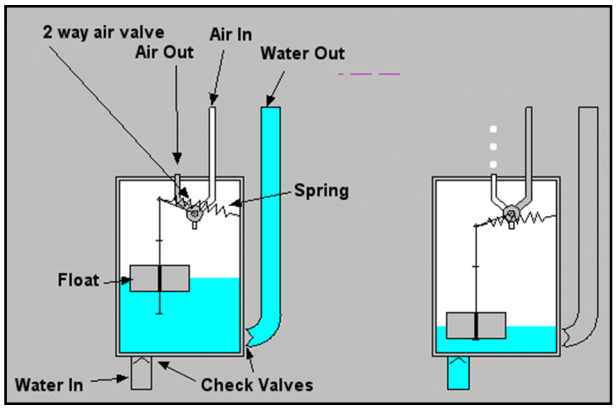


Figure 33: The "Little Wonder" system.

The chamber is under the water level. On startup, water enters the chamber through a check valve, then compressed air pushes the water out a 2nd check valve, up into the tank. When the water level gets low, a float closes off the incoming air, and opens a vent to let the air inside the chamber escape. The chamber refills with water, and either the same or another float switches the air valves back, and the cycle starts again.

E.3 ELECTRIC MOTOR DRIVEN AIR PUMPS

In electrical engineering, an armature is the component of a motor which carries alternating current. The armature windings interact with the magnetic field in the air-gap; the magnetic field is generated either by permanent magnets, or electromagnets formed by a conducting coil. The armature's role is twofold. The first is to carry current across the field, thus creating shaft torque in a rotating motor. The second role is to generate an electromotive force (EMF). In the armature, an electromotive force is created by the relative motion of the armature and the field. The EMF opposes the armature current, and the armature converts electrical power to mechanical power in the form of torque, and transfers it via the shaft.

Figure 34 shows an old aquarium air pump of the 1890s. The armature, i.e., the coiled wire, is shown just below the rotor which is, in this case, a permanent magnet. Although the rotor looks as if it was a gear, the grooves provided the air gap in which the magnetic field was formed.

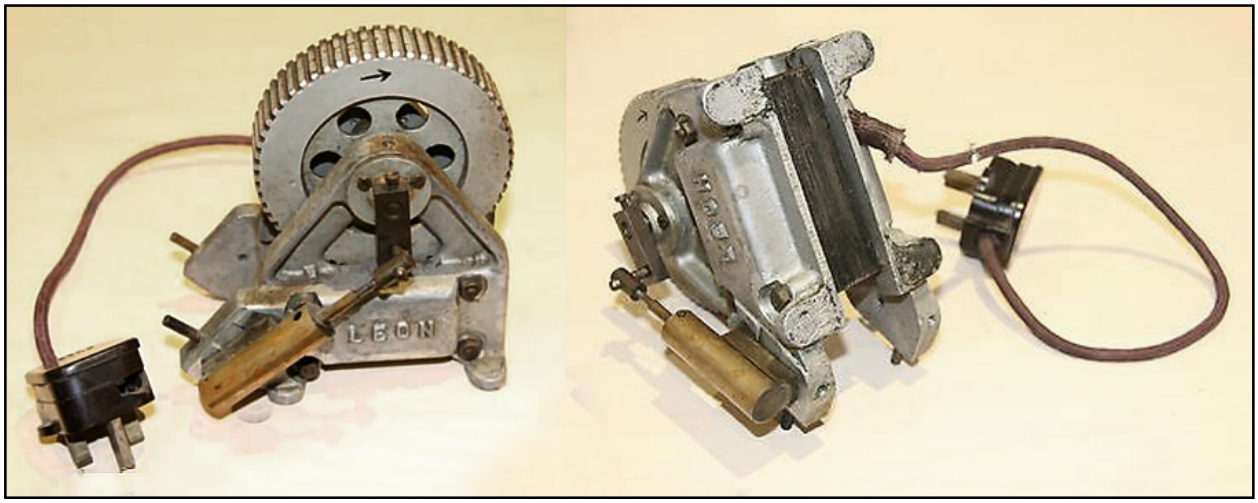


Figure 35: LEFT: The Leon air pump n its upright position; RIGHT: The pump turned upside-down, showing the coiled armature between the four corners of the stand.

Figure 35 shows two views of the Leon air pump, the one on the left being an overall view and the one on the right a look at the underside showing the coiled armature between the four corners of the stand.

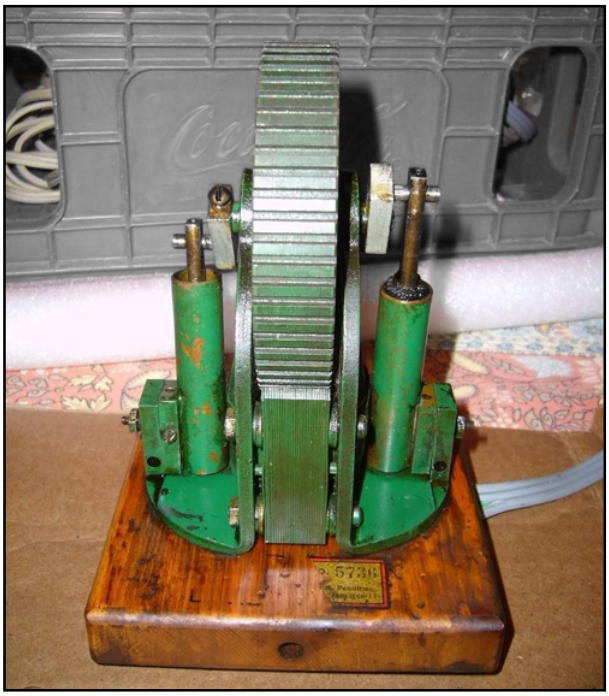


Figure 36: The Tankaire used "wobbler" type cylinders and valves similar to those used on many model steam engines.

The Tankaire (Figure 36) used a rotor that drove a piston on each side. The pump used "wobbler" type cylinders and valves similar to those used on many model steam engines. Later induction pumps such as the Marco used a much thinner rotating wheel. How the wobbler type works is shown in Figure 37 The rotor turns as a result of the induction motor. One end of the piston rotates around a pin attached to the flywheel. As the fly-wheel rotates, the piston goes back and forth, pushing out air to the aquarium when the piston end is in the low position and pulling in air when it is in the high position. Both the Leon and Tankaire pumps were on the market circa 1908.

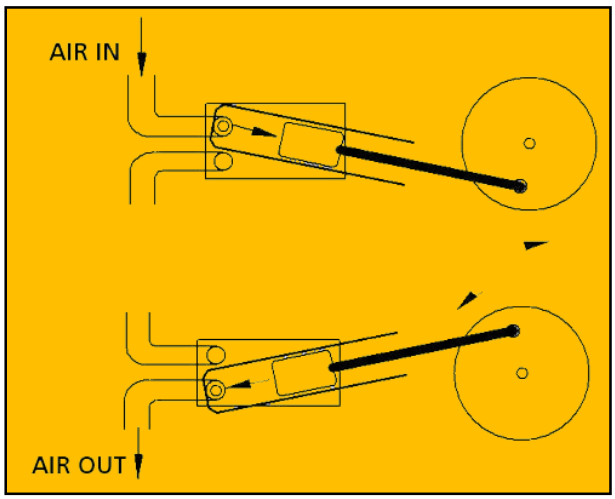


Figure 37: How the pistons work.

Figure 38: The "Eureka Electric Air Pump," made by the Bishop-Babcock-Becker Co.

The Bishop-Babcock-Becker Company also produced an induction motor double-piston air pump that looked much like the Leon and Tankaire pumps that were just described. It was patented in 1913 under the name "Eureka Electric Air Pump" (Figure 38), but it is not known what year it came on the market. Its appearance suggests that it was larger and better-made than the other pumps.

E.4 HEATING SYSTEMS

Because of the expense of individual tank heaters, aquarists having many tanks usually heat the room the tanks are in rather than separately. Those who want to heat a single tank in the Dawn period, however, did not have available the electric heaters that are common today so they had to construct heating systems themselves. These systems are of two types: direct heating systems and water-circulating systems. The first five of the six shown in Figure 39 are of the first type and involved making holes in the bottom of the tank; the last is a water-circulating system where no holes were required. All were heated with Bunsen burners as the households of the day were often supplied with gas for heating and/or lighting. My book, "The Toy Fish, etc.," (Klee, 2014) shows many types of heating systems devised during this time.

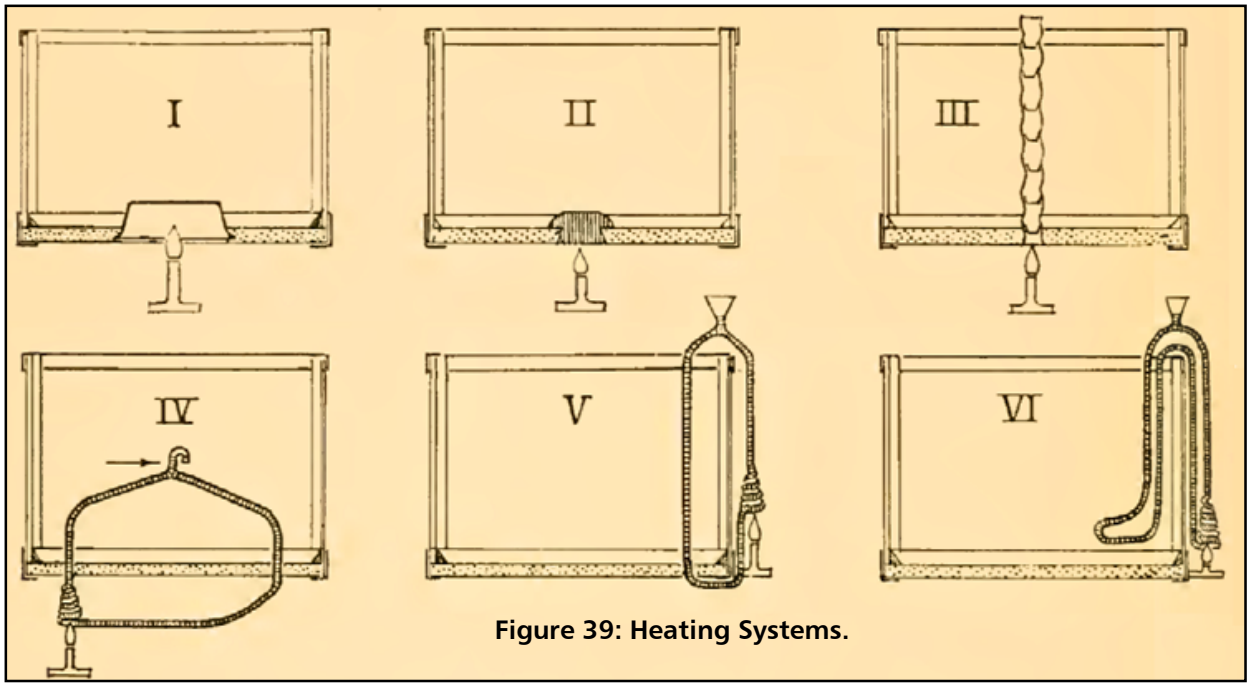


Figure 39: Heating Systems.

E.5 FILTRATION

Filtration, however, was virtually unknown during this period and the popularization of filtration would have to wait until 1932 when the first inexpensive inside box filter was placed on the market. However, the Treasurer of the Chicago Fish Fanciers' Club, Carl Fossetta, devised the first airlift outside filter. His equipment is shown in Figure 40. Water was drawn through a perforated glass tube, down a rubber hose to a triple-necked Wolff bottle. The Wolff bottle, used by chemists, contained the gravel used as the filtering medium. The filtered water passed through an airlift, up through a rubber hose and then back to the tank. The third neck of the Wolff bottle was used for back-washing the gravel. In principle this is identical to the outside airlift filter systems used much later.

E.6 FISH FOODS

The manufacturers of commercial fish foods kept their ingredients close to their vests but some of them mentioned Daphnia and Cypris, along with "cereal." Harry Peters of Philadelphia sold his fish food, Greenriver Fish and Baby Fish Food and advertised that it contained 17 ingredients plus Daphnia. Mulertt sold two foods and advertised that all goldfish and other carp-like fishes, also paradise and some catfish, were best fed regularly on "IXL" and occasionally on " Nero," and sunfish , eels and other carnivorous fish, also salamanders and turtles, should be fed regularly on "Nero."

Otherwise, aquarists made do with their own food preferences. The natural foods, Daphnia, Cyclops, Cypris and worms were the best, but aside from these, fish eggs, raw or boiled, finely scraped fish flesh of the fresh or salt water varieties, oysters, clams, shrimp, or lobster meat, smoked fish, such as herring, whitefish or salmon were used with more or less success. After these came animal foods such as beef, veal, lamb or game of any sort, used either raw or boiled, but in all cases scraped, dried or pulverized. A popular food for small fish or fry that have pasted the yolk-sac stage was the yolk of a very hard-boiled egg, fed in a fluid or powdered state. When fishes were fed with meat, care was taken to have it cut or scraped into smaller pieces.

E.7 THE FISH SOLD DURING THE DAWN ERA

Tables 1 and 2 (next page) show the fish offered by two different full-page advertisers in *The Aquarium* in its October 1912 issue. The list of fish in the ad by The Nature Shop at 579 W. 181st Street, New York City is impressive. The list of fish in the ad by Franklin Barrett at 4815 D Street, Olney, Philadelphia is less so since it mainly offers only fancy (read "expensive") goldfish. This clearly shows the large difference in demand between the Philadelphia and New York City aquarists and this holds true for aquarists in Philadelphia and any other city at the time for that matter.

This not to say that there wasn't a market for fancy goldfish in New York City. In the Nature Shop add is added below the list the statement that

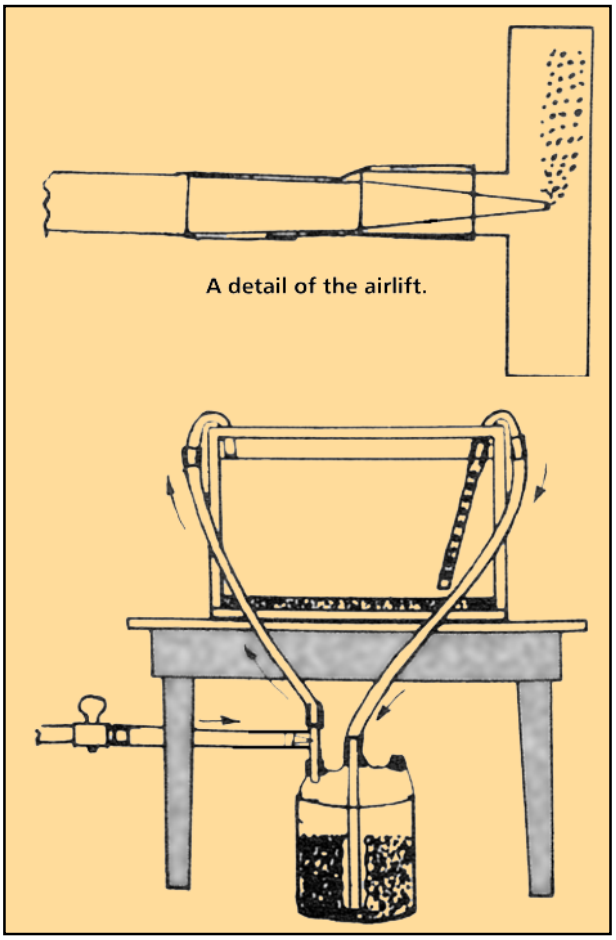


Figure 40: The Carl Fossa Filtration System.

TABLE 1: LIST OF FISHES FOR SALE BY THE NATURE SHOP, NEW YORK CITY

Anabas scandens	Mollienesia latipinna
Barbus conchonius	Ophiocephalus striatus
Barbus semifasciolatus	Paratilapia multicolor
Badis badis	Paratilapia species
Betta rubra	Pantodon buchholzi
Betta splendens	Platypoecilia maculata
Callichthys callichthys	Platypoecilia niger
Callichthys marmoratus	Platypoecilia rubra
Cichlasoma nigrofasciatum	Platypoecilia species
Danio rerio	Poecilia poecilioides
Danio malabaricus	Poecilia species
Gambusia affinis	Polycentrus shomburgkii
Gambusia caudimaculata	Polyacanthus dayi
Gambusia holbrooki	Pseudoxiphophorus bimaculata
Gambusia nicaraguensis	Rivulus flabellicauda
Gambusia rachowi	Trichogaster fasciatus
Girardinus reticulatus	Trichogaster lalius
Gymnogeophagus gymnogenys	Tetrogonopterus lineatus
Haplochilus chaperi	Tetrogonopterus guppyi
Haplochilus panchax	Tetrogonopterus rubilus
Haplochilus rubrostigma	Tetrogonopterus ulreyi
Haplochilus sexfasciatus	Xiphophorus brevis
Hero facetus	Xiphophorus helleri
Macropodus viridiauratus	

TABLE 2: LIST OF FISHES FOR SALE BY FRANKLIN BARRETT, PHILADELPHIA

Common	Celestials
Scaled	Lion's Heads
Scaleless	Shubunkins
Comet	Paradise
Fantail	Golden Orfes
Fringetail	Golden Tench
Telescopes	Gambusia affinis

We are constantly getting in new varieties of fish, so if there are any species that you want, let us know, and we will quote prices. We always have on hand a nice collection of common and rare Gold Fish at prices that are right; also aquarium plants, snails, tadpoles, etc.

Barrett did, however, did list the following twenty five aquatic plants that he sold: Cabomba, Myriophyllum, Anacharis, Sagittaria, Ludwigia, Vallisneria, Hornwort, Potamogeton, Snow Flake, Water Poppy, Water Hyacinth, Salvinia, Water Fern, Lace Leaf, Water Lettuce, Umbrella Palms, Cyperus Papyrus, Cyperus, Alternifolius, Gracilis, Laxus Folva, Variegated, Boston Ferns, Pteris Ferns, Water Lilies. I venture to say that this was because there was a longer history of aquatic plants being kept by goldfish fanciers since many of them were aquatic gardeners from whence the word "aquarium" came.

F. RES GESTAE

Res Gestae is a Latin term which means "things done." *Res Gestae Divi Augusti* ("The Deeds of the Divine Augustus"), for example, is a monumental inscription composed by the first Roman emperor, Augustus, giving a first-person record of his life and accomplishments. Another *res gestae* is *Pater patriae* ("Father of his country"), sometimes used by the Romans to designate distinguished statesmen.

Figure 41: Caesar Augustus (63 BC–AD 14), also known as Octavian, was the first Roman emperor. Res *Gestae Divi Augusti* ("The Deeds of the Divine Augustus") is a monument inscription composed by him.

Figure 42: Antoine Laurent Lavoisier (1743–1794), "The Father of Chemistry."

Discoveries and innovations often are the work of multiple people, resulting from continual improvements over time; however, certain individuals are remembered for making significant contributions to the birth or development of a field or technology. Historically, persons have been dubbed, mostly in Western societies, as being the father, mother, founder or similar of a particular field or invention. Two examples are Ada Lovelace: "The Mother of Computer Programming" and Antoine-Laurent Lavoisier, "The Father of Chemistry." These are honorary titles given to people by a person or group for specific accomplishments, most of the time unofficially.

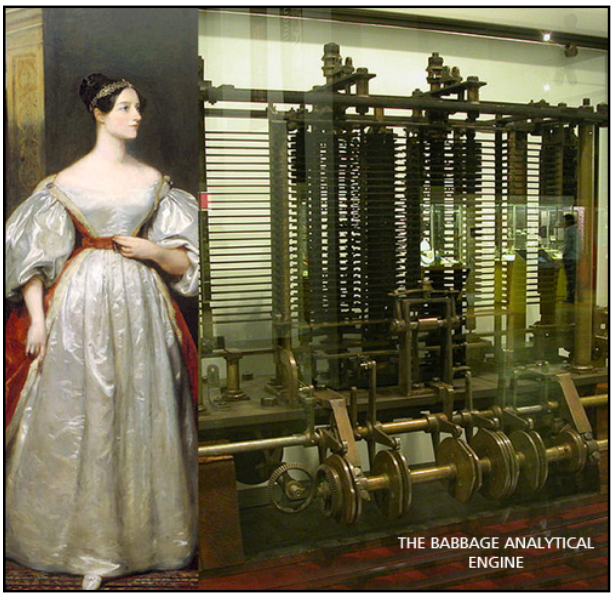


Figure 43: Ada Lovelace (1815-1852). She was the first to recognize that Charles Babbage's proposed mechanical general-purpose computer, the Analytical Engine, had applications beyond pure calculation, and to have published the first algorithm intended to be carried out by such a machine. As a result, she is often regarded as the "Mother of Computer Programming."

To date, I have named four of them myself, i.e., The Grandfather of the Aquarium Hobby in America (Hugo Mulertt), The Father of Aquarium Photography (Dr. Robert W. Schufeldt), The Father of the Fancy Guppy (Charles Visel), and The Father of the Aquarium (Carl Linneatus). In my writings I have mentioned many other "fathers," but these are the four I myself have named. It is now time to honor Eugene Smith for his important contributions to the development of the aquarium hobby in America and I have named him, "Father of Aquarium Societies in America."

G. SUMMARY

As the aquarium hobby marched on with time, aquariums became more popular as many houses had an electricity supply after World War I. Electricity allowed artificial lighting, as well as cheaper and more efficient aeration, filtration, and heating of the water. It ushered in more and more aquarium societies, new commercial aquarium magazines, advanced air pumps, (somewhat) better heating devices and sturdier tanks. One right after another, new to the hobby tropical fish species were imported as transportation became better and cheaper. I won't go into the changes that occurred after World War II since most readers will know them well enough.

Over time, there has been an increasing appreciation of the value of an aquarium in providing many health benefits such as reducing stress, blood pressure and heart rate. In addition, the process of keeping a successful aquarium exposes the aquarium keeper to a vast array of scientific information, principles, processes and methods. Nonetheless, there is an irrepressible and sentimental longing or wistful affection for the past, and I commend those aquarists that paved the way for the rest of us.

FINIS CORONAT OPUS

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SPECIES & NAMES

by Albert J. Klee, Ph.D.

(*Essays on Aquarium Hobby History*, January 4, 2022)

This essay was sparked by my interest in two excerpts I found in a pair of books that should be known to serious aquarists interested in aquarium history. The first was something I found in Charles Kingsley's book, "Glaucus; or, the Wonders of the Shore" (Kingsley, 1855). Glaucus was a deity of the sea. According to Ovid, he was a fisherman who found an herb that brought dead fish to life, so he decided to try it himself. As a result, he became immortal, but he grew fins, and his legs stuck and melded in a fish tail. As a creature of water, he could no longer walk the earth with earthly feet, but despite his sorrow, the other sea deities like Oceanus and Tethys welcomed him with open arms and taught him the skill of prophecy.

A1. CHARLES KINGSLEY

The son of a country parson, Charles Kingsley was born on June 12, 1819. After attending several schools he entered Magdalene College, Cambridge in 1838 where he was more sportsman than scholar. Shortly after graduation in 1842, he was ordained an Anglican priest. In 1842 he became rector of Eversley, the parish he served until his death in 1875. In 1859 Kingsley was appointed chaplain to Queen Victoria, and in 1860 he became Regius Professor (in the United Kingdom the holder of a university chair founded by a sovereign, especially one at Oxford or Cambridge instituted by Henry VIII, or filled by Crown appointment of modern history at Cambridge). A man of so varied activities was hardly a scholar, but Kingsley's lectures, more about men than politics or economics, were popular. In 1861 he tutored the Prince of Wales, later Edward VII, in history.

Kingsley was a tall, thin, excitable man with a stammer. His enthusiasms pulled him in many directions, just as they drew famous people, including royalty, to him. Among his friends was Philip Henry Gosse. In 1848, he was one of the founders of Christian Socialism. To support the movement he wrote many articles over the signature "Parson Lot" and two novels, *Alton Locke* (1850), about the plight of the urban worker, and *Yeast* (1851), about the ills of the rural poor. However, Kingsley's opinions were far more Christian than socialist. Certainly he never wanted to upset the established social order.

Turning to history, Kingsley wrote two historical novels, *Hypatia* (1853) and *Westward Ho!* (1855). He also grew interested in biology and wrote *Glaucus* (1855), a nonfictional description of the wonders of the shore. Kingsley was a poet too. However, perhaps his best-loved book was *The Water-Babies* (1863), a children's story in which he combined his interests in natural science and religion. In 1869 Kingsley resigned his professorship of history and was appointed canon of Chester (a title given by the bishop to a priest or lay person to mark their special contribution to the church. They are important in the Church of England and men of the highest caliber); in 1873

Charles Kingsley (1819–1875).

he became canon of Westminster. He died on Jan. 23, 1875.

A2. A THEOLOGICAL CONTROVERSY

Kingsley for the most part was a good person but from the first, he had been anti-Roman Catholic (and consequently, anti-Irish as well). In 1864, while holding the Chair of History at Cambridge, Kingsley published a review of J. A. Froude's "History of England" (a work with strong anti-Catholic bias) and made the statement that Cardinal Newman had declared that 'truth' was not a matter of great importance to Roman clergy. John Henry Newman (1801–1890) was an English theologian, scholar and poet, first an Anglican priest and later a Catholic priest and cardinal, who was an important and controversial figure in the religious history of England in the 19th century. He was known nationally by the mid-1830s and was canonized as a saint in the Catholic Church in 2019

Newman took great offense at this, leading to an exchange of pamphlets and a public apology by Kingsley for misrepresenting Newman. What began was a correspondence between himself and Kingsley which started in private but rapidly became a veritable pamphlet war in which it was soon very clear that Kingsley was completely out of his depth. Sir Henry Wotton (1568-1639), an English poet and diplomat wrote *disputandi pruritis ecclesiarum scabes* (literally "an itch for disputation is the mange of the churches). If Wotton had been alive at the time I wonder what his comment would be then! (Wotton is also known for his definition of an ambassador: "an honest man sent to lie abroad for the good of his country."

Most of the pamphlets by Newman in this exchange were later published under the title, Apologia Pro Vita Sua ("apologia" then meant "defense," not "apology" as it does today), and it ranks just below Augustine's Confessions as one of the great works of religious self-analysis in the canon of Western literature. It starts off by taking Kingsley apart thoroughly and with a certain relish. But now to my main point, which involves Kingsley's "Glaucus; or, The Wonders of The Shore."

A2. GLAUCUS; OR, THE WONDERS OF THE SHORE

The following is an 1856 anonymous review of the book:

It is a very difficult thing to write a good review, more especially on subjects of a scientific nature: the review must not be too learned, or it will have too few readers; it must not betray ignorance of the subject by the writer, or it is simply useless. "Glaucus," if considered as a review, shares both these faults; it is much too learned, and at the same time reveals to us an alarming extent of ignorance in the writer on the subject of natural history. Yet, few works published during the past year have been more read than "Glaucus"; go where you will, talk to whom you will, everyone has seen "Glaucus," and speaks approvingly of it; some, indeed, suggest, that it would have been better "if so and so had been omitted," or object to a passage in this page or a sentence in that; but,

Cardinal John Henry Newman (1801–1890).

taken as a whole, it is very seldom that a work receives so cordial a welcome. Now, what is the secret of this success? Mr. Kingsley had acquired fame as a writer on other topics before he touched upon natural history; and though apparently very ignorant of this latter subject, still he brought all the trained skill of the author, and all the weight of a pen of no mean calibre, to bear upon the topic he chose to advocate. Imagine the excitement that would be caused if Macaulay or Dickens were to bring out a book on natural history; all the world would read it, to see what they could have to say on the subject; and we presume it has been with much the same motive that all the world has read Kingsley's "Glaucus."

Glaucus was one of the earliest books I picked up during my early days of delving into the history of the aquarium hobby. I was, however, not tempted to read every page since the book is saturated with theological arguments like the following:

…we meet with many a Christian passage in scientific books, which seems to us to go, not too far, but rather not far enough, in asserting the God of the Bible, as Saint Paul says, "not to have left Himself without witness," in nature itself, that He is the God of grace. Why speak of the God of nature and the God of grace as two antithetical terms? The Bible never, in a single instance, makes the distinction; and, surely, if God be (as He is) the Eternal and Unchangeable One, and if (as we all confess) the universe bears the impress of His signet, we have no right, in the present infantile state of science, to put arbitrary limits of our own to the revelation which He may have thought good to make of Himself in nature. Nay rather , let us believe that, if our eyes were opened , we should fulfil the requirement of Genius, to see the universal in the particular," by seeing God's whole likeness, His whole glory, reflected as in a mirror even in the meanest flower ; and that nothing but the dullness of our own sinful souls prevents them from seeing day and night in all things, however small or trivial to human eclecticism, the Lord Jesus Christ Himself fulfilling His own saying, " My Father worketh hitherto, and I work ."

Even though Kingsley in part is arguing in favor of science, which I am of course in accordance with, a little of this ecumenical exuberance goes a long way. He provides little detail in setting up a saltwater aquarium, referring to Gosse's 1854 book instead (Gosse, 1854). One example is the following:

Buy at any glass-shop a cylindrical glass jar, some six inches in diameter and ten high, which will cost you from three to four shillings; wash it clean, and fill it with clean salt water, dipped out of any pool among the rocks, only looking first to see that there is no dead fish or other evil matter in the said pool, and that no stream from the land runs into it. If you choose to take the trouble to dip up the water over a boat's side, so much the better.

Unfortunately, this is bad advice. It would have been better to have recommended the reverse, i.e., a cylindrical glass jar, some ten inches in diameter and six inches high.

Nonetheless, after a more careful reading I was more impressed with some of his advice and although the following excerpt is long, it says a lot for raising children:

Glaucus or Wonders of the Shore, Plate 2.

I have been sketching an ideal but one that I seriously recommend to the consideration of all parents; for, though it be impossible and absurd to wish that every young man should grow up a naturalist by profession, yet this age offers no more wholesome training, both moral and intellectual, than that which is given by instilling into the young an early taste for out-door physical science. The education of our children is now more than ever a puzzling problem if by education we mean the development of the whole humanity, not merely of some arbitrarily chosen part of it. How to feed the imagination with wholesome food, and teach it to despise French novels, and that sugared slough of sentimental poetry, in comparison with which the old fairy-tales and ballads were manful and rational; how to counteract the tendency to shallow and conceited sciolism [*i.e., superficial knowledge*]**, engendered by hearing popular lectures on all manner of subjects, which can only be really learnt by stern methodic study; how to give habits of enterprise, patience, accurate observation, which the counting-house or the library will never bestow; above all, how to develop the physical powers, without engendering brutality and coarseness, —are questions becoming daily more and more puzzling, while they need daily more and more to be solved, in an age of enterprise, travel, and emigration, like the present.**

For the truth must be told, that the great majority of men who are now distinguished by commercial success, have had a training the directly opposite to that which they are giving to their sons. They are for the most part men who have migrated from the country to the town, and had in their youth all the advantages of a sturdy and manful hill-side or sea-side training; men whose bodies were developed, and their lungs fed on pure breezes, long before they brought to work in the city the bodily and mental strength which they had gained by loch and moor. But it is not so with their sons. Their business habits are learnt in the counting-house; a good school, doubtless, as far as it goes: but one which will expand none but the lowest intellectual faculties; which will make them accurate accountants, shrewd computers and competitors, but never the originators of daring schemes, men able and willing to go forth to replenish the earth and subdue it.

And in the hours of relaxation, how much of their time is thrown away, for want of anything better, on frivolity, not to say on secret profligacy, parents know too well; and often shut their eyes in very despair to evils which they know not how to cure . A frightful majority of our middle class young men are growing up effeminate, empty of all knowledge but what tends directly to the making of a fortune; or rather, to speak correctly, to the keeping up the fortunes which their fathers have made for them; while of the minority, who are indeed thinkers and readers, how many women as well as men have we seen wearying their souls with study undirected, often misdirected; craving to learn, yet not knowing how or what to learn;

cultivating, with unwholesome energy, the head at the expense of the body and the heart; catching up with the most capricious self-will one mania after another, and tossing it away again for some new phantom; gorging the memory with facts which no one has taught them to arrange, and the reason with problems which they have no method for solving; till they fret themselves into a chronic fever of the brain, which too often urges them on to plunge, as it were to cool the inward fire, into the ever restless sea of doubt and disbelief.

It is a sad picture. There are many who may read these pages whose hearts will tell them that it is a true one. What is wanted in these cases is a methodic and scientific habit of mind; and a class of objects on which to exercise that habit, which will fever neither the speculative intellect nor the moral sense; and those physical science will give, as nothing else can give it.

A3. KINGLSEY'S COMMENTS ON THE NAMING OF NEW SPECIES

The following is the section that provided part of the impetus for my writing this essay. Here Kingsley is describing the values in strolling along or in the seaside looking for desirable specimens perhaps to take home–usually anemones, invertebrates and fishes.

But what is even this to the delight of finding a new species?—of rescuing (as it seems to you) one more thought of the divine mind from Hela [i.e., *Odin's first born; she served as Executioner and Goddess of Death as she and her father made their way through the Nine Realms bringing death, destruction and conquest along for the ride*]**, and the realms of the unknown, unclassified, uncomprehended? As it seems to you: though in reality it only seems so, in a world wherein not a sparrow falls to the ground unnoticed by our Father who is in heaven.**

The truth is, the pleasure of finding new species is too great; it is morally dangerous; for it brings with it the temptation to look on the thing found as your own possession, all but your own creation; to pride yourself on it, as if God had not known it for ages since; even to squabble jealously for the right of having it named after you, and of being recorded in the Transactions of I-know-not-what Society as its first discoverer:—as if all the angels in heaven had not been admiring it, long before you were born or thought of.

Wow! This is a viewpoint that I never before considered, but I will leave it to the reader to discover to whom it might apply. However, this is a good time to discuss the hurdles in the history of naming fish species. In the past, when an ichthyologist discovers or receives a fish that he thinks is a new species, he does some research to determine whether it has been named previously. This is a risky business, fraught with the possibility that someone else has beaten him to it. If he is satisfied that it is new he writes a paper and submits it to the editor of a professional journal.

After World War II, however, there was a splurge of new species being discovered and named, placing a severe economic burden on these professional journals, most of which were sponsored by educational organizations such as universities. One of the results was that it took longer and longer to get the article published and some publications even started to charge the author if the paper were accepted.

A stamp from East Germany. Cardinal Tetra (*Cheirodon axelrodi*) (Germany, Democratic Republic (DDR) 1966)

A4. THE CHEIRODON AXELRODI DISPUTE AND ICZN RULES ON PUBLICATION

In 1956, specimens of a small characin were sent independently to Leonard P. Schultz by Herbert Axelrod, who originally acknowledged that the specimens had been received from a New Jersey fish dealer on 10–11 February 1956, and to George S. Myers and Stanley H. Weitzman by William T. Innes and Paramount Aquarium (Myers and Weitzman, 1956). Both Schultz (1956) and Myers and Weitzman (1956) published a description of the species in February 1956, and, after a heated debate and split vote, the International Commission on Zoological Nomenclature (ICZN) ruled on the priority of the name *Cheirodon axelrodi* Schultz (ICZN, 1957; Opinion 485). In the letters concerning this case, however, no one has been able to answer why Vol. 4, No. 4 of the *Tropical Fish Hobbyist* should carry the precise date 20 February 1956, and the succeeding one reverts to the similar form, May-June 1956. In any event, the general feeling to this day is that the ICZN had been duped.

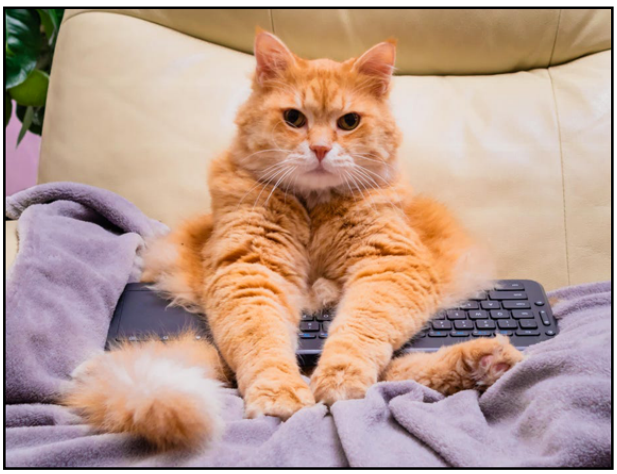
Hyphessobrycon cardinalis Myers & Weitzman was clearly published as a voluntary act of publication in a journal normally serving as a vehicle of taxonomic publication–the Stanford Ichthyological Bulletin– dated 21 February. *Cheirodon axelrodi* Schultz, on the other hand, does not appear to have been deliberately published by its author. Schultz sent a personal letter to Axelrod who published the article on his own responsibility in the *Tropical Fish Hobbyist*, a lay journal which, unappreciated at the time, satisfied the ICZN's publishing rules which roughly were as follows: Article 8 of the ICZN specified the following for what constituted a published work. A work was to be regarded as published for the purposes of zoological nomenclature if it complied with the requirements of the Article and was not excluded by the provisions of Article 9 (this discussed what does not consist of published work). A work had to satisfy the following criteria:

1. It must be issued for the purpose of providing a public and permanent scientific record,
2. It must be obtainable, when first issued, free of charge or by purchase,
3. It must have been produced on paper, by a printing method (such as letterpress, offset printing) or by hectographing or mimeographing.

This led to a breaking of the log jam in publishing new names. It not only relieved the author of any financial burden but publication now was a lot faster.

A5. ICHTHYOLOGY AFTER WORLD WAR II

After World War II there was a general decline in systematics and taxonomy, the science dealing with the identification, description, naming and classifying of organisms. Ichthyology today is not in vogue in universities, especially not in taxonomic ichthyology. As a result, it is difficult to acquire tenure, much less the grants necessary to fund the collecting trips that are required. Also, most taxonomists are faced with editorial resistance to publishing their work in the high impact journals that will secure tenure and promotion and allow them to continue their work and contributions. I personally know two who are in this unenviable position, whiling their way to teaching anatomy or some other biological course where students are not as scarce. For a young ichthyologist to make a name for himself, it is not enough to name new species. One way out is to take one or more species and create new taxa for them. As a result, genera long familiar to aquarists now are split into one or more genera or even subgenera.



A new member of the Aquarium Hobby Historical Society preparing his latest post.

The terms "lumpers" and "splitters" were introduced more widely by George G. Simpson in his 1945 work *The Principles of Classification and a Classification of Mammals*. As he put it:

…splitters make very small units–their critics say that if they can tell two animals apart, they place them in different genera…and if they cannot tell them apart, they place them in different species. … Lumpers make large units–their critics say that if a carnivore is neither a dog nor a bear, they call it a cat.

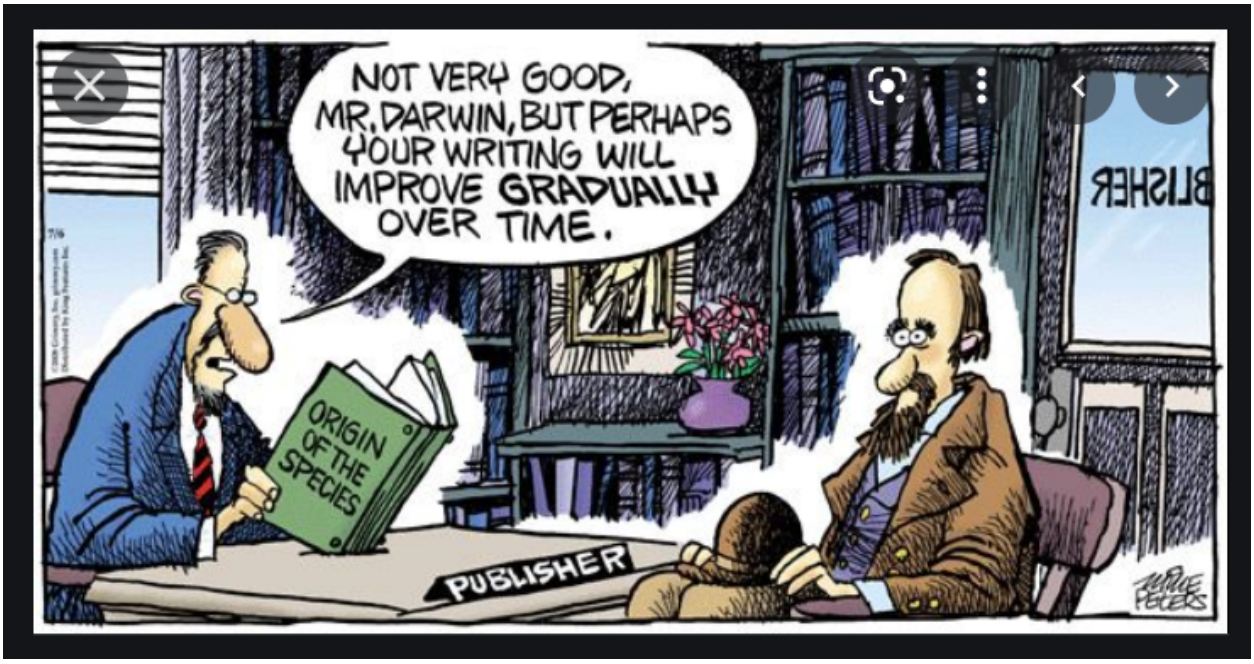
Both the *Oxford English Dictionary* and the Wikipedia article for "Lumpers and splitters" credit the first use of the terms to none other than Darwin, on the strength of a letter he wrote to his friend Joseph Dalton Hooker in 1857:

I am got extremely interested [sic and Boldfaced emphasis in the original] **in tabulating according to mere size of genera, the species having any varieties marked by Greek letters or otherwise: the result (as far as I have yet gone) seems to me one of the most important arguments I have yet met with, that varieties are only small species–or species only strongly marked varieties. The subject is in many ways so very important for me; I wish much you would think of any well-worked Floras with from 1000–2000 species, with the varieties marked. It is good to have hair-splitters & lumpers.**

Hooker's priority was to establish a reputation as a philosophical naturalist (i.e., one who believes the doctrine that the natural world is all there is), and to do so he embarked on a survey of global vegetation patterns. He believed that taxonomic "splitters" hindered his ambition to create natural laws for botany (and hence establish it as a prestigious science) by generating a multitude of redundant synonyms for every plant variety. Despite the fact that Darwin's ideas apparently promised a justification for splitting, they also offered a philosophical justification for Hooker's taxonomic practice, and so he enthusiastically championed his friend. However, splitting is not the main reason for the plethora of species described after World War II.

A6. TAXONOMIC PUBLISHING ENTERS THE DIGITAL AGE

The ICZN for dealing with paper publications first appeared over fifty years ago–in 1961–and the earliest attempt at a formal code of nomenclature had been proposed by Hugh Edwin Strickland another 120 years before that. Despite all this time, the Code as it pertains to paper publica-



tions has still not been perfected, and revisions continue to be proposed and published. Indeed, some of the issues the code grapples with (such as what does or does not constitute "publication") are, in the end, probably not universally soluble, because they deal with factors such as judging ethical behavior that cannot be expressed in simple formulae applicable to every situation. So it should hardly be expected that rules for electronic publication should have immediately attained perfection when not even those for paper publication, with 170 years or more of a head start, have not yet done so. In any event, following four years of highly charged debate, the rules for publication of scientific names of animals have been changed to allow electronic publications to meet the requirements of the stringent ICZN.

In a landmark decision, the ICZN has passed an amendment to its rules that will accept an electronic-only publication as "legitimate" if it meets criteria of archiving and the publication is registered on the ICZN's official online registry, ZooBank. ZooBank is a central, authoritative and comprehensive resource for scientific names in zoology. It provides an authoritative online, open-access, community-generated registry for zoological nomenclature, as a service to taxonomists, biologists, and the global biodiversity informatics community. With ZooBank in place there will be access to a single reference list of animal names, and so discussions about priority species and habitats can proceed with greater clarity and speed. The criteria mentioned above include:

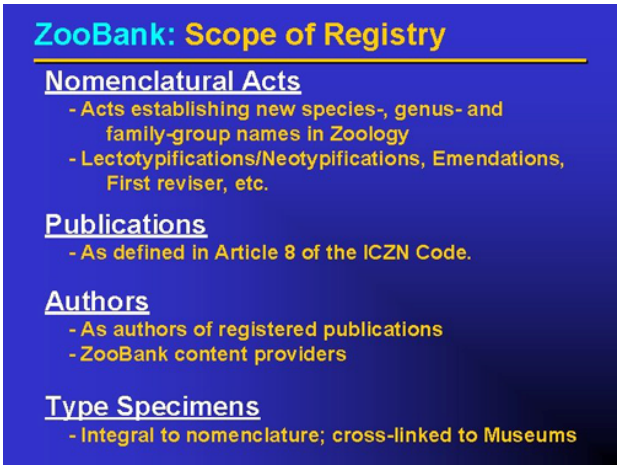
1. Wide accessibility;
2. Issued for the permanent scientific record (online posting for a limited time is not accepted);
3. Fixed content and layout (e.g., a protected PDF file, not an editable Word file);
4. Date of publication must be stated in the work itself (i.e., paper or book); a note on the journal's webpage is not sufficient;
5. Work (i.e., a paper or a book) must be registered in ZooBank, the Official Registry of Zoological Nomenclature (http://zoobank.org), and contain evidence that such registration took place (e.g., exact date of registration or/and registration number); registration of new animal names is not mandatory, but encouraged (paper publications, on the other hand, do not yet have to be registered);
6. ZooBank registration entry must give the name and internet address of an organization other than the publisher that is intended to permanently archive the work in a matter that preserves content and layout, and is capable of doing so (this does not need to be stated in the published work itself; such archives are currently Bioline International, Biotaxa, CLOCKSS, Harvard Digital Repository Service, Hathitrust, LOCKSS, National Digital Heritage Archive of the National Library of New Zealand, Portico®, PubMedCentral®, and Virginia State Publications Depository Program);
7. ZooBank registration entry must contain the ISBN or ISSN number (the former identifies editions of books and the latter is used for serials such as journals, magazines and newspapers).

Currently, ZooBank accommodates the registration of four different kinds of data objects:

1. Nomenclatural Acts: Published usages of scientific names for animals, which represent nomenclatural acts as governed by the ICZN Code of Nomenclature. Most of these acts are original descriptions of new scientific names for animals, but other acts may include emendations, lectotypifications (a lectotype is a specimen chosen as the type of a species or subspecies if the author of the name fails to designate a type**)**, and other acts as governed by the ICZN Code.

2. Publications: Publications that contain Nomenclatural Acts, as defined above.

3. Authors: Anyone who is an author of one or more Publications (as defined above), or who is a contributor to ZooBank content.



4. Type Specimens: Type specimens for scientific names of animals. The registration of Type Specimens is considered provisional and is not yet fully implemented in ZooBank.

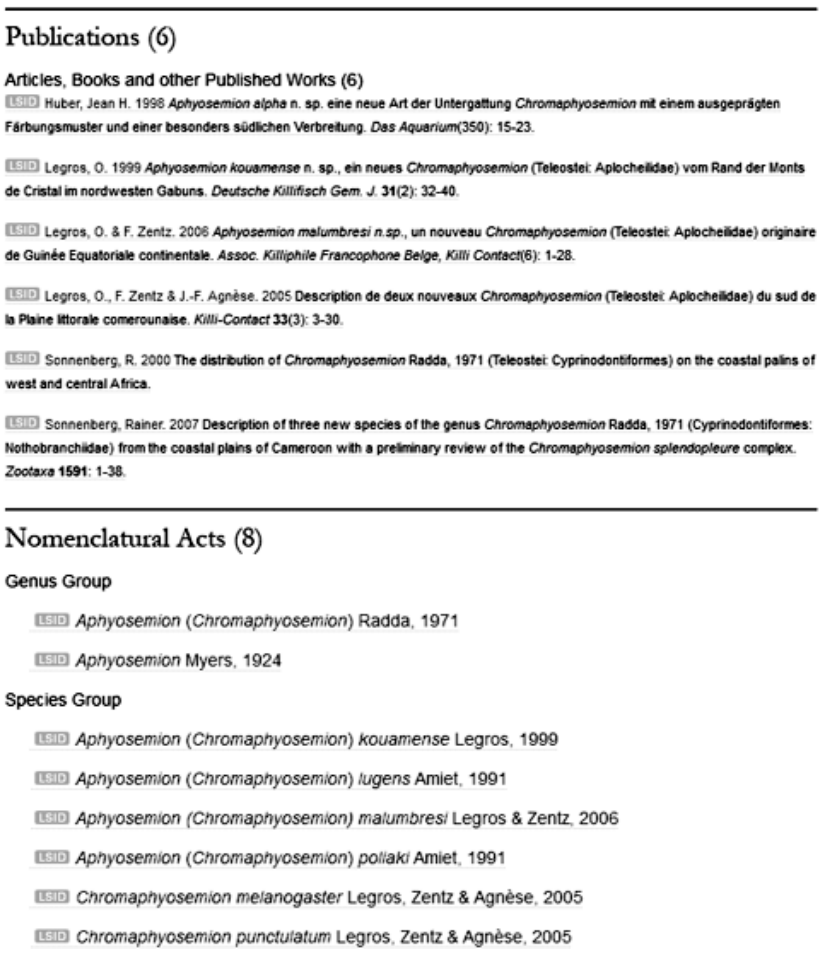
The accompanying image shows what ZooBank looks like when I entered "Chromaphyosemion" in its search box. Clicking on entries leads to addition information regarding the species.

The decision about electronic publication has not been without controversy because the rules of the ICZN are considered, and intended, to be among the most rigorous for scientific publication. The task of keeping correct information on animal names is immense and critical, as almost all information on the living world is linked through names. Animals comprise the vast majority of the world's recognized living species and currently stands at around 1.9 million, growing at a rate of about 20,000/year. For each of these groups there are as many as 2–10 legitimately published names due to past debate and poor information exchange. Estimates of the total of living animal biodiversity are 4–20 times this number (8–50 million species), with fossils adding many more. When the task of cataloguing biodiversity approaches completion, this vast amount of information will be linked through names.

The new decision means that the difficulty in naming some species such as the case of *Darwinius masillae* can be avoided. In 2009 a fossil discovery was announced that was supposed to profoundly change our views on human evolution. The 47 million year old fossil nicknamed "Ida," was published in the electronic journal *PLoS One*. The publishers had an 11th hour realization that this publication would not be legitimate under ICZN rules. The name could even have been scooped by an unscrupulous author. A "special paper copy" of the journal had to be published, which would not be needed under the new rules.

The ICZN ruling is explicit that while the publication can exist in an electronic-only format, it must still be published through a recognized scientific journal. Purely web options such as blog posts, forums, Wikimedia, Wikipedia, Scratchpads and other potentially ephemeral, unarchived web-only sources still do not qualify as legitimate electronic publications under the new ICZN rules.

It should be noted that it is currently not the purpose of the Code nor is it in the purview of the ICZN to police taxonomy. Taxonomy is a scientific endeavor, whereas nomenclature is not. The Code should be used as those names which are regarded as being established and



Publications (6)

Articles, Books and other Published Works (6)

LSID Huber, Jean H. 1998 *Aphyosemion alpha* n. sp. eine neue Art der Untergattung *Chromaphyosemion* mit einem ausgeprägten Färbungsmuster und einer besonders südlichen Verbreitung. *Das Aquarium*(350): 15-23.

LSID Legros, O. 1999 *Aphyosemion kouamense* n. sp., ein neues *Chromaphyosemion* (Teleostei: Aplocheilidae) vom Rand der Monts de Cristal im nordwesten Gabuns. *Deutsche Killifisch Gem. J.* **31**(2): 32-40.

LSID Legros, O. & F. Zentz. 2006 *Aphyosemion malumbresi n.sp.*, un nouveau *Chromaphyosemion* (Teleostei: Aplocheilidae) originaire de Guinée Equatoriale continentale. *Assoc. Killiphile Francophone Belge, Killi Contact*(6): 1-28.

LSID Legros, O., F. Zentz & J.-F. Agnèse. 2005 Description de deux nouveaux *Chromaphyosemion* (Teleostei: Aplocheilidae) du sud de la Plaine littorale camerounaise. *Killi-Contact* **33**(3): 3-30.

LSID Sonnenberg, R. 2000 The distribution of *Chromaphyosemion* Radda, 1971 (Teleostei: Cyprinodontiformes) on the coastal palins of west and central Africa.

LSID Sonnenberg, Rainer. 2007 Description of three new species of the genus *Chromaphyosemion* Radda, 1971 (Cyprinodontiformes: Nothobranchiidae) from the coastal plains of Cameroon with a preliminary review of the *Chromaphyosemion splendopleure* complex. *Zootaxa* **1591**: 1-38.

Nomenclatural Acts (8)

Genus Group

LSID *Aphyosemion* (*Chromaphyosemion*) Radda, 1971

LSID *Aphyosemion* Myers, 1924

Species Group

LSID *Aphyosemion* (*Chromaphyosemion*) *kouamense* Legros, 1999

LSID *Aphyosemion* (*Chromaphyosemion*) *lugens* Amiet, 1991

LSID *Aphyosemion* (*Chromaphyosemion*) *malumbresi* Legros & Zentz, 2006

LSID *Aphyosemion* (*Chromaphyosemion*) *poliaki* Amiet, 1991

LSID *Chromaphyosemion melanogaster* Legros, Zentz & Agnèse, 2005

LSID *Chromaphyosemion punctulatum* Legros, Zentz & Agnèse, 2005

What I got when I entered "Chromaphyosemion" in the ZooBank search box.

accepted by which to determine whether taxon names are nomenclaturally available for use in subsequent publications. But this is precisely where a dilemma exists. The Code is by definition not scientific, but it generates a set of nomenclatural rules for taxonomy and is only useful if there are scientists willing to use the rules. Thus, a name that slips through the (admittedly imperfect) scrutiny of peer review or names generated *en masse* by poorly executed taxonomy automatically enter nomenclature. All it takes is the observance of a few very simple criteria for a taxon name to become available according to the Code. Under these circumstances, it is possible to produce large numbers of names that are Code compliant but have no scientific basis; the Code expects these names to be considered in the same manner as science-based names.

A7. TAXONOMIC VANDALISM

Much of what is in this section and section A6 is due to Hinrich Kaiser (2013), Darren Naisch (2013) and Benjamin Jones (2017). These are lengthy–and also a bit complicated–documents so I have edited them to make them more readable to aquarists. Those wishing to read their complete contents can access them using the above entries in my bibliography.

In taxonomic herpetology there has recently been a troubling development with the emergence of what Hinrich Kaiser, Professor of Biology, Victor Valley College described as pseudoscientific works, in which taxonomic decisions are reported whose methodology fails on basic scientific principles based on modern concepts of publication in science (i.e. demonstrated scientific methodology including a list of specimens examined, scientific publication outlet and peer review with inclusion of editorial oversight). In a textbook definition, Kaiser states:

Pseudoscience attempts to look like actual science so that its assertions might appear valid. However, unlike science, pseudoscience begins with a claim and looks only for things that support it. Controlled experiments are never done. In fact, direct tests of any kind even if possible, are generally avoided. Pseudoscience is indifferent to facts and tries to persuade with appeals to emotion, sentiment, or distrust of established knowledge. Unlike real science, pseudoscience does not progress; nothing is revised or learned. These pseudoscientific works also run afoul of the Code of Ethics appended to the Code.

Recently, Australian snake enthusiast Raymond Hoser has presented over 500 new taxon names in 20 issues of his self-edited and probably non-peer reviewed *Australasian Journal of Herpetology* (*AJH*); Hoser is invariably the only author. As mentioned previously, taxonomy is a scientific endeavor, whereas nomenclature is not. It is currently not the purpose of the Code, nor is it in the purview of the International Commission on Zoological Nomenclature, to police taxonomy. The

American herpetologist Hinrich Kaiser prepares specimens at his makeshift research station at East Timor.

Code should be used as a statement which is assumed to be true without question, and which does not require proof by which to determine whether taxon names are nomenclaturally available for use in subsequent publications.

But as Kaiser points out, this is precisely where a dilemma exists. The Code is by definition not scientific, but it generates a set of nomenclatural rules for taxonomy, and is only useful if there are scientists willing to use the rules. Thus, a name that slips through the (admittedly imperfect) scrutiny of peer review, or names generated *en masse* by poorly executed taxonomy automatically enter nomenclature. All it takes is the observance of a few very simple criteria for a taxon name to become available according to the Code. Under these circumstances, it is possible to produce large numbers of names that are Code compliant but have no scientific basis; the Code expects these names to be considered in the same manner as science-based names.

Hoser uses the Code as a 'name-laundering scheme': his mass-produced names go in and 'clean' names come out. The more names that are put through the system, the greater is the likelihood that some will by coincidence stand if science eventually produces supporting facts. None of these names have a rigorous scientific foundation, which would at the very least require a certain amount of specimen work to validate holotypes along with careful first-hand examination of comparative material (either using museum specimens or molecular data). Hoser does neither; he resorts to bulk citations of all literature on a given taxonomic group, including particularly those papers that feature unnamed branches on relationship trees, and creates a new taxon name for any node that falls in line with his ideas. These passages generally include disclaimers, similar to the following from Hoser to which are appended 151 citations that are not shown here:

Where it is appropriate to rely on earlier published material, this is not necessarily rehashed herein. This is especially in terms of when the relevant material is widely available to readers on the worldwide web '(internet).'

Although Hoser violates multiple areas of ethics in his publications his deportment is not a problem for the Code since the Code of Ethics (which is violated by intemperate behavior) is unfortunately only an Appendix, and not mandatory.
Vandals churn out names of so-called "new species" in their journals, often when the scientific evidence to support a discovery is lacking. And if the names are properly constructed and accompanied by characteristics that are "purported" to distinguish the species, they become valid under the Code. As long as you create a name, state intention that the name is new, and provide just the vaguest description of a species, the name is valid.

A8. METHODS OF TAXONOMIC VANDALISM

Taxonomic vandalism usually isn't subtle. Oftentimes, vandals will explicitly steal others' science to support their so-called "discovery." They don't do any of the research and they don't own any of

Raymond Hoser.

the research. One of the most common lines of evidence they steal is what's known as the phylogenetic tree.

Phylogenetic trees, not unlike family trees, reveal how different animal specimens are related to each other based on their genetics; specimens that are genetically similar are grouped together. In some cases, those groupings represent species that have yet to be named, which scientists call "candidate species." Researchers commonly publish phylogenetic trees on the road to discovering a new species and then use those published trees as evidence for that species' uniqueness.

However, gathering enough evidence to make a discovery can take months or even years. Meanwhile, culprits like Hoser swoop in. Once the tree is publicly available, vandals use it as evidence to justify a "discovery," which they quickly publish in their personal journals. Vandals go through literature and comb through phylogenetic trees, find a group in the phylogenetic tree that could be named, and quickly give it a name.

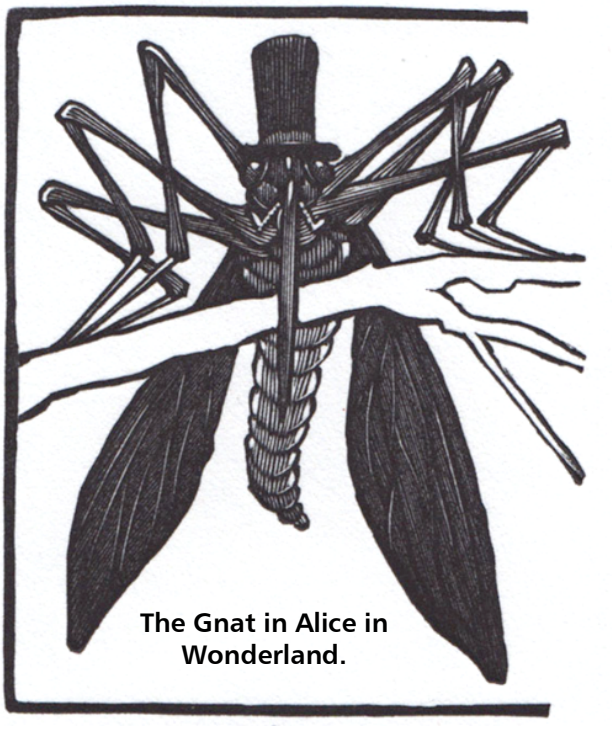
It's difficult to pinpoint the total number of species named by these vandals, but it has been estimated that there are tens of thousands. Hoser readily admits that he has used this approach to name tens–if not hundreds–of taxa. "I managed to name about 100 genera [of snakes] by basically looking at phylogenetic trees," Hoser said. Among them was the African spitting cobra, *Spracklandus*.

Another approach is based on a theory called "allopatric speciation," or the evolution of new species through geographic isolation. The theory states that when animal populations are physically separated without opportunities to interbreed, they can grow genetically distinct. Over time, the populations can become separate species—meaning, in simplistic terms, that they can't successfully reproduce with each other. This is a widely-accepted theory, but not proof in itself. Without DNA samples and a detailed examination of several individuals from each population, it's not so much a discovery as it is a clue.

Taxonomic vandals have been known to take full advantage of this theory to make "discoveries." To find and name new species, they will search for geographic barriers that cut through the range of an existing species, such as rivers or mountains. If the species populations look different on either side of the barrier–on one side they're red and on the other side they're blue, for example–vandals will automatically declare them two separate species although there is no scientific underpinning of that statement. Hoser, Kaiser writes, uses both existing phylogenetic trees and allopatric speciation to justify generating "new" species names.

B1. DEFINING SPECIES

"What sort of insects do you rejoice in, where you come from?" the Gnat inquired.
"I don't *rejoice* in insects at all," Alice explained, "because I'm rather afraid of them — at least the large kinds. But I can tell you the names of some of them."
"Of course they answer to their names?" the Gnat remarked carelessly.
"I never knew them do it."
"What's the use of their having names," the Gnat said, "if they won't answer to them?"
"No use to *them*," said Alice; "but it's useful



The Gnat in Alice in Wonderland.

to the people that name them, I suppose. If not, why do things have names at all?"
"I can't say," the Gnat replied. "Further on, in the wood down there, they've got no names."
[Lewis Carroll, 1962, pg, 225]

The definition of "species" is a tricky one. Depending on a person's focus and need for the definition, the idea of the species concept can be different. Most basic scientists agree that the common definition of the word "species" is a group of similar individuals that live together in an area and can interbreed to produce fertile offspring. However, this definition is not truly complete. It cannot be applied to a species that undergoes asexual reproduction since "interbreeding" does not happen in these types of species. Therefore, it is important we examine all of the species concepts to see which are usable and which have limitations. The following are species concepts by various authors from 1789 to 1859.

JEAN-BAPTISTE LAMARCK
"*Species*: in botany as in zoology, a species is necessarily constituted of the aggregation of similar individuals which perpetuate themselves, the same, by reproduction." [Vol. 2, *Encyclopedie Methodique*, 1786]

ANTOINE-LAURANT DE JUSSIEU
"Just so many plants agreeing in all their parts, or being consistent in their universal character, and born from and giving birth to those of like nature, are the individuals together constituting a species, [a term] wrongly used in the past, now more correctly defined as the perennial succession of like individuals, successively reborn by continued generation." [*Genera plantarum secundum ordines naturalis disposita*, 1789]

GEORGES CUVIER
"... the word species means the individuals who descend from one another or from common parents and those who resemble them as much as they resemble each other." [**Annales du Museum d'Histoire Naturelle,** 1812]

RICHARD OWEN
"The proposer of the new species now intends to state no more than he actually knows; as for example, that the differences in which he founds the specific character are constant in individuals of both sexes, so far as observation has reached..." [*On the Osteology of the Chimpanzee and Orang Utan*, 1835]

PHILLIP HENRY GOSSE
"It is often difficult in practice to determine the difference or identity of species; as we know of no fixed principle on which to found our decision, except the great law of nature, by which specific individuality is preserved – that the progeny of mixed species shall not be fertile *inter se*." [*An Introduction to Zoology*, 1844]

GEOFFROY SAINT-HILAIRE
"The species is a collection or a succession of individuals characterized by a whole of distinctive features whose transmission is natural, regular and indefinite in the current order of

French naturalist Jean-Baptiste Lamarck (1744-1829). Lamarck was an early proponent of the idea that evolution occurred and proceeded in accordance with natural laws.

things." [*Histoire naturelle génerale des règnes organiques*, vol. 2, 437, 1859)]

B2. EARLY CONCEPTS OF SPECIES

There was a concept of species before there was any clear idea of what they might be (Templeton, 1989). Species were identified in the 15th century that are still regarded as species, and there wasn't the slightest hint of an explanation in the air at the time. And it's an old concept, too, although the first simply biological definition of "species" (a Latin word that means "form" or "appearance") waited until 1686. The earliest taxonomist to achieve a species definition was the English naturalist and botanist John Ray (1627–1705). In his major work *Historia Plantarum* (Ray, 1686) he stated:

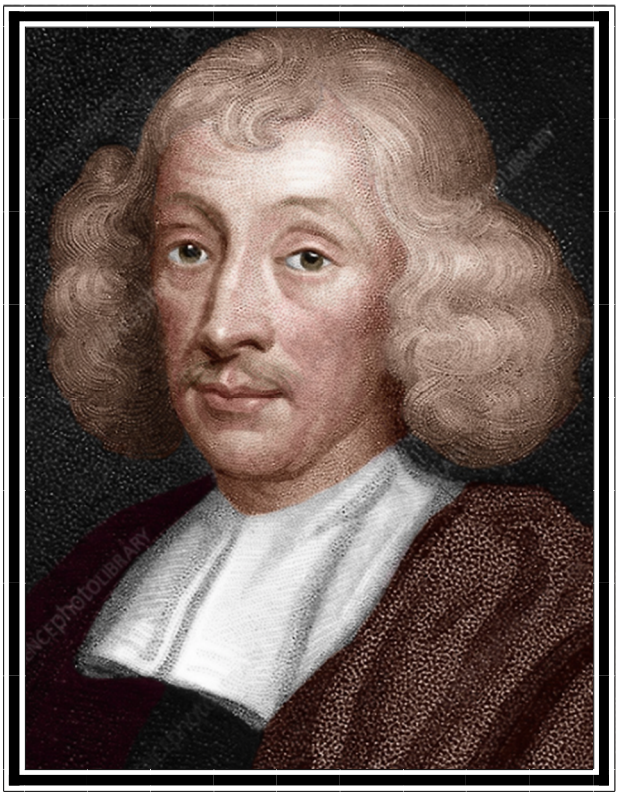
No matter what variations occur in the individuals or the species, if they spring from the seed of one and the same plant, they are accidental variations and not such as distinguish a species permanently; one species never springs from the seed of another nor vice versa.

Therefore, Ray attempted to define species as groups of plants that truly breed within their limits of variation. Ray additionally said of a species:

After long and considerable investigation, no surer criterion for determining species has occurred to me than the distinguishing features that perpetuate themselves in propagation from seed. Thus, no matter what variations occur in the individuals or the species, if they spring from the seed of one and the same plant, they are accidental variations and not such as to distinguish a species ... Animals likewise that differ specifically preserve their distinct species permanently; one species never springs from the seed of another nor vice versa.

Ray's definition was based on a simple observation: progeny resemble their parents. Species are those groups of organisms that resemble their parents. A version of it can be found in Epicurus' disciple, Lucretius (Smith, 1975)]:

If things could be created out of nothing, any kind of things could be produced from any source. In the first place, men could spring from the sea, squamous fish from the ground, and birds could be hatched from the sky; cattle and other farm animals, and every kind of wild beast, would bear young of unpredictable species, and would make their home in cultivated and barren parts without discrimination. Moreover, the same fruits would not invariably grow on the same trees, but would change: any tree could bear any fruit. Seeing that there would be no elements with the capacity to generate each kind of thing, how could creatures constantly have a fixed mother? But, as it is, because all are formed from fixed seeds, each is born and issues out into the shores of light only from a source where the right ultimate particles exist. And this explains why all things cannot be



John Ray (1627–1705).

produced from all things: any given thing possesses a distinct creative capacity.

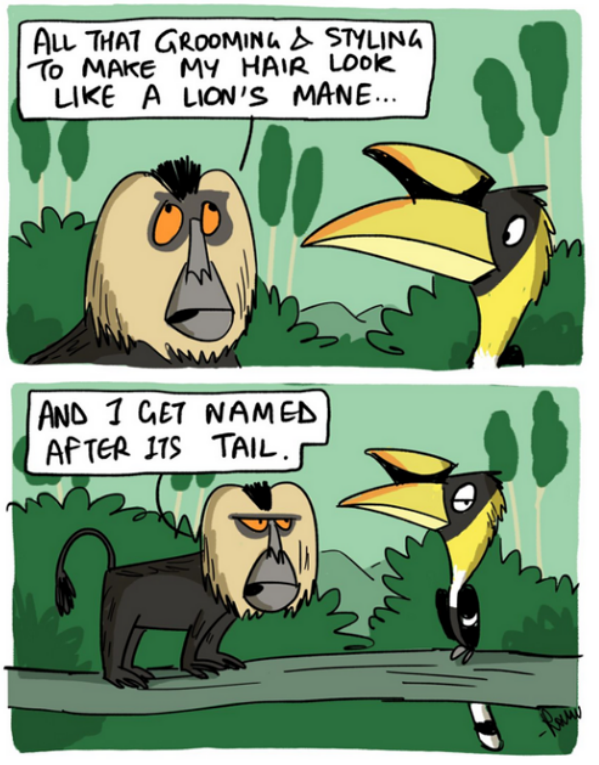
Linnaeus (1707–1778), whose work nearly 50 years later was the most eminent and momentous in the taxonomy field, adopted a broader concept, providing a new definition of species. In his work *Species Plantarum* (Linnaeus, 1753), using mainly the floral structure and sexual characters, Linnaeus described briefly and systematically approximately 5900 species of plants known to man then. Thus he used a sexual or "natural system" for defining species. The Linnaeus concept was simple, applicable and was accepted widely.

Both the Ray and the Linnaeus approaches in defining species were typological; i.e., they believed that under natural intraspecific variations exists a fixed unchangeable type of each species and this refuted the Ancient Greek idea of transmission of species (i.e., that a species was a collection of objects that had a common underlying "essence") that was widely believed in those days (Briggs and Walters, 1984).

De Candolle (1778–1841), who was the first to introduce the word taxonomy through his book *Théorie Élémentaire de la Botanique* (De Candole, 1813), defined species as "a collection of all the individuals which resemble each other more than they resemble anything else, which can by natural fecundation produce fertile individuals, and which reproduce themselves by generation, in such a manner that we may from analogy suppose them all to have sprung from one single individual." He divided plants into two major groups, non-vascular and vascular plants. A book in seven volumes covered all species of cotyledons in the world including 161 families and 58000 species was his main and most important work which is called *Prodromus Systematis Naturalis Regni Vegetabilis* (1823–1873). Most taxonomists after him, before the next phase of taxonomy, used De Candolle's system, although sometimes with modifications.

Years later, in his theory of evolution with Wallace (Darwin and Wallace, 1859) even before his famous book *On the origin of species by means of natural selection,* Charles Darwin (1809–1882) considered species as the fundamental units of evolution, starting a new era of species definition. Darwin emphasized the fact that species could be produced rapidly if the conditions were appropriate and in the absence of such conditions, species might remain unchanged for a long time. It should be noted that all Darwinian theories and studies were carried out before the establishment of genetic science. The following is from Darwin writing about species (*On the Origin of Species*, 1859):

Hereafter we shall be compelled to acknowledge that the only distinction between species and well-marked varieties is, that the latter are known, or believed, to be connected at the present day by intermediate gradations, whereas species were formerly thus connected. Hence, without quite rejecting the consideration of the present existence of intermediate gradations between any two forms, we shall be led to weigh more carefully and to value higher the actual amount of difference between them. It is quite possible



that forms now generally acknowledged to be merely varieties may hereafter be thought worthy of specific names, as with the primrose and cowslip; and in this case scientific and common language will come into accordance. In short, we shall have to treat species in the same manner as those naturalists treat genera, who admit that genera are merely artificial combinations made for convenience. This may not be a cheering prospect; but we shall at least be freed from the vain search for the undiscovered and undiscoverable essence of the term species.

If things could be created out of nothing, any kind of things could be produced from any source. In the first place, men could spring from the sea, squamous fish from the ground, and birds could be hatched from the sky; cattle and other farm animals, and every kind of wild beast, would bear young of unpredictable species, and would make their home in cultivated and barren parts without discrimination. Moreover, the same fruits would not invariably grow on the same trees, but would change: any tree could bear any fruit. Seeing that there would be no elements with the capacity to generate each kind of thing, how could creatures constantly have a fixed mother? But, as it is, because all are formed from fixed seeds, each is born and issues out into the shores of light only from a source where the right ultimate particles exist. And this explains why all things cannot be produced from all things: any given thing possesses a distinct creative capacity.

For Darwin, "species" was an undefinable term. In an 1856 letter to his friend Joseph Hooker, Darwin wrote:

It is really laughable to see what different ideas are prominent in various naturalists' minds, when they speak of 'species'; in some, resemblance is everything and descent of little weight – in some, resemblance seems to go for nothing, and creation the reigning idea – in some, sterility an unfailing test, with others it is not worth a farthing. It all comes, I believe, from trying to define the indefinable.

That hasn't stopped scientists in the 150 years since then from trying, however. When scientists today sit down to study a new form of life, they apply any number of more than 70 definitions of what constitutes a species–and each helps get at a different aspect of what makes organisms distinct. In the Appendix I have supplied a list of other distinct species concepts. The listing is somewhat technical but I provide it to show some of the many definitions that have appeared in the literature.

Darwin even dreamt of a time when a revolution would come about in biology. He proposed that one day, biologists could pursue their studies without ever worrying about what a species is, or

Sir Joseph Dalton Hooker (1817-1911) was a British botanist and explorer in the 19th century. He was a founder of geographical botany and Charles Darwin's closest friend.

which animals belong to which species. Indeed, some contemporary biologists and philosophers of biology have taken up this idea, and suggested that biology would be much better off if it didn't think about life in terms of species at all.

Scrapping the idea of a species is an extreme idea: it implies that pretty much all of biology, from Aristotle right up to the modern age, has been thinking about life in completely the wrong way. The upshots of this new approach would be enormous, both for our scientific and philosophical view of life. It suggests that we should give up thinking about life as neatly segmented into discrete groups. Rather, we should think of life as one immense interconnected web. This shift in thinking would fundamentally reorient our approach to a great many questions concerning our relation to the natural world, from the current biodiversity crisis to conservation.

And, in a way, this kind of picture may be a natural progression in biological thought. One of the great discoveries of evolutionary biology is that the human species is not special or privileged in the grand scheme of things, and that humans have the same origins as all the other animals. This approach just takes the next step. It says that there is no such thing as "the human species" at all.

B3. THREE SIMPLIFIED CONCEPTS OF SPECIES

Regardless of the many species concepts listed in the Appendix, it is possible to distill them into the following three main ideas.

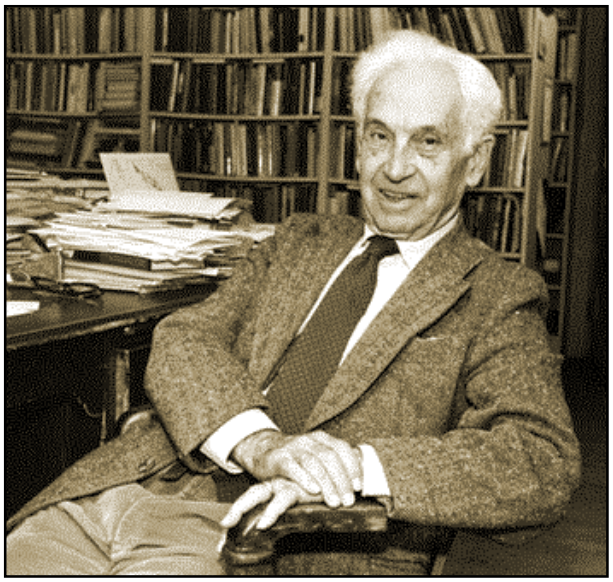
1. BIOLOGICAL SPECIES

The most universally accepted species concept is the idea of the biological species. This is the species concept from which the generally accepted definition of the term "species" comes. First proposed by Ernst Mayr, the biological species concept explicitly says, "Species are groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups." This definition brings into play the idea of individuals of a single species being able to interbreed while staying reproductively isolated from each other (Mayr, 1942).

Without reproductive isolation, speciation cannot occur. Populations need to be divided for many generations of offspring in order to diverge from the ancestral population and become new and independent species. If a population is not divided, either physically through some sort of barrier, or reproductively through behavior or other types of prezygotic or postzygotic isolation mechanisms, then the species will stay as one species and will not diverge and become its own distinct species. This isolation is central to the biological species concept.

2. MORPHOLOGICAL SPECIES

Morphology is how an individual looks. It is their physical features and anatomical parts. When Linnaeus first came up with his binomial nomenclature taxonomy, all individuals were grouped by morphology. Therefore, the first concept of the term "species" was based on the morphology. The morphological species concept does not take into account what we now know about genetics



Ernst Walter Mayr (July 1904-2005) was one of the 20th century's leading evolutionary biologists. He was also a renowned taxonomist, tropical explorer, ornithologist, philosopher of biology, and historian of science. His work contributed to the conceptual revolution that led to the modern evolutionary synthesis of Mendelian genetics, systematics, and Darwinian evolution, and to the development of the biological species concept.

and DNA and how it affects what an individual looks like. Linnaeus did not know about chromosomes and other micro-evolutionary differences that actually make some individuals that look similar a part of different species.

The morphological species concept definitely has its limitations. First, it does not distinguish between species that are actually produced by convergent evolution and are not really closely related. It also does not group individuals of the same species that would happen to be somewhat morphologically different like in color or size. It is much more accurate to use behavior and molecular evidence to determine what is the same species and what is not.

3. LINEAGE SPECIES

A lineage is similar to what would be thought of as a branch on a family tree. The phylogenetic trees of groups of related species branch off in all directions where new lineages are created from speciation of a common ancestor. Some of these lineages thrive and live on and some become extinct and cease to exist over time. The lineage species concept becomes important to scientists who are studying the history of life on Earth and evolutionary time.

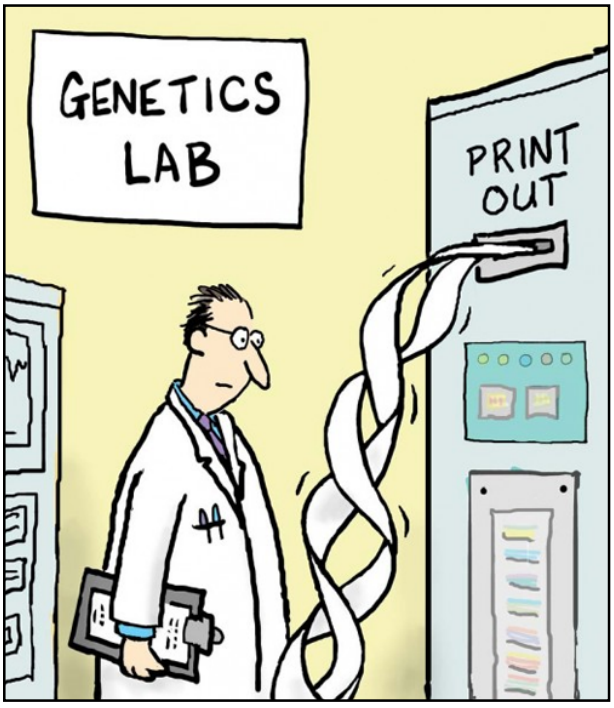
By examining the similarities and differences of lineages that are related, scientists can determine most likely when the species diverged and evolved compared to when the common ancestor was around. This idea of lineage species can also be used to fit asexually reproducing species (and there are examples even among fishes, e.g., *Rivulus marmoratus*)). Since biological species concept is dependent upon reproductive isolation of sexually reproducing species, it cannot necessarily be applied to a species that reproduces asexually. The lineage species concept does not have that restraint and therefore can be used to explain simpler species that do not need a partner to reproduce.

B4. DNA ENTERS THE PICTURRE

In a way, this plethora of definitions helps prove Darwin's point: The idea of a species is ultimately a human construct. With advancing DNA technology, scientists are now able to draw finer and finer lines between what they consider species by looking at the genetic code that defines them. How scientists choose to draw that line depends on whether their subject is an animal or plant; the tools available; and the scientist's own preference and expertise. Now, as new species are discovered and old ones thrown out, researchers want to know: How do we define a species today? Let's look back at the evolution of the concept and see how far it's come.

The most classic definition of species is a group of organisms that can breed with each other to produce fertile offspring, an idea originally set forth in 1942 by evolutionary biologist Ernst Mayr whom I have mentioned above. While elegant in its simplicity, this concept has since come under fire by biologists who argue that it didn't apply to many organisms, such as single-celled ones that reproduce asexually, or those that have been shown to breed with other distinct organisms to create hybrids.

Alternatives arose quickly. Some biologists championed an ecological definition that assigned species according to the environmental niches they fill such as this animal recycles soil nutrients and this predator keeps insects in check. Others



asserted that a species was a set of organisms with physical characteristics that were distinct from others (e.g., the peacock's fanned tail and the beaks of Darwin's finches).

The discovery of DNA's double helix prompted the creation of yet another definition, one in which scientists could look for minute genetic differences and draw even finer lines denoting species. Based on a 1980 book by biologists Niles Eldredge and Joel Cracraft, under the definition of a "phylogenetic species" (i.e., the concept of a species as an irreducible group whose members are descended from a common ancestor and who all possess a combination of certain defining or derived, traits), animal species now can differ by just 2 percent of their DNA to be considered separate.

Back in 1996, the world recognized half the number of species of lemur there are today. (Today there are more than 100 recognized lemur species. Advances in genetic technology have provided a much more detailed picture of the world's species and their health. These advances have also renewed debates about what it means to be a species, as ecologists and conservationists discover that many species that once appeared singular are actually multitudes. Smithsonian entomologist John Burns has used DNA technology to distinguish a number of so-called "cryptic species"–organisms that appear physically identical to members of a certain species, but have significantly different genomes. In a 2004 study, he was able to determine that a species of tropical butterfly identified in 1775 actually encompassed 10 separate species.

In 2010, advanced DNA technology allowed scientists to solve an age-old debate over African elephants. By sequencing the rarer and more complex DNA from the nuclei of elephant cells, instead of the more commonly used mitochondrial DNA, they determined that African elephants actually comprised two separate species that diverged millions of years ago. "You can no more call African elephants the same species as you can Asian elephants and the mammoth," David Reich, a professor in the department of genetics at the Harvard Medical School, a population geneticist and lead author on the study, told *Nature News* (Gilbert, 2010). What does it mean to be a species? Genetics is changing the answer.

In the wake of these and other paradigm-shifting discoveries, Mayr's original concept is rapidly falling apart. Those two species of African elephants, for instance, kept interbreeding as recently as 500,000 years ago. Another example falls closer to home: Recent analyses of DNA remnants in the genes of modern humans have found that humans and Neanderthals–usually thought of as separate species that diverged roughly 700,000 years ago–interbred as recently as 100,000 years ago.

So are these elephants and hominids still separate species? This isn't just an argument of scientific semantics. Pinpointing an organism's species is critical for any efforts to protect that animal, especially when it comes to government action. A species that gets listed on the U.S. Endangered Species Act, for example, gains protection from any destructive actions from the government and private citizens. These protections would be im-

David Emil Reich is an American geneticist known for his research into the population genetics of ancient humans, including their migrations and the mixing of populations, discovered by analysis of genome-wide patterns of mutations.

possible to enforce without the ability to determine which organisms are part of that endangered species.

At the same time, advances in sequencing techniques and technology are helping today's scientists better piece together exactly which species are being impacted by which human actions. "We're capable of recognizing almost any species [now]," says Mary Curtis, a wildlife forensic scientist who leads the genetics team at the U.S. Fish and Wildlife Service's Forensics Laboratory. She has a demonstrated history of working in US Federal wildlife law enforcement field and is skilled in Population Genetics and data analysis, Molecular Biology and Freshwater Fisheries Biology, Her lab is responsible for identifying any animal remains or products that are suspected to have been illegally traded or harvested. Since adopting DNA sequencing techniques more than 20 years ago, the lab has been able to make identifications much more rapidly, and increase the number of species it can reliably recognize by the hundreds.

"A lot of the stuff we get in in genetics has no shape or form," Curtis says. The lab receives slabs of unidentified meat, crafted decorative items or even the stomach contents of other animals. Identifying these unusual items is usually out of the reach of taxonomic experts using body shape, hair identification and other physical characteristics. "We can only do that with DNA," Curtis says. Still, Curtis, who previously studied fishes, doesn't discount the importance of traditional taxonomists. "A lot of the time we're working together," she says. Experienced taxonomists can often quickly identify recognizable cases, leaving the more expensive DNA sequencing for the situations that really need it.

Not all ecologists are sold on these advances. Some express concerns about "taxonomic inflation," as the number of species identified or reclassified continues to skyrocket. They worry that as scientists draw lines based on the narrow shades of difference that DNA technology enables them to see, the entire concept of a species is being diluted. "Not everything you can distinguish should be its own species," as German zoologist Andreas Wilting told the *Washington Post* in 2015 (Gebelhoff, 2015). Wilting had proposed condensing tigers into just two subspecies from the current nine.

The study reinforces evidence that tigers are perhaps the least diverse big cat in the world. It also supports a theory that there was a massive population decline after a super-eruption took place in Sumatra about 73,000 years ago, leaving only a single ancestor for all modern tigers from the South China area.

But in a field where one of the biggest goals is to preserve the diversity in tigers, convincing people that tigers aren't really that diverse can be a challenge. This is not the first time tiger taxonomy has been challenged, but earlier proposals have had trouble gaining ground due to a lack of evidence.

At the heart of the debate is a concept called "taxonomic inflation," or the massive influx of newly recognized species and subspecies. Some critics blame the trend in part on emerging meth-

Mary Burnham Curtis, expert Wildlife Forensic Scientist working in the US Federal wildlife law enforcement field. Skilled in Population Genetics and data analysis, Molecular Biology and Freshwater Fisheries Biology.

ods of identifying species through ancestry and not physical traits. Others point to technology that has allowed scientists to distinguish between organisms at the molecular level.

Other scientists are concerned about the effects that reclassifying once-distinct species can have on conservation efforts. In 1973, the endangered dusky seaside sparrow, a small bird once found in Florida, missed out on potentially helpful conservation assistance by being reclassified as a subspecies of the much more populous seaside sparrow. Less than two decades later, the dusky seaside sparrow was extinct.

CONCLUSION

The nature of species is controversial in biology and philosophy. Biologists disagree on the definition of the term 'species,' and philosophers disagree over the ontological status of species (ontology is the branch of philosophy that studies concepts such as existence, being, becoming and reality and includes the questions of how entities are grouped into basic categories and which of these entities exist on the most fundamental level).

A proper understanding of species is important for a number of reasons. Species are the fundamental taxonomic units of biological classification. The concept of species plays an important role both in and outside of biology. Within biology, species are the fundamental units of biological classification. Species are also units of evolution—groups of organisms that evolve in a unified way. Outside of biology, the concept of species plays a role in debates over environmental law and ecological preservation. Environmental laws are framed in terms of species and even our conception of human nature is affected by our understanding of species.

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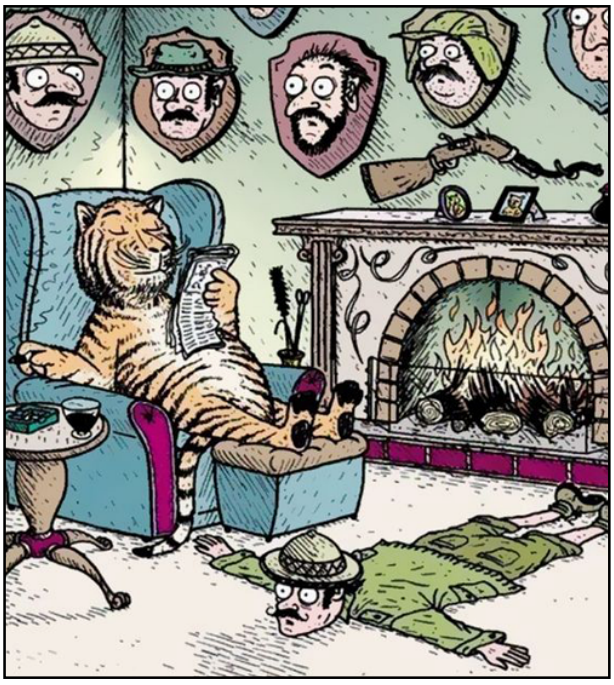

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APPENDIX: A SUMMARY OF 26 SPECIES CONCEPTS

There are numerous species "concepts" (i.e., conceptions of "species") at the research and practical level in the scientific literature. (Mayden 1997) has listed 22 distinct species concepts along with synonyms. Authors have been added where they can be located in addition to Mayden's references, and instead of his abbreviations an attempt has been tried to give the concepts names, such as biospecies for Biological Species, etc. (following George 1956), except where nothing natural suggests itself. There have also been several additional concepts since Mayden's review, which is added here the views of Pleijel and Wu, and several new revisions presented in Wheeler and Meier (2000). Also added are some "partial" species concepts - the compilospecies concept and the nothospecies concept. Two phylospecies concepts are distinguished here that go by various

names, mostly the names of the authors presenting at the time (as in the Wheeler and Meier volume). To remedy this terminological inflation, they have been christened here as the Autapomorphic species concept and the Phylogenetic Taxon species concept.

1. AGAMOSPECIES

Synonyms: Microspecies, paraspecies, pseudospecies, semispecies, quasispecies, genomospecies (for prokaryotes Euzéby 2006) Principal authors: Cain (1954), Eigen (1993, for quasispecies) Specifications: Asexual lineages, uniparental organisms (parthenogens and apomicts), that cluster together in terms of their genome. May be secondarily uniparental from biparental ancestors.

2. AUTAPOMORPHIC SPECIES

See: Phylospecies Principal authors: Nelson and Platnick (1981); Rosen (1979) Specification: A geographically constrained group of individuals with some unique apomorphous characters, the unit of evolutionary significance (Rosen); simply the smallest detected samples of self-perpetuating organisms that have unique sets of characters (Nelson and Platnick); the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character traits (Wheeler and Platnick 2000).

3. BIOSPECIES

Synonyms: Syngen, speciationist species concept Related concepts: Biological species concept, Genetic species, isolation species Principal authors: John Ray, Buffon, Dobzhansky (1935); Mayr (1942) Specifications: Inclusive Mendelian population of sexually reproducing organisms (Dobzhansky 1935, 1937, 1970), interbreeding natural population isolated from other such groups (Mayr 1942, 1963, 1970; Mayr and Ashlock 1991). Depends upon endogenous reproductive isolating mechanisms (RIMs).

4. CLADOSPECIES

Synonyms: Internodal species concept, Hennigian species concept, Hennigian convention Principal authors: Hennig (1966; 1950); Kornet (1993) Specifications: Set of organisms between speciation events or between speciation event and extinction (Ridley 1989), a segment of a phylogenetic lineage between nodes. Upon speciation the ancestral species is extinguished and two new species are named.

5. COHESION SPECIES

Synonyms: Cohesive individual (in part) (Ghiselin and Hull) Principal authors: Templeton (1989) Specifications: Evolutionary lineages bounded by cohesion mechanisms that cause reproductive communities, particularly genetic exchange, and ecological interchangeability.

6. COMPILOSPECIES

Synonyms: None Related concepts: Introgressive taxa Principal authors: Harlan (1963), Aguilar (1999) Specifications: A species pair where one species “plunders” the genetic resources of another via introgressive interbreeding.

7. COMPOSITE SPECIES

Synonyms: Phylospecies (in part), Internodal species (in part), cladospecies (in part) Principal authors: Kornet (1993) Specifications: All organisms belonging to an internodon and its descendents until any subsequent internodon. An internodon is defined as a set of organisms whose parent-child relations are not split (have the INT relation).

8. ECOSPECIES

Synonyms: Ecotypes Related concepts: Evolutionary species sensu Simpson, Ecological mosaics Principal authors: Simpson (1961); Sterelny (1999); Turesson (1922); Van Valen (1976) Specifications: A lineage (or closely related set of lineages) which occupies an adaptive zone minimally different from that of any other lineage in its range and which evolves separately from all lineages outside its range.

9. EVOLUTIONARY SPECIES

Synonyms: Unit of evolution, evolutionary group Related concepts: Evolutionary significant unit Principal authors: Simpson (1961); Wiley (1978); (1981) Specifications: A lineage (an ancestral-descendent sequence of populations) evolving separately from others and with its own unitary evolutionary role and tendencies (Simpson).

10. EVOLUTIONARY SIGNIFICANT UNIT

Synonyms: Biospecies (in part) and evolutionary species (in part) Principal authors: Waples (1991) Specifications: A population (or group of populations) that (1) is substantially reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species.

11. GENEALOGICAL CONCORDANCE SPECIES

Synonyms: Biospecies (in part), cladospecies (in part), phylospecies (in part) Principal authors: Avise and Ball (1990) Specifications: Population subdivisions concordantly identified by multiple independent genetic traits constitute the population units worthy of recognition as phylogenetic taxa

12. GENIC SPECIES

Synonyms: none Related concepts: Genealogical concordance species, genetic species (in part), biospecies (in part), autapomorphic species (in part) Principal author: Wu (2001b; 2001a) Specifications: A species formed by the fixation of all isolating genetic traits in the common genome of the entire population.

13. GENETIC SPECIES

Synonyms: Gentes (sing. Gens) Related concepts: Biospecies, phenospecies, morphospecies, genomospecies Principal authors: Dobzhansky (1950); Mayr (1969); Simpson (1943) Specifications: Group of organisms that may inherit characters from each other, common gene pool, reproductive community that forms a genetic unit

14. GENOTYPIC CLUSTER

Synonyms: Polythetic species Related concepts: Agamospecies, biospecies, genetic species, Hennigian species, morphospecies, non-dimensional species, phenospecies, autapomorphic phylospecies, successional species, taxonomic species , genomospecies Principal author: Mallet (1995) Specifications: Clusters of monotypic or polytypic biological entities, identified using morphology or genetics, forming groups that have few or no intermediates when in contact.

15. HENNIGIAN SPECIES

Synonyms: Biospecies (in part), cladospecies (in part), phylospecies (in part), internodal species Principal authors: Hennig (1966; 1950); Meier and Willman (1997) Specifications: A tokogenetic community that arises when a stem species is dissolved into two new species and ends when it goes extinct or speciates.

16. INTERNODAL SPECIES

Synonyms: Cladospecies and Hennigian species (in part), phylospecies Principal author: Kornet (1993) Specifications: Organisms are conspecific in virtue of their common membership of a part of a genealogical network between two permanent splitting events or a splitting event and extinction.

17. LEAST INCLUSIVE TAXONOMIC UNIT (LITUS)

Synonyms: evolutionary group (in part), phylospecies Principal authors: Pleijel (Pleijel 1999; Pleijel and Rouse 2000) Specifications: A taxonomic group that is diagnosable in terms of its autapomorphies, but has no fixed rank or binomial.

18. MORPHOSPECIES

Synonyms: Classical species, Linnaean species. Related concepts: Linnean species, binoms, phenospecies, monothetic species, monotypes, types, Taxonomic species Principal authors: Aristotle and Linnaeus, and too many others to name, but including Owen, Agassiz, and recently, Cronquist (1978) Specifications: Species are the smallest groups that are consistently and persistently distinct, and distinguishable by ordinary means (Cronquist). Contrary to the received view, this was never anything more than a diagnostic account of species.

19. NON-DIMENSIONAL SPECIES

Synonyms: Folk taxonomical kinds (Atran 1990) Related concepts: Biospecies, genetic species, morphospecies, paleospecies, successional species, taxonomic species Principal authors: Mayr (1942; 1963) Specifications: Species delimitation in a non-dimensional system (a system without the dimensions of space and time, Mayr 1963)

20. NOTHOSPECIES

Synonyms: hybrid species, reticulate species Related concepts: Compilospecies, horizontal or lateral genetic transfer Principal author: Wagner (1983) Specifications: Species formed from the hybridization of two distinct parental species, often by polyploidy.

PHYLOSPECIES

Synonyms: Autapomorphic phylospecies, monophyletic phylospecies, minimal monophyletic units, monophyletic species, lineages Related concepts: Similar to internodal species cladospecies, composite species, least inclusive taxonomic units. Principal authors: Cracraft (1983); Eldredge and Cracraft (1980); Nelson and Platnick (1981); Rosen (1979) Specifications: The smallest unit appropriate for phylogenetic analysis, the smallest biological entities that are diagnosable and monophyletic, unit product of natural selection and descent. A geographically constrained group with one or more unique apomorphies (autapomorphies). There are two versions of this and they are not identical. One derives from Rosen and is what I call the Autapomorphic species concept. It is primarily a concept of diagnosis and tends to be favored by the tradition known as pattern cladism. The other is what I call the Phylogenetic Taxon species concept, and tends to be favored by process cladists.

21. PHYLOGENETIC TAXON SPECIES

See: Phylospecies Principal authors: Cracraft (1983); Eldredge and Cracraft (1980); Nixon and Wheeler(1990) Specifications: A species is the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent (Cracraft); the least inclusive taxon recognized in a classification, into which organisms are grouped because of evidence of monophyly (usually, but not restricted to, the presence of synapomorphies), that is ranked as a species because it is the smallest 'important' lineage deemed worthy of formal recognition, where 'important' refers to the action of those processes that are dominant in producing and maintaining lineages in a particular case (Mishler and Brandon 1987).

22. PHENOSPECIES

Synonyms: Phena (sing. phenon) (Smith 1994), operational taxonomic unit (OTU) Related concepts: Biospecies, genetic concordance species, morphospecies, non-dimensional species, phylospecies (in part), phenospecies, successional species, taxonomic species, quasispecies, viral species, genomospecies (bacteria) Principal authors: Beckner (1959); Sokal and Sneath (1963) Specifications: A cluster of characters that statistically covary, a family resemblance concept in which possession of most characters is required for inclusion in a species, but not all. A class of organisms that share most of a set of characters.

23. RECOGNITION SPECIES

Synonyms: Specific mate recognition system (SMRS) Related concepts: Biospecies Principal author: Paterson (1985) Specifications: A species is that most inclusive population of individual, biparental organisms which share a common fertilization system

24. REPRODUCTIVE COMPETITION SPECIES

Synonyms: Hypermodern species concept , Biospecies (in part) Principal author: Ghiselin (1974) Specifications: The most extensive units in the natural economy such that reproductive competition occurs among their parts.

25. SUCCESSIONAL SPECIES

Synonyms: Paleospecies, evolutionary species (in part), chronospecies Principal authors: George (1956); Simpson (1961) Specifications: Arbitrary anagenetic stages in morphological forms, mainly in the paleontological record.

26. TAXONOMIC SPECIES

Synonyms: Cynical species concept (Kitcher 1984) Related concepts: Agamospecies, genealogical concordance species, morphospecies, phenospecies, phylospecies Principal author: Blackwelder (1967), but see Regan (1926) and Strickland et al. (1843) Specifications: Specimens considered by a taxonomist to be members of a kind on the evidence or on the assumption they are as alike as their offspring of hereditary relatives within a few generations. Whatever a competent taxonomist chooses to call a species.

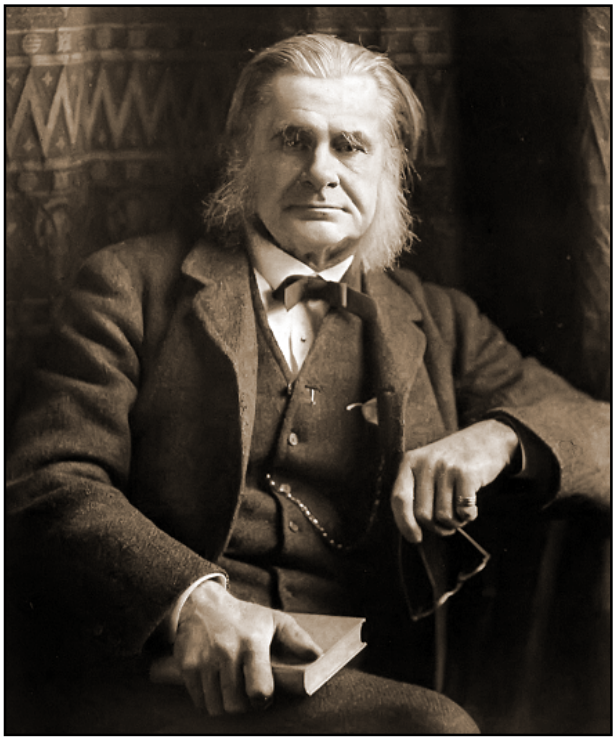
WALLACE, DARWIN AND THE SPIRITUALISM SCANDAL OF 1876

by Albert J. Klee, Ph.D.

(*Essays on Aquarium Hobby History*, November 22, 2014)

I became interested in this subject after reading a section called "Spiritualism and Evolution" in Tattersall and Névraumont's, book "Hoax" (see bibliography) because it involved of number of individuals I have written about previously in my two books. However the material was somewhat sketchy and I was looking for more detail and more information. Wikipedia was useless but I finally found two articles written by Richard Milner, an anthropologist and historian of science and a senior editor of Natural History Magazine at the American Museum of Natural History, New York City (see bibliography).

When it came to debating bishops, or lecturing on the new evolutionary biology, Charles Darwin preferred to send his "bulldog" and "publicist" Thomas Henry Huxley into the fray. Polemicist, surgeon ("too busy doing science" to ever practice medicine), zoologist, comparative anatomist, educator, and essayist, the bombastic Huxley enjoyed fighting for the new ideas. Huxley's protégé, in turn, became England's most influential biologist.



Thomas Henry Huxley (1825-1895).

Sir Edwin Ray Lankester (1847-1929).

His name, all but forgotten today, was Edwin Ray Lankester. He, too, was a zoologist, comparative anatomist, essayist, and educator—and for a decade (1898–1908) served as director of London's Natural History Museum.

For over 80 years, spiritualism enjoyed tremendous popularity in England, the U.S. and Europe. It attracted people with a wide spectrum of interests, but its major focus was on the possibility of communication with the dead. In the early 1870s Darwin's cousin and brother-in-law Hensleigh Wedgwood (his sister Emma married him in 1839) became a convert. Wedgwood (1803–1891) was a British etymologist, philologist, barrister and author of "A Dictionary of English Etymology." Wedgwood yearned to become a respected savant like Darwin, their cousin Francis Galton and Darwin's grandfather Erasmus, but a pair of swindlers, Charles Williams and Frank Herne, recognized that he was the most gullible of the clan. At their urg-

Hensleigh Wedgwood (1803-1891, Darwin's brother-in-law believed in Spiritualism.

ing, Wedgwood begged Darwin to come and see the self-playing accordions, levitating tables, automatic writing and glowing spirit hands at Williams's séances.

Darwin always managed to be too tired, too busy or too ill to attend but in January 1874, Darwin sent two close members of his circle to attend a séance with Williams. His friend Thomas H. Huxley was introduced as "Mr. Henry" (his middle name) and Darwin's son George, then 29 years old, went as well. Although bottles moved around and a guitar played by itself, the two concluded they had observed nothing but crude trickery. George, a budding astronomer, wrote that he was shocked to find his uncle Hensleigh's account of Williams's séances "so worthless." Later that year Darwin wrote to a newspaperman, urging him to expose Williams as "a scoundrel who has imposed on the public for so many years."

The following year Huxley's young laboratory assistant Edwin Ray Lankester decided to catch Williams and Herne in fraud—an act he knew would impress his heroes Darwin and Huxley. But after Huxley and George's visit, the medium became wary, avoiding anyone connected to Darwin's circle. Then, in April 1876, a tempting new target moved into Lankester's sights. A celebrated American psychic, "Dr." Henry Slade, had come to London "to prove the truth of communication with the dead." Slade was a trickster who plied his trade on both sides of the Atlantic. His specialty was slate writing, which involved a small chalkboard on which written messages from the Other Side would miraculously appear while it was hidden under a table. Having been caught out in New York scrawling messages with chalk held between his toes, as well as surreptitiously substituting boards,

Slade went to London in 1876 to try his luck. Unfortunately for him, some well-connected skeptics were lying in wait. Among them were Darwin, Huxley and Lankester. A highly practical man, Huxley actually had taught himself many of the

"Dr." Henry Slade (1835-1905), an American con man who plied his trade on both sides of the Atlantic.

Spiritualists' tricks. These included the curious ruse of snapping his toes inside his shoe to make rapping noises at varying volumes (he recommended rapping wearing thin socks and wide shoes).

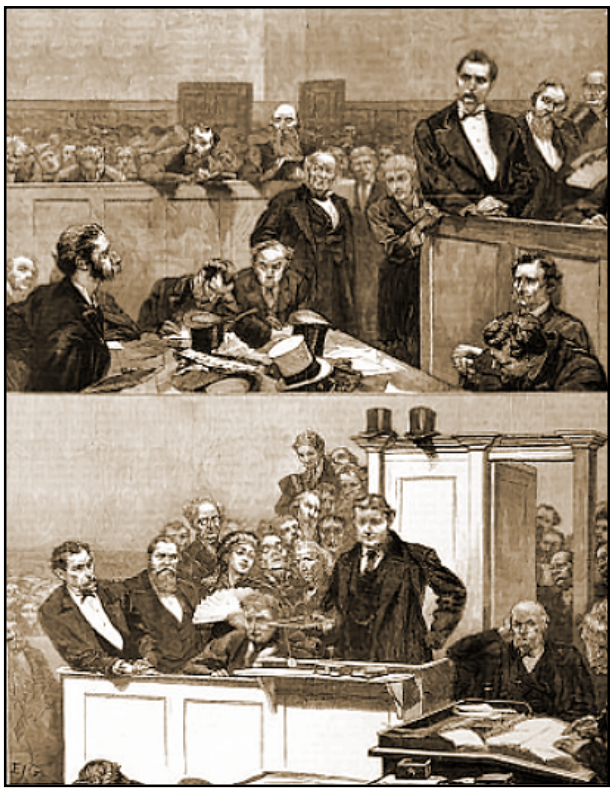
Lankester and his fellow medical student Horatio Donkin went to Slade's pretending to be believers. They paid the admission fee, asked questions of the spirits and received mysteriously written answers. Then, in the darkened room, Lankester suddenly snatched a slate out of Slade's hands, found the written answer to a question he had not yet asked, and proclaimed him "a scoundrel and an impostor."

The next day Slade and his partner, Geoffrey Simmonds, were in the hands of the police, charged with violating the Vagrancy Act, an old law intended to protect the public from traveling palm readers and sleight-of-hand artists. Throughout the fall of 1876, all London was abuzz over the Slade trial. The little courtroom was packed with Slade's supporters and detractors and 30 journalists, who spilled out into the street. The Times of London carried trial transcripts day after day.

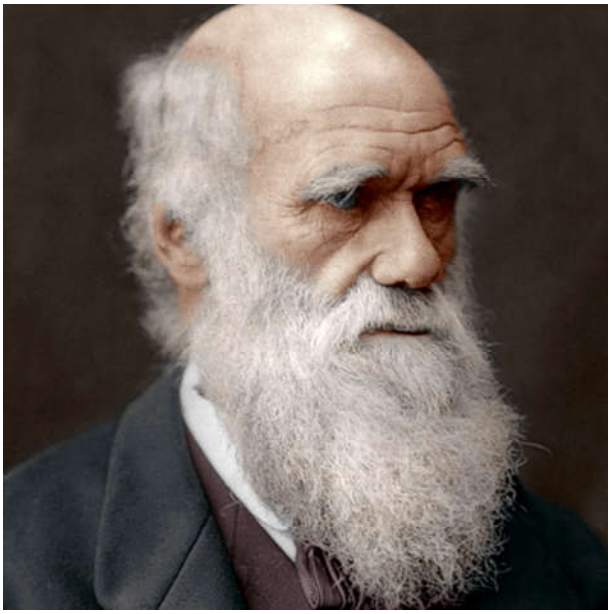
By hauling Slade into court as "a common rogue," Lankester would become the first scientist to prosecute a professional psychic for criminal fraud—an action Darwin thought long overdue. Although he was delighted at Lankester's attack on Slade, Darwin was distressed to learn that Alfred Russel Wallace, his friendly rival and co-discoverer of the theory of natural selection, was also a target.

The Slade trial was to become one of the strangest courtroom cases in Victorian England. Some saw it as a public arena where science could score a devastating triumph over superstition. For others, it was the declaration of war between professional purveyors of the "paranormal" and the fraternity of honest stage magicians. Arthur Conan Doyle, the zealous spiritualist whose fictional detective, Sherlock Holmes, was logic personified, characterized it as "the persecution [rather than prosecution] of Slade." But what made the trial unique was that the two greatest naturalists of the century ranged themselves on opposite sides. The "arch-materialist" Darwin gave aid and comfort to the prosecution, and his old friend Alford Lord Wallace, a sincere spiritualist, was to be the defense's star witness—making it one of the more bizarre and dramatic episodes in the history of science.

Wallace was respected as an author, zoologist, botanist, the discoverer of scores of new species, the first European to study apes in the wild and a pioneer in the study of the distribution of animals. But he constantly courted ruin by championing such radical causes as socialism, pacifism, land nationalization, wilderness conservation, women's rights and spiritualism. In addition to his classic volumes on zoogeography, natural selection, island life and the Malay Archipelago, he had written "Miracles and Modern Spiritualism," which lauded spirit-mediums. And he had just allowed a controversial paper on "thought transference" to be read at a meeting of the British Association for the Advancement of Science—touching off an uproar that led him to avoid scientific meetings for the rest of his life.



The trial of Henry Slade, the medium who was said to communicate with spirits by a slate board. Top sketch shows Mr G. Leis, counsel for the Prosecution and bottom image shows Professor E. Ray Lankester, giving evidence.



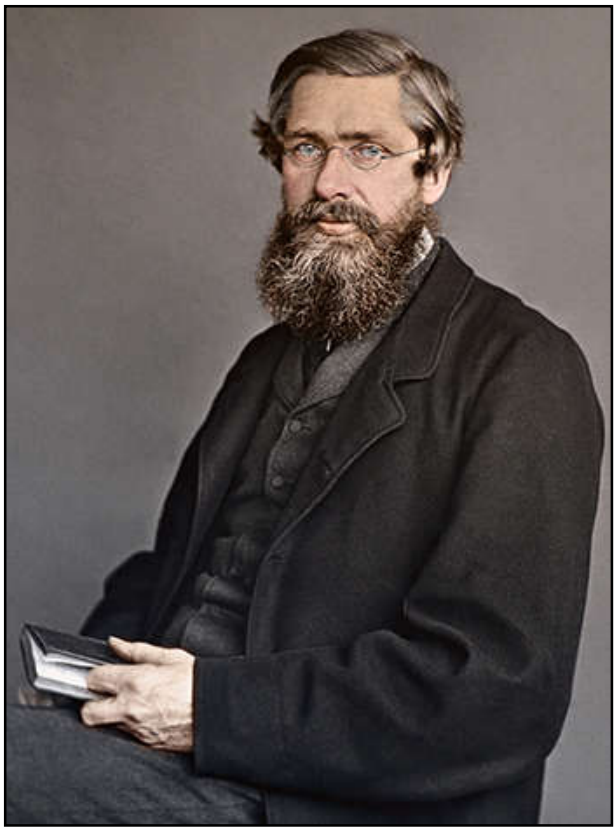
Charles Darwin (1809-1882).

Wallace wanted the best of both worlds. With insects or birds, he was even more rigorous than Darwin in applying the principle of natural selection, but he questioned its efficacy for humans. If early hominids required only a gorilla's intelligence to survive, Wallace asked, why had they evolved brains capable of devising language, composing symphonies and doing mathematics? Although our bodies had evolved by natural selection, he concluded, *Homo sapiens* has "something which he has not derived from his animal progenitors—a spiritual essence or nature… [that] can only find an explanation in the unseen universe of Spirit." Wallace's position did not stem from any conventional religious belief but from his long-standing interest in spiritualism: a melding of ancient Eastern beliefs with the Western desire to "secularize" the soul and prove its existence.

When Wallace published this view in 1869, Darwin wrote him: "I differ grievously from you; I can see no necessity for calling in an additional and proximate cause [a supernatural force] in regard to Man.... I hope you have not murdered too completely your own and my child"—meaning their theory of natural selection.

Darwin, whose beloved 10-year-old daughter Annie had died in 1851, had nothing but contempt for the "clever rogues" who preyed on grieving relatives. Yet he avoided saying so publicly—"On the Origin of Species" had stirred up enough controversies for a lifetime. Privately, he wrote Lankester an effusive letter of congratulations. Jailing Slade was a public benefit, he said, and insisted on contributing £10 to the costs of prosecution. (Under English law, the complainant paid court costs; £10 was a substantial sum, comparable to a month's wages for a workingman.)

As the trial got under way, the prosecutor announced that stage magician John Nevil Maskelyne was prepared to reproduce all the "alleged phenomena" that were observed at the séance. The judge, in turn, warned that performing magic slate tricks in court would prove nothing; the question was whether Lankester and Donkin had actually caught the defendants faking the alleged spirit writing. Both scientists turned out to be terrible witnesses; their observational skills, developed in anatomy and physiology labs, were useless in detecting fraud by professional cheats. As Huxley later noted, "In these investigations, the qualities of the detective are far more useful than those of the



Alfred Lord Wallace (1823-1913).

philosopher.... A man may be an excellent naturalist or chemist; and yet make a very poor detective."

Indeed, Lankester and Donkin apparently could not agree on anything much beyond their charge that Slade was an impostor. Did the medium use a thimble device for writing, or did he hold a pencil stub while his thumb was visible on the tabletop? Did he switch the blank slate for one that was previously written on? Was the table of ordinary construction, or did it have sliding bars and trick panels? The two could not establish when or how the writing had been done. Maskelyne's courtroom conjuring, in contrast, was perfect. In answer to a question about instant writing—and before the judge could stop him—he began scrubbing a blank slate with a wet sponge until writing appeared: "THE SPIRITS ARE HERE!" Then he wiped the slate clean and ran the sponge over it again.

Whenever the prosecutor could, he had Maskelyne slip in another slate trick until the judge finally barred them. The prosecutor then offered Slade two small slates joined by hinges and a hasp lock. Why not make writing appear inside the locked slates and convince the world? Slade replied he had been so pestered by such tests that Allie, his wife's spirit, had vowed never to write on a locked slate.

A chemist named Alexander Duffield was one of many witnesses for the prosecution. He said Slade had convinced him "that there could be established a sort of post office in connection with the 'other place.'" But now he had his doubts. Another witness testified that a few years earlier, in the U.S., someone had similarly snatched a slate from Slade in mid-séance and exposed him in fraud.

The high point of the trial was Wallace's appearance for the defense. His integrity and candor were known to all. When called, he said that he had witnessed the alleged phenomena but refused to speculate on whether the writings were caused by spirits. He considered Slade to be an honest gentleman, "as incapable of an imposture...as any earnest inquirer after truth in the department of Natural Science."

In his summation, Slade's lawyer argued that there was no real evidence against his client. No one had proved the table was rigged, and Maskelyne's demonstrations of how the trick *could* have been done were irrelevant. The writing's appearance before the corresponding question was asked proved nothing about its origin, and Lankester and Donkin could not agree on exactly what they had seen during the séance. Moreover, such an eminent scientist as Wallace should be considered at least as credible as young Lankester. The barrister concluded by invoking Galileo, remarking that innovative scientists who challenge the beliefs of their time are always vilified. His irony was not lost on the evolutionists.

John Nevil Maskelyne (1839 -1917) was an English stage magician and inventor of the pay toilet, along with other Victorian-era devices. His book "Sharps and Flats: A Complete Revelation of the Secrets of Cheating at Games of Chance and Skill" is considered a classic overview of card sharp practices. In 1914 he founded the Occult Committee, a group to "investigate claims to supernatural power and to expose fraud".

But nothing could save Slade. The judge said that he understood that spiritualism was "a kind of new religion" and did not wish to offend sincere believers. Still, the question before the court was whether Slade and Simmonds had fraudulently represented their own actions as paranormal phenomena. Concluding that he must decide "according to the well-known course of nature," the judge sentenced the defendant to three months' hard labor in the House of Corrections.

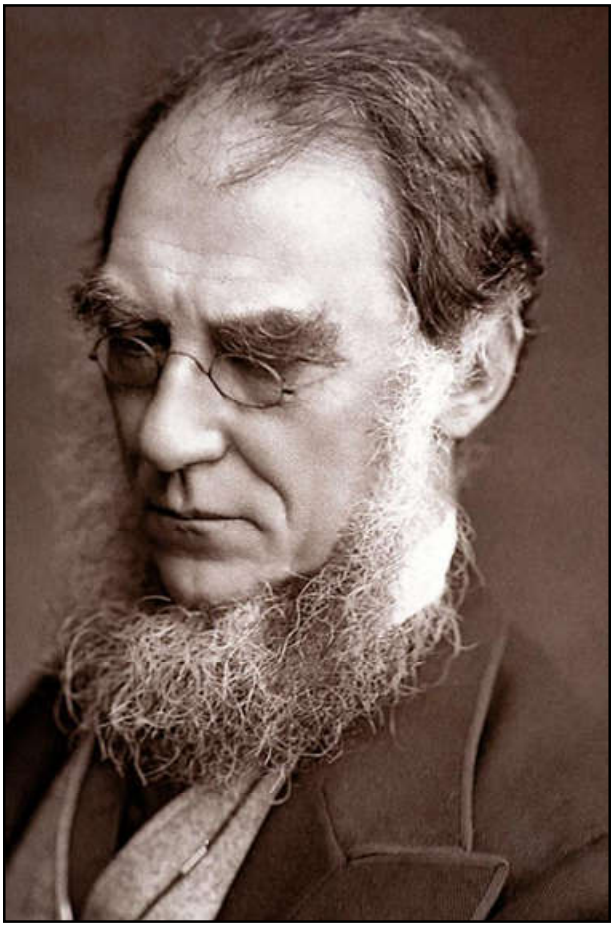
Slade, however, never served his sentence. On appeal, another judge ruled that the Vagrancy Act that prohibited palmistry was not applicable to claims of spirit writing. Slade and his partner fled England for Germany. Within a short time, Slade had convinced his landlord, a local conjurer, the chief of police and several prominent German scientists (including the physicist Johann Zöllner of the University of Leipzig) that he was in contact with spirits and various paranormal forces. When his act wore thin, he took to the road again. Eventually he wound up an alcoholic in a run-down New York boardinghouse, easy prey for tabloid editors who sent cub reporters to expose him one more time.

After the trial the controversy took a toll on participants other than Slade. In 1879 Darwin tried to drum up support for a government pension in recognition of Wallace's brilliant contributions to natural history. Wallace, he knew, had to earn his meager living by grading examination papers. But when Darwin wrote to his friend Joseph Hooker, director of Kew Gardens, the botanist refused to help. "Wallace has lost caste terribly," he replied nastily, "not only for his adhesion to Spiritualism, but by the fact of his having deliberately and against the whole voice of the committee" allowed the paper on mental telepathy at the scientific meetings. In addition, he thought the government "should in fairness be informed that the candidate is a public and leading Spiritualist!

Undaunted, Darwin replied that Wallace's beliefs were "not worse than the prevailing superstitions of the country"— meaning organized religion. Darwin and Huxley twisted a few more arms. Darwin personally wrote to Prime Minister William Gladstone, who passed the petition on to Queen Victoria. In the end, Wallace got his modest pension and was able to continue writing his articles and books; he died in 1913, at the age of 90.

In the years after the trial, Wedgwood and Darwin did not see much of each other. In 1878 a reporter for the journal *Light* had finally managed to unmask Charles Williams, the medium who had attempted to use Wedgwood to win over Darwin's family. When the journalist suddenly turned on the lights at a séance, Williams was found to be wearing a false black beard, phosphorescent rags and, as Darwin later put it, "dirty ghost-clothes."

"A *splendid* exposure," crowed Darwin when he read of it. But even then, his brother-in-law's faith remained unshaken; a few faked performances indicated only that the medium was having difficulty getting through to the other side and was under



Sir Joseph Hooker (1817-1911). Darwin tried to drum up support for a government pension for Wallace but Hooker declined because of Wallace's belief in Spirituality.

pressure not to disappoint his sitters. For Darwin, this was the last straw: "Hensleigh Wedgwood admits Williams is proved a rogue," he fumed, "but insists he has seen real ghosts [at Williams's séances]. Is this not a psychological curiosity?"

In 1880 Wedgwood sent Darwin a long handwritten manuscript: a spiritualist synthesis of science and religion. Would Darwin read it and perhaps suggest where it might be published? In a melancholy mood, Darwin sat down to reply to his cousin. He may have remembered the times Wedgwood had gone to bat for him many years before: he had helped persuade Darwin's uncle and father to let him go on the HMS *Beagle* expedition, and it was to his cousin that Darwin had once entrusted publication of his theory of natural selection.

"My dear Cousin," Darwin wrote, "It is indeed a long time since we met, and I suppose if we now did so we should not know one another; but your former image is perfectly clear to me." He refused even to read Hensleigh's paper, writing that "there have been too many such attempts to reconcile Genesis and science." The two cousins, who had once been so close, were now hopelessly estranged over the question of science and the supernatural.

That same year Lankester, now a professor of zoology, declined requests to continue ghostbusting. "The Spirit Medium," he wrote in an 1880 letter to the *Pall Mall Gazette*, "is a curious and unsavory specimen of natural history, and if you wish to study him, you must take him unawares…. I have done my share of the skunk-hunting; let others follow." As I have mentioned previously, he was later appointed director of the British Museum of Natural History.

Ironically, in 1912 Lankester, the nemesis of fakers was completely fooled by the Piltdown man hoax, one of the most notorious frauds in the history of evolutionary biology. For the next 40 years, scientists accepted the "ape-man" fragments, dug up about 25 miles from Darwin's home, as remains of the "missing link." Fired with enthusiasm for the Darwin-Wallace theory, Lankester and the younger generation of evolutionists uncritically embraced this fossil forgery.

Huxley, who died in 1895, knew full well that more than a few scientists were prone to develop their own irrationally held beliefs. While young, he had battled churchmen to establish the scientific approach to unraveling human origins but later quipped to an educator that "we or our sons shall live to see all the stupidity *in favor of science*"—a fitting prophecy of the Piltdown man. In *The Descent of Man*, Darwin himself had urged a skeptical approach to unconfirmed observations; he believed that accepting flimsy evidence is much more dangerous than adopting incorrect theories. "False facts are highly injurious to the progress of science, for they often long endure," he wrote. "But false views, if supported by some evidence, do little harm, as everyone takes a salutary pleasure in proving their falseness."

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AQUARIUM ORNAMENTAL PLANT HISTORY

by Albert J. Klee, Ph.D.

(Essays on Aquarium Hobby History, April 8, 2022)

I have written much about the history of the aquarium, using as my definition of aquarium as any man-made container containing water with fish and/or plants. However, these writings mention very little about aquatic plants and so I plan to correct this in this essay. Discussions about aquatic plants in aquaria can involve many different aspects. In their historical context this is primarily food or religion but in this essay I am concerned with aquatic ornamental plants in the aquarium.

A.1 A BIT OF BOTANICAL NOMENCLATURE

Rules have been devised for the publication, validation and documentation of scientific names in order to ensure a unique name for every taxon. In defining taxonomic names for organisms, two primary sets of rules apply, depending on whether the species is zoological or botanical:

(1) International Code of Zoological Nomenclature (ICZN) and (2) The International Code of Nomenclature for Algae, Fungi and Plants, the latter being the set of rules and recommendations that govern the scientific naming of all organisms traditionally treated as algae, fungi or plants, whether fossil or non-fossil. Before 2011 it was called the International Code of Botanical Nomenclature (ICBN) and that is the abbreviation I will use in this essay.

Aquarists are more apt to be familiar with the ICZN rules than those of the ICBN. While there are many similarities between the two, there are some important differences. For instance:

According to the rules of ICZN, when a species is combined with a different genus, the name of the author of this new combination is not included in the scientific name. However, according to the rules of the ICBN the combination authors are included. For example:

(1) According to the ICBN the taxonomic name *Cucamis chysocomus* Shumacher, (1827) becomes *Rhaphiodiocystis chrysocoma* (Schumacher) C. Jeffrey (1962).

(2)According to the ICZN the taxonomic name *Bothynoproctiis portai* Straneo, 1941 becomes *Neotalis portai* (Straneo. 1941).

A tautonym is when the scientific name for a species is identical for both the genus and its specific names. While this is relatively common in zoology, in botany it is not allowed. For example, *Bison bison* is allowed in the ICZN but *Cabomba cabomba* would not be allowed in the ICBN.

The levels of classification hierarchy in the ICBN are rather specific: *kingdom, division* or *phylum, class, order, family, genus* and *species*. However, the levels of classification hierarchy in the ICZN do not go above the *superfamily*. Thus with regard to nomenclature, things are more complex than those in zoology. Because of this I will describe aquatic ornamentals mostly by their shapes and where they grow without their scientific nomenclature except for their Latin names.

A.2 ANGIOSPERMS

Angiosperms, also called flowering plants, are any of about 950,000 species of flowering plants, the largest and most diverse group within the kingdom Plantae. Angiosperms represent approximately ninety percent of all the known green plants now living. Aquatic plants are phylogenetically well dispersed across the angiosperms, but the fraction of aquatic species probably comprises less than two percent of the angiosperm species. Nevertheless, this two percent contains most of our aquatic aquarium plants. The term “angiosperm” is derived from the Greek words αγγειον (receptacle) and σπερμα (seed), and refers to those plants that produce their seeds enclosed within a fruit.

Angiosperms are classified in a single phylum: the Anthophyta. Modern angiosperms appear to be a monophyletic group, which means that they originate from a single ancestor. Figure 1 shows an angiosperm cladogram. A cladogram (from Greek clados "branch" and gramma "character")

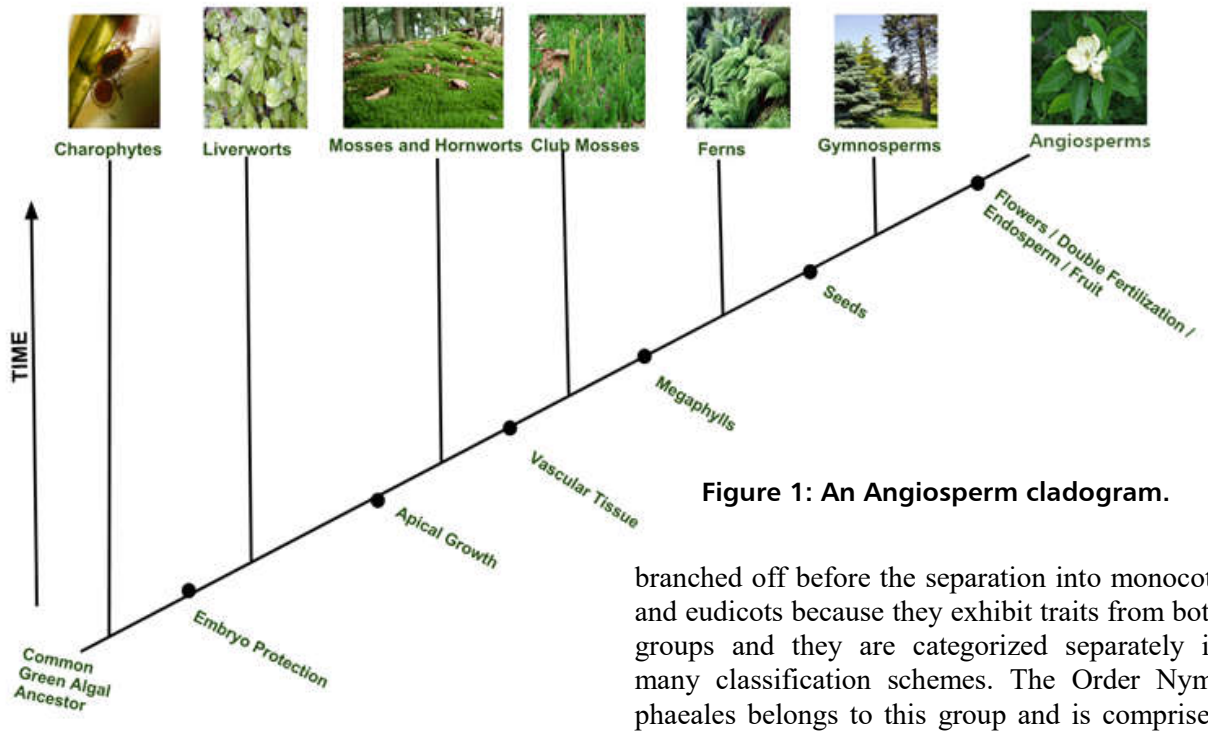


Figure 1: An Angiosperm cladogram.

is a diagram used in cladistics to show relations among organisms. A cladogram is not, however, an evolutionary tree because it does not show how ancestors are related to descendants, nor does it show how much they have changed, so many differing evolutionary trees can be consistent with the same cladogram. A cladogram uses lines that branch off in different directions ending at a clade, a group of organisms with a last common ancestor. Although traditionally such cladograms were generated largely on the basis of morphological characters, DNA and RNA sequencing data and computational phylogenetics, i.e., the application of computational algorithms, methods, and programs to phylogenetic analyses, are now very commonly used in the generation of cladograms.

Flowering plants are divided into two major groups; the monocots which include grasses and lilies, and the eudicots or dicots which form a polyphyletic group. Most common garden plants, shrubs and trees, and broad-leafed flowering plants such as magnolias, roses, geraniums, and hollyhocks are dicots. Basal angiosperms however are a group of plants that are believed to have branched off before the separation into monocots and eudicots because they exhibit traits from both groups and they are categorized separately in many classification schemes. The Order Nymphaeales belongs to this group and is comprised of the water lilies, lotus, cabomba and similar plants (Figure 2). All these species thrive in freshwater biomes (i.e., regions of the world with similar climate, e.g., weather, temperature, animals and plants, and have leaves that float on the water surface or grow underwater.

Water lilies are particularly prized by gardeners, and have graced ponds and pools for thousands of years. They live as rhizomatous aquatic herbs in temperate and tropical climates around the world. The family contains five genera with about 70 known species. During the initial growth period, the water lilies have strong roots while roots but will gradually thin themselves so that the plant

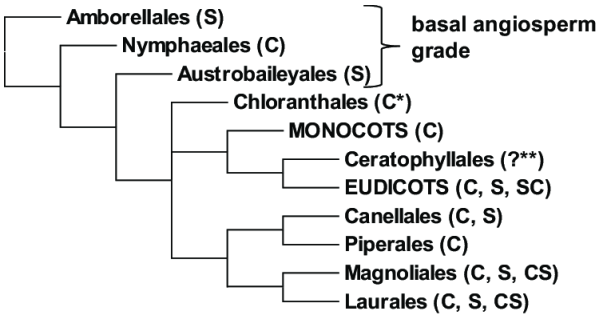


Figure 2: A simplified classification of the Dicots.

can easily absorb the nutrients from the soil. They save energy because they don't need to grow elaborate root structures or vascular tissues. Also, they don't need this additional support because the water keeps them afloat. Thus, water lilies don't need adaptations like strong woody stems and deep anchoring roots.

The angiosperm life cycle is dominated by the sporophyte stage (in plants and certain algae, this is the nonsexual phase in the alternation of generations—a phenomenon in which two distinct phases occur in the life history of the organism, each phase producing the other; the sexual phase is the gametophyte). Double fertilization is an event unique to angiosperms. One sperm in the pollen fertilizes the egg, forming a diploid zygote, while the other combines with the two polar nuclei, forming a triploid cell that develops into a food storage tissue called the endosperm.

An ancient Chinese fossil of a flower adds to the growing body of evidence that angiosperms originated underwater. An article by Ge Sun and his colleagues (Ge Sun *et al.*, 2002) provides the first fossil evidence to answer the question that has long puzzled scientists. It suggests that flowering plants evolved in parallel with non-flowering plants, rather than evolving from them.

"This is the first time we've got a completely reconstructed fossil plant which helps explain the evolution of flowering plants," comments Dr. Mark Clements of the Australian National Botanic Gardens in Canberra. Sun and his team analyzed recently discovered fossilized remains of a plant named *Archaefructus sinensis* and discovered that it lived at least 125 million years ago and was most likely an underwater plant. Farmers in China stumbled across the fossil and passed it onto the researchers.

Although it had no petals, said co-author Dr. David Dilcher (2010—present, Professor Emeritus , Department of Geology and Department of Biology, Indiana University), it had seeds enclosed in immature fruit, a trait separating flowering plants from all other seed plants. The researchers claim that the new fossil, together with fossil fragments of a related species *Archaefructus liaoningensis* discovered nearby four years ago, form the earliest known family of flowering plants, a now extinct sister group to other flowering plants.

Dr. Dilcher also studied *A. liaoningensis* but at the time was unable to locate where the plant fitted in the fossil record because of the fragmented nature of the fossils. However the *Archaefructus sinensis* fossil was so complete the researchers were able to construct the whole plant and then work out where it fitted into the evolutionary tree.

The plant was about 20 inches high, with long, thin, curving stems, which suggests it would have needed water for support, the researchers say. It probably stretched up to the surface, where its pollen and seed organs extending above the water. It is likely the seeds dispersed in the water and floated up along the shore and germinated in shallow water. Clements said that the new fossil material supports evidence from the morphology and genetics of living plants, such as the waterlily. "There's been a long-standing assumption that flowering plants came from non-flowering plants," he said. "We tend to think in linear terms but nature isn't necessarily like that." Thus, aquatic plants were among the earliest angiosperms (flowering plants). Fossil evidence places an early form of waterlily and the *Archaefructus sinensis* mentioned above at 125-115 million years BC.

Figure 3: Fossil of *Archaefructus liaoningensis*, one of the earliest known genera of flowering plants.

B. MACROPHYTES

Aquatic plants grow in wetlands, shallow lakes, rivers and streams. They are also referred to as hydrophytes or macrophytes to distinguish them from algae and other microphytes. They can be seen with the naked eye and include large algae, flowering plants and ferns.

Macrophytes are often classified according to their growth form: (a) submerged plants with roots, (b) floating plants with roots, (c) exclusive floating plants, and (d) emergent plants (Figure 4). Most macrophytes are attached to the water bottom with their roots in the sediment but some are free floating with their roots floating in the water beneath them. The macrophytes that have their roots in the sediment can be submerged, with all their parts under the water, or emergent, with some of their structures above the water. Some submerged macrophytes have leaves or flowers that come out of the water for only a short period of time. Emergent macrophytes are often in the transitional zone, the area along the shoreline between the land and the water.

This classification enables to transfer findings to general principles applicable to other species with a similar growth form (O'Hare 2015). The underground parts are used to anchor the plant in the soil to prevent uprooting (Sand-Jensen 1998) as well as for the uptake of nutrients from the soil. Plant parts rising above the water level can be used to produce flowers (O'Hare 2015) and the stems of emerged vegetation have often air channels to transport gases from the leaves to the submerged parts. The submerged leaves are often long and thin with a high surface to volume ratio, which increases light interception and gas exchange (Bloemendaal 1988). This specific shape also enables streamlining with high flow velocities (Sand-Jensen and Pedersen 2008; Schoelynck et al., 2013). Macrophytes growing in rivers developed two distinct strategies to cope with the hydrodynamic forces they encounter in rivers: avoidance versus tolerance strategy (Puijalon et al., 2011). The first strategy is characterized by a high flexibility of the plants which can bend with increasing flow velocities and as such maximally reduce the drag force they feel frim the flowing water. They also don't need to invest much energy in strength tissue (e.g. lignin). Plants with a tolerance strategy however, are mainly built of stiff and strong tissue with a high tensile force. Consequently they have less capacity to bend and therefore experience high drag forces (Coops and VanderVelde, 1996; Puijalon et al., 2011)

In lakes and rivers, macrophytes provide cover for fish, substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife. Macrophytes are primary producers and are the basis of the food web for many other organisms. One of the most important plants of the world is rice (and an aquatic!) was domesticated in 4000 years BC, based on evidence in Thailand. The value of many aquatic plants as food cannot be underestimated but the subject here is their ornamental history.

Figure 4: A classification of macrophytes according to their growth form: (a) submerged plants with roots, (b) floating plants with roots, (c) exclusive floating plants and (d) emergent plants. (Figure from Schoelynck, 2011).

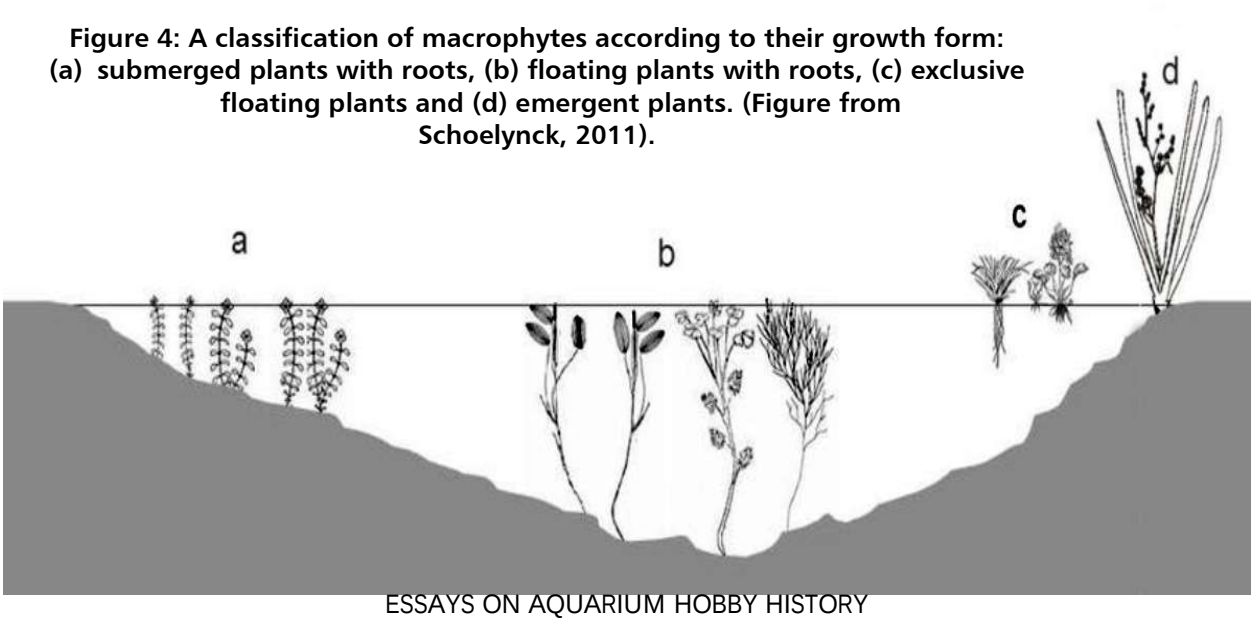


Figure 5: Lily on the left and lotus on the right.

C.1 EARLY HISTORICAL REFERENCES TO ORNAMENTAL PLANTS

The question sometimes arises, are the waterlily and lotus the same? *Nelumbo nucifera*, also known as Indian lotus, sacred lotus or simply lotus, is one of two extant species of aquatic plants in the family Nelumbonaceae. It is sometimes colloquially called a waterlily, though this more often refers to members of the family Nymphaeaceae. The biggest difference between the waterlily (*Nymphaea* species) and lotus (*Nelumbo* species) is that the flowers and leaves of the waterlily grow on the surface of the water while the leaves and flowers of the lotus grow above water. The lotus also grows up to 6 feet tall, while the waterlily is only 8 inches tall. Also, the seedpod of *Nelumbo* is very distinctive. The waterlily has the typical center of most flowers, that is, the pistil and stamens are placed there. At the same time, the lotus has a ring of stamens surrounding the pistil at the summit of the ovary) in the middle of the flower that looks quite unusual and gives some decorative value.

The "lotus," most likely *Nymphaea caerulea* and *Nymphaea lotus*, appears in ancient Egyptian hieroglyphics as early as the First Dynasty (2950-2770 BC). Legends, myths, art and physical evidence bespeak its importance in ancient Egyptian culture and religion. How and when the lotus *Nelumbo nucifera* reached Egypt is not really known, but the Greek historian Herodotus wrote of its presence there in the fifth century BC.

The earliest planned gardens which included ponds were probably in Egypt, documented as early as 2800 BC. Decorative ponds and fountains were a major feature in gardens of the Middle Eastern civilizations of Mesopotamia, stimulated by the need for irrigation canals. The design tended to include four water features in the form of a cross, thought to stem from the four rivers of the Garden of Eden and the concept of "flowing to the four corners of the earth." The later Persian and Islamic empires greatly influenced garden design in such nations as Spain and India.

Hinduism had some of its roots in Mesopotamian civilizations as well as in the Indus, where the native lotus *Nelumbo nucifira* was and is today a major symbol in religion. Though its cultivation is not mentioned, we can surmise that it was featured in many gardens. Buddhism, which developed in part from Hinduism in India, also symbolized the lotus and made its way to China via the Silk Road.

Lotus seeds were found as a part of the Hemudu Culture in ancient China as long ago as 5000 BC and presumably were native to that region. Chinese poetry from the Zhou Dynasty (1122-256 BC) speaks of the lotus. The Imperial Gardens developed during the Han Dynasty (from 206 BC) in China are the first we can find noted for water features.

At about this same time, interest in plants was growing in Greece, though the Greeks were not known for ornamental gardens. The philosopher and botanist Theophrastus wrote "De Historia Plantarum" ("A History of Plants") and "De Causis Plantarum" ("About the Reasons of Vegetable Growth"). Though it's difficult to tell which plants he was writing about, he can be considered the first botanical taxonomist.

Roman gardens were largely utilitarian though the gardens of the affluent during the Roman Empire assimilated Islamic design, the use of fountains in particular. The collapse of the Roman Empire signaled a virtual end to ornamental gardening in Western Europe until the Islamic conquest of Spain in the eighth century. The pools and fountains of the Alhambra are major examples of that influence as is the Taj Mahal in India. In 552, Buddhism was introduced to Japan, en-

Figure 6: Theophrastus (c371-c287 BC).

hancing the incorporation of water and the lotus in Japanese garden design. Even earlier water was an important element. The lotus first appeared in the art and/or architecture of Japan in the seventh century.

From the eleventh to the thirteenth centuries, Crusaders brought back from the Middle East a desire to create ornamental gardens with water features. The Renaissance brought with it a resurgence of formal gardens in Europe, in Italy especially. Baroque gardens of the seventeenth century included Versailles.

C.2 THE GOLDEN AGE OF ORNAMENTAL AQUATIC PLANTS

The seventeen hundreds have been called the Golden Age of Botany, partly because wide exploration of exotic lands provided material for a growing group of scientists to study and partly because of Carl Linnaeus, whose "Species Plantarum" established the system of nomenclature and basis of taxonomy used today. In this book," Linnaeus named *Nymphaea alba* and *Nymphaea lotus*.

C.2.1 JOSEPH PAXTON

In the late eighteenth and early nineteenth centuries, a flurry of plant species was sent to Europe from around the world, heightening interest in waterlilies and ponds. News of the successful cultivation and flowering of *Victoria amazonica* by Joseph Paxton at Chatsworth in England in 1849 spread far and wide. Sir Joseph Paxton (1803-1865) was an English gardener, architect, engineer and Member of Parliament, best known for designing the Crystal Palace. In the early 1830's Paxton began experimenting with glass houses, which were to be the forerunners of green houses. He designed constructions with the exact angles to make optimal use of the morning and evening sun. In 1836, the first *Victoria amazonica*, a large waterlily was sent to England, but they would not grow and not flower so one seedling was sent to Paxton. Under his observation, his gardeners managed to grow the plant successfully and got it to flowering not much later. Since it continued growing, Paxton had to build another, much larger green house, later known as the Victoria Regia House. His experimentation resulted in a glass

Figure 7: Sir Joseph Paxton (1803-1865).

Figure 8: *Nymphaea hybr. Ortiesii* (*Ortgiesiano -rubra*) from Flore des serres et des jardins de l'Europe (Gand, L.van Houtte, 1852-1853).

house that later depicted a great inspiration for his famous Crystal Palace. His design was the first to make use of the invention of the cast plate glass method in 1848, which made it possible to cheaply produce large sheets of glass strong enough for construction.

This set the stage for the first waterlily hybrids to be made. The first generally accepted as a true hybrid was *N. 'Ortgiesiano-rubra'* by Eduard Ortgies at the Van Houtte nurseries in Belgium and the second was *N. 'Boucheana'* by Carl Bouché in Germany. Both of these were night blooming tropicals, created in 1852. William T. Baxter at Oxford Botanic Garden in England introduced a hybrid day blooming tropical, *N. 'Daubenyana'*, possibly as early as 1851, named for Dr. Charles Daubeny.

Figure 9: Eduard Ortgies (1829-1916).

Figure 10: Charles Antoine Lemaire (1800-1871).

C.2.2 CHARLES ANTOINE LEMAIRE

Charles Antoine Lemaire (1800-1871), was a French botanist and botanical author, noted for his publications on Cactaceae. It took an article by Lemaire about *Nymphaea devoniensis*, which appeared in the Belgian publication *Le Jardin Fleuriste* in 1854, to inspire a Frenchman to explore the potential of hybridizing waterlilies. Joseph Bory Latour-Marliac (1830-1911) was a

Figure 11: Joseph Bory Latour-Marliac (1830-1911).

French lawyer and horticulturalist noted for breeding waterlily hybrids. Latour-Marliac founded a waterlily nursery at Le Temple-sur-Lot in 1875. A display of his plants at the Exposition Universelle of 1889 in Paris attracted the attention of the painter Claude Monet who then obtained water lilies for his garden in Giverny from Latour-Marliac. Though much of the cultivation and study of aquatic plants was going on in England, Belgium and Germany, it was Latour-Marliac who, at the turn of the twentieth century, created hardy waterlily hybrids that set the standard for all who followed.

C.3 PONDS AND WATERLILIES IN AMERICA

Interest in ponds and waterlilies spread to America where Edmund Sturtevant, William Tricker and James Gurney led the way, and Henry S. Conard published his landmark monograph, The Waterlilies, in 1905. George Pring soon made Missouri Botanical Garden the aquatic Mecca of the United States and in the 1930's Martin E. Randig and Otto Beldt introduced their first waterlilies.

C.3.1 EDMUND STURTEVANT

Edmund Sturtevant established the first aquatics nursery in the United States in Bordentown, New Jersey, in 1876, with its first catalog published in 1881. Sturtevant developed a large collection of species and hybrid waterlilies from around the world and was, in many cases, the first to introduce them in America. His tropical night blooming hybrid *N. 'Sturtevantii'* was introduced in 1884 and is still in cultivation today. Sturtevant was fortunate in owning a sheltered millpond and so was able to get even quite tender plants to bloom in quantity. He received seeds of *Victoria amazonica* from Edward S. Rand Jr., in Para, Brazil. The flowers started out white but turned crimson over time. Sturtevant found that slashing the seeds improved the rate of germination.

C.3.2 WILLIAM TRICKER

Figure 12 Edmund D. Sturtevant (1842-1898).

Figure 13: Charles William Brett Tricker (1853-1916).

The firm of William Tricker is still very active today in Independence, Ohio, though it is no longer in family hands. The first William, whose complete name was Charles William Brett Tricker (1853-1916), was born into a gardener's family in England and became an apprentice at the Royal Botanic Gardens in Kew. When he immigrated to the United States, he initially worked for Henry Dreer in Philadelphia. He eventually established two aquatic nurseries of his own in New Jersey, the first one in 1892. Tricker's youngest son, Charles, took over the business in 1916 after William died.

William Tricker became prominent when he differentiated *Victoria cruziana* from *V. amazonica* in the early 1890s. In 1897, he published a book about the care and culture of water lilies: *The Water Garden.* Perry Slocum commented that he had learned how to raise water lilies from reading this comprehensive and authoritative book. Tricker is known for several excellent cultivars. One was *Nymphaea* 'Blue Beauty', a name chosen by the American Committee on Nomenclature because it was considered to be identical with Henry Conard's blue 'Pennsylvania', introduced at about the same time. Tricker had named his cultivar 'Pulcherrima'.

C.3.3 JAMES GURNEY

Born in Newport Pagnell, Buckinghamshire, England, October 12, 1831, James Gurney (1831-1920) learned gardening from his father, and as a young man received an appointment as a gardener at the Royal Botanic Garden, Kew. He was in charge of the aquatics section. The first *Victoria amazonica* at Kew was under his care and he was present when Queen Victoria, accompanied by, among other royals, the French president (later Napoleon III), went to view the first flowering.

Gurney was appointed to a Royal Commission going to Africa for botanical research Circumstances prevented him from leaving with the group which saved his life, as all of those who went died. Perhaps this is why he decided at age 36 to move to the United States, planning to settle in California. On the way there while staying in St. Louis, he heard that an epidemic was raging on the west coast and so elected to remain in St. Louis. He was short of funds and needed employment. The proprietor of his hotel suggested he see Henry Shaw, who was starting a garden outside the city.

Shaw was a businessman who had found great success in St. Louis. One of his many real estate acquisitions was a large tract of land southwest of the city where he built a country home. Shaw traveled widely and in 1851, he visited the Royal Botanic Gardens at Kew, the Crystal Palace and Chatsworth. He returned home determined to create a garden on his property equal to Kew. In 1859 he opened "Shaw's Garden" to the public. The same year, he made a will that would create the Missouri Botanical Garden (MBG) as a charitable trust upon his death.

In 1867 Shaw hired Gurney as his head gardener.

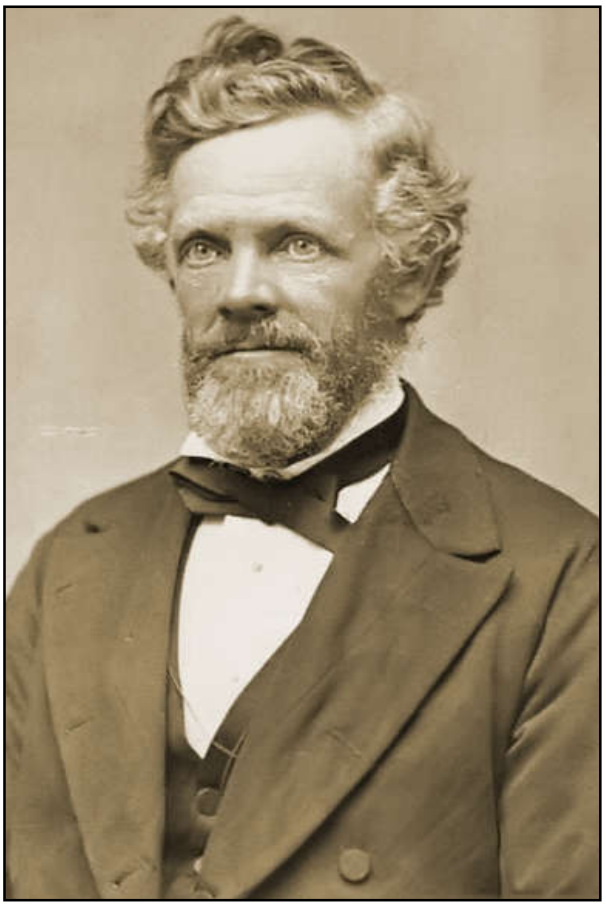


Figure 14: James Gurney (1831-1920).

Figure 15: Back in the early 20th century, working people were only free to go to the Park at night. This is why James Gurney concentrated on developing night flowering waterlilies. The Park was illuminated by bright arc lights atop tall poles.

It turned out they had been born only a few miles apart in England, possibly contributing to their lifelong friendship. Gurney was instrumental in the major changes made to the Garden in subsequent years. He was also responsible for the concepts and design of Shaw's other gift to the city of St. Louis, Tower Grove Park. The Park was first authorized by a state law passed in 1867, and came into existence in 1868, when Shaw conveyed the land, approximately 300 acres, to the city.

Gurney's idea of a park was that it be walled in with green, tall trees and shrubs, so that it would become a place of restfulness, solace and spirituality, without external distractions. He personally planted or helped to plant nearly every tree in Tower Grove Park, though Henry Shaw was deeply involved. Gurney became the Park's Superintendent when Shaw died in 1889, all the while retaining his position with the MBG and its *Shaw School of Botany* until 1903 when he began devoting full time to Tower Grove Park.

Aquatic plants, especially waterlilies, remained Gurney's first love. He was instrumental in making waterlilies an important feature of Tower Grove Park. He became well known as a specialist in their cultivation and hybridization. Working almost exclusively with tropical night bloomers, his earliest cultivar was *N. 'Frank Trelease'*, named for the son of then MBG Director William Trelease. The next were *N. 'Stella Gurney'* (a day blooming "star" lily named for his daughter-in-law), *'James Gurney, Junior'*, *'Rufus J. Lackland'* and *'D.R. Frances'*. A number of others were later described by B.C. Berry in the *MBG Bulletin*. These include *N. 'B.C. Berry'*, *'C.E. Hutchings'*, *'Emily Grant Hutchings'*, *'H.C. Haarstick'*, *'J.S. Walsh'*, and *'Tulipifera'*.

A Victoria was first grown in St. Louis by Gurney at the MBG in 1894, in a special heated pool. The next and subsequent years Victorias were also grown in a heated pool at Tower Grove Park which had better lighting for evening display. Attendance increased dramatically in those first years as residents flocked to see the massive water platters. On Gurney's death, a former student of his at the MBG, Professor A.T. Erwin, was quoted in the *MBG Bulletin*: "The job of head gardener often included about everything - time-

Figure 16: Henry S. Conard (1874 - 1971).

keeper, label writer, foreman, and what not. Careful, methodical, always on the job, courteous, and even-tempered even under trying conditions, the work of Mr. Gurney deserves an important place in the early day history of the Garden and Tower Grove Park, and the Garden pupils of his day remember his labors in their behalf with reverence and appreciation."

C.3.4 HENRY S. CONARD

Henry Shoemaker Conard (1874-1971) was a native of Pennsylvania who earned his B.S. and M.A. degrees at Haverford College and a Ph.D. at the University of Pennsylvania. As a Senior Harrison Fellow in Botany at the University of Pennsylvania, four years of study led to the publication of his landmark monograph on the genus *Nymphaea*, The Waterlilies, by The Carnegie Institution of Washington in 1905. In 1906 Conard joined the faculty of Grinnell College in Iowa as professor of botany. There he gained international recognition as an authority on mosses and waterlilies. He was honored by the *Botanical Society of America* on its 50th anniversary as a "taxonomist, morphologist, mycologist, ecologist, bryologist...and above all a beloved teacher." He retired to Florida in 1944, where he continued his research and publishing until his death in 1971 at age 97.

C.3.5 GEORGE PRING

George Henry (Harry) Pring (1885-1974), was an English-born horticulturist, plant collector and superintendent of Missouri Botanical Garden. Pring was an expert on orchids and an early and successful breeder of tropical waterlilies. He was born in Devon, but grew up near the Royal Botanic Gardens, Kew, where he began his horticultural training aged 14. At 19 years old he was permitted, thanks to his aptitude and enthusiasm, to join the two-year Kew training program at the Queen's School, although rules stipulated that students should be over 21. Completing the course, he joined Missouri Botanical Garden in 1906, where he remained employed for 63 years, shaping parts of the garden including its orchid collection and waterlily pools.

It was in the early part of the 20th century that MBG began research programs in tropical climes, seeking to catalogue the diverse species in Central and South America and beyond. George Pring was one of those sent to remote regions to amass dried specimens for the Missouri herbarium. His

Figure 17: The Mrs. George Pring lily, Introduced by the hybridizer of the Missouri Botanical Garden, George S. Pring and was awarded the silver medal in 1922 by the *Society of American Florists*.

Figure 18: *Nymphaea* 'Mr. Martin E. Randig' (Randig, 1939), a cultivar in the tropical day-blooming group of waterlilies, flowering in the Missouri Botanical Garden.

first plant collecting trip was made in 1923 to Colombia and Panama, where he established a tropical station for MBG. He returned with thousands of plants, including many living orchids, and met the orchid collector Charles Powell in the Panama Canal Zone. Powell later donated his impressive selection of plants to MBG. Over the course of Pring's career, a world-class orchid collection of more than 50,000 plants was amassed at Missouri, which hosted the first World Orchid Congress in 1954, chaired, of course, by Pring.

In 1907, Pring went home to see his family, meeting his future wife on the boat from America. He married Isabelle McAdie (known as Belle) three years later and together they had four children. Belle Pring also played a role at MBG, bringing in a team of volunteers to give public tours of Tower Grove House, home of the garden's founder, Henry Shaw.

As well as the fruits of his collecting trips, Pring left a legacy of fascinating hybrid water lilies. He first cross-pollinated water lilies in 1912 and went on to introduce a host of new cultivars. His creations, many of them firsts in the field, were so impressive that larger ponds had to be installed at MBG to showcase them. Pring wrote about horticulture for many popular publications and also hosted a radio show for gardeners. He collaborated on several gardening books and served as president of various plant societies, often giving lectures on horticultural topics. He was also a key consultant in the design of the lily pools at the Longwood Gardens of Pennsylvania.

C.3.5 MARTIN RANDIG

Martin E. Randig started his San Bernardino CA nursery in 1918 at 21 years of age. He specialized in growing water lilies and orchids. Starting with tropical waterlily species, (particularly color forms of Nymphaea capensis, var. zanzibariensis), he developed many hybrids which he exhibited in California state and county fairs in the 1930's. Randig consistently won first prize for the best collection of waterlilies. He won the gold certificate of merit for his display at the San Francisco's world fair, and Special recognition for new hybrids at the New York World Fair.

When the United States entered World War II, Randig put aside his hybridizing experiments to enter war work. All his tubers were covered with slightly moist sand and stored in sealed metal cans. After the war, he discovered that many of the cans had rusted, allowing mice to chew them open and eat the tubers. Nevertheless, he resumed his hybridizing starting with the few remaining tubers until after 12 years he had sufficient plants to introduce them to the public. He asked Ted Uber of Van Ness Water Gardens to utilize a separate page of his catalogue for the new waterlily introductions. Even after this momentous event, Randig continued his hybridizing and introduced new named varieties.

After his death, Mrs. Randig invited Ted Uber to select some waterlilies among the remaining stock that showed promise for subsequent introduction. This, Mr. Uber did, and after increasing the stock, introduced 5 more hybrids, one of which he named after Randig. The total number of named waterlily hybrids attributed to Martin Randig is 28.

The story of Ted Uber (1908-2007) is unusual. He was a master aluminum craftsman with a thriving business in metal objects for the house when the Korean War reduced the supply of aluminum for nonmilitary purposes to a trickle. In order to survive, Ted became a teacher in industrial arts at a local high school for a time. Things looked up when his cousin Edith Van Ness asked him to take over her water lily business in Upland, California. He accepted. The supply of aluminum subsequently returned to prewar levels, and he picked up his former work again, alternating between the two lines of business.

Randig consigned amazing new flowers to Van Ness, such as 'Afterglow' and 'Green Smoke'. Gardening reporters quickly found out about them and featured them in magazine articles. This boosted sales very effectively. About fifteen cultivars can be attributed to Randig. Uber's son William also bred water lilies of his own. His contribution to water gardening was gratefully acknowledged by Louella Uber in the March1987 Issue of The Water Garden Journal, Van Ness Water gardens Past, Present and Future "We owe much of our success to my friendship with Mr. Randig. His new introductions with their many shades and colors put Vans Ness Water Gardens on the Map." One of his lilies, 'Evelyn Randig," was not named for 10 years until the birth of his daughter Evelyn. Randig was inducted into the Hall of Fame in 1992 at the Houston Texas Symposium.

D.1 THE FLAT GLASS HISTORY OF AQUATIC ORNAMENTAL PLANTS

I have ended my chronical history of water lilies even though it overlaps the introduction of the aquatic ornamental plants that that came into vogue with the flat sided glass aquaria that appeared in the mid-eighteenth century. Prior to this, the aquarium was an in-ground container with its top near the surface of the water. This meant that submerged plants where all of their parts were under the water could not be observed; only emergent plants—which usually surrounded the border—or floating plants could be viewed from above. In other words, only the rooted submerged plants were favored in the glass-sided aquarium (although some floating plants were used for special purposes).

For example, the following plant genera are listed by Linnaeus as examples under "AQUARIUM PALUSTRA" (marsh ponds) in his *Hortus Upsaliensis, (Linnaeus, 1742)***:** *Acerus, Alisma, Butomus, Cyperus, Erigeron, Eriophora, Funcus, Iris, Phellandrium, Scheuchzeria, Scirpus, Shoenus, Sisymbrium, Sium, Sparganium, Triglochi*. Under "AQUARIUM FLUVIATILE" (river ponds) the following were listed: *Caricum, Hippuris, Hottonia, Myriophyllum, Potamogeton, Sagittaria* and *Utricularia*. Under "AQUARIUM LACUSTRA" (lake ponds) the following were listed: *Hydrocharis, Nuphar lutea* and *Nymphaea* alba. The Aquaria Palustra plants are definitely emergent plants as are some of the Aquaria Fluviatile plants such as *Sagittaria* which throw up summer stalks which develop long, oval leaves above the water. The Aquaria Lacustra plants are floating plants and include the waterlilies.

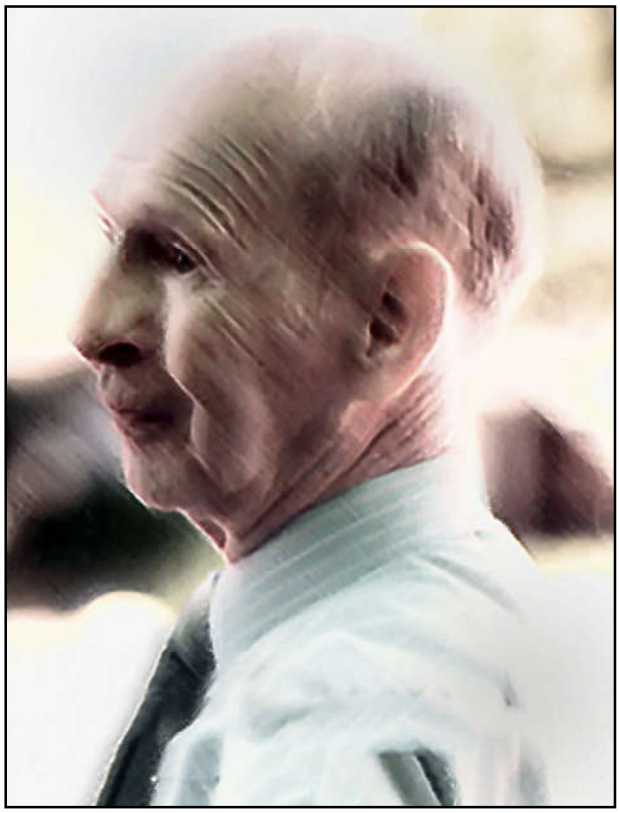


Figure 19: Theodore Uber (1908-2007).

John Claudius Loudon (1783—1843) was a Scottish botanist, garden designer and author. He was the first to use the term arboretum in writing to refer to a garden of plants, especially trees, collected for the purpose of scientific study. He was married to Jane, née Webb, a fellow horticulturalist and author of science-fiction, fantasy, horror and gothic stories. Loudon's *Encyclopaedia of Gardening* (Loudon, 1824) listed many more aquatic plants used by aquarists including *Aponogeton, Ceratophyllum, Crinum, Equisetum, Hippuris, Hottonia, Hydrocharis, Hydrocotyle, Lobelia, Nuphar, Sagittaria* and *Utricularia*.

Robert Warington FRS (1807-1867) was an English chemist considered the driving force behind the creation of the world's first enduring chemistry society, *The Chemical Society of London*, which later became the *Royal Society of Chemistry*. He who worked out that plants added to water in a container would give off enough oxygen to support animals, so long as their numbers do not grow too large. He published his findings in 1850 in the *Quarterly Journal of the Chemical Society of London* and his work is considered the origin of modern aquaria. Warington used *Vallisneria spiralis* in his experiments in 1850 and subsequent years.

D.2 HISTORY PROBLEMS

The problem with rooted, submerged aquatic aquarium plants—the type of most interest to aquarists—is that, as Table I shows, there are so many of them that tracing their history to determine the date they were introduced into the aquarium hobby and who imported them, would be both tedious and difficult, although where they were found geographically usually can be determined by examining their original scientific descriptions. The following two references were listed in the Wikipedia article from which the list was taken:

(1) The Plant List (TPL) is a working list of all known plant species produced by the botanical community in response to Target 1 of the 2002-2010 Global Strategy for Plant Conservation (GSPC). TPL has been static since 2013, but was used as the starting point for the taxonomic backbone of the *World Flora Online (WFO)*. Collaboration between the Royal Botanic Gardens, Kew and Missouri Botanical Garden enabled the creation of The Plant List by combining multiple checklist datasets held by these institutions and other collaborators.

Figure 20: The Plants List is composed of four groups: Flowering plants (Angiosperms), Conifers, cycads and allies (Gymnosperms), Ferns and fern allies (Pteridophytes) and Mosses and liverworts (Bryophytes).

COMMON AQUARIUM PLANT SPECIES CTD.

Aciotis acuminifolia
Acmella repens
Acorus calamus (Common sweet flag)
Acorus gramineus (Japanese sweet flag)
Aldrovanda vesiculosa
Alisma canaliculatum
Alisma gramineum
Alisma lanceolatum
Alisma nanum
Alisma orientale
Alisma plantago-aquatica
Alisma subcordatum
Alisma triviale
Alisma wahlenbergii
Alternanthera bettzickiana
Alternanthera philoxeroides
Alternanthera reineckii
Alternanthera sessilis
Ammania capitellata
Ammannia crassicaulis (Synonym Nesaea crassicaulis)
Ammania gracilis (Delicate ammania, red ammania)
Ammania latifolia
Ammannia pedicellata
Ammannia praetemissa
Ammania senegalensis
Anubias afzelii (Narrow-leafed anubias)
Anubias barteri var. barteri (Broadleaved anubias)
Anubias barteri var. angustifolia
Anubias barteri var. caladiifolia
Anubias barteri var. glabra
Anubias barteri var. nana (Dwarf anubias)
Anubias gigantea
Anubias gilletti
Anubias gracilis
Anubias hastifolia
Anubias heterophylla
Anubias pynaertii
Aponogeton appendiculatus
Aponogeton bernierianus
Aponogeton boivinianus
Aponogeton capuronii
Aponogeton crispus (Crinkled or Ruffled aponogeton)
Aponogeton decartyi
Aponogeton desertorum
Aponogeton dioecus
Aponogeton distachyos
Aponogeton elongatus
Aponogeton fenestralis
Aponogeton henkelianus
Aponogeton junceus
Aponogeton longiplumulosus
Aponogeton loriae
Aponogeton madagascariensis (Madagascar laceleaf, lace plant)
Aponogeton natans
Aponogeton rigidifolius
Aponogeton tenuispicatus
Aponogeton ulvaceus (Compact aponogeton)
Aponogeton undulatus
Armoracia aquatica
Arthraxon hispidus
Azolla caroliniana (water velvet, mosquito fern)
Azolla filiculoïdes (Azolla, moss fern)
Azolla pinnata
Bacopa amplexicaulis
Bacopa australis
Bacopa caroliniana (Lemon Bacopa, Water hyssop, Giant Bacopa)
Bacopa crenata
Bacopa innominata
Bacopa lanigera
Bacopa madagascarensis
Bacopa monnieri (Water hyssop, dwarf Bacopa, Baby Tears)
Bacopa myriophylloides
Bacopa rotundifolia (Round bacopa)
Bacopa salzmannii
Bacopa serpyllifolia
Baldellia ranunculoides
Barclaya longifolia (Orchid lily)
Barclaya motleyi
Berula erecta
Blyxa aubertii
Blyxa echinosperma
Blyxa japonica (Japanese rush)
Blyxa novoguineensis
Blyxa octandra
Bolbitis heteroclita (sometimes sold as B. asiatica)
Bolbitis heudelotii (African or Congo fern)
Bucephalandra gigantea
Bucephalandra motleyana
Bucephalandra catherineae
Cabomba aquatica (Yellow cabomba, giant cabomba)
Cabomba caroliniana (Green cabomba)
Cabomba furcata
Cabomba palaeformis
Cabomba piauhyensis (Red cabomba)
Caldesia parnassifolia
Calla palustris
Caltha palustris
Callitriche hamulata
Callitriche hermaphroditica
Callitriche palustris
Callitriche stagnalis
Callitriche terestris
Cardamine lyrata (Chinese ivy, Japanese cress)
Cardamine rotundifolia
Ceratophyllum demersum (hornwort)
Ceratophyllum submersum (tropical hornwort)
Ceratopteris cornuta
Ceratopteris pteridoides
Ceratopteris thalictroides (water sprite)
Cladophora aegagropila
Clinopodium brownei
Crassula aquatica
Crassula helmsii
Crinum calamistratum
Crinum natans (African onion plant)
Crinum purpurascens
Crinum thaianum (water onion)
Cryptocoryne affinis
Cryptocoryne alba
Cryptocoryne albida
Cryptocoryne aponogetifolia
Cryptocoryne auriculata
Cryptocoryne axelrodii
Cryptocoryne balansae
Cryptocoryne beckettii (Beckett's Cryptocoryne)
Cryptocoryne blassii
Cryptocoryne bogneri
Cryptocoryne bullosa
Cryptocoryne ciliata
Cryptocoryne cognata

COMMON AQUARIUM PLANT SPECIES CTD.

Cryptocoryne cordata (Giant cryptocoryne)
Cryptocoryne crispatula
Cryptocoryne cruddasiana
Cryptocoryne dewitii
Cryptocoryne diderici
Cryptocoryne elliptica
Cryptocoryne ferruginea
Cryptocoryne fusca
Cryptocoryne gasserii
Cryptocoryne grabowskii
Cryptocoryne gracilis
Cryptocoryne griffithii
Cryptocoryne hudoroi
Cryptocoryne keei
Cryptocoryne legroi
Cryptocoryne lingua
Cryptocoryne longicauda
Cryptocoryne lucens
Cryptocoryne lutea
Cryptocoryne minima
Cryptocoryne moehlmannii (Moehlmann's cryptocoryne)
Cryptocoryne nevillii
Cryptocoryne nurii
Cryptocoryne pallidinervia
Cryptocoryne parva (Tiny cryptocoryne)
Cryptocoryne petchii
Cryptocoryne pontederiifolia
Cryptocoryne purpurea
Cryptocoryne retrospiralis
Cryptocoryne schulzei
Cryptocoryne scrurillis
Cryptocoryne siamensis
Cryptocoryne spiralis
Cryptocoryne striolata
Cryptocoryne thwaitesii
Cryptocoryne tonkinensis
Cryptocoryne undulata (Undulate cryptocoryne)
Cryptocoryne usteriana
Cryptocoryne venemae
Cryptocoryne versteegii
Cryptocoryne walkeri
Cryptocoryne wendtii 'Tropica'
Cryptocoryne x willisii
Cryptocoryne zewaldiae
Cryptocoryne zonata
Cryptocoryne zukalii
Cuphea anagalloidea
Cyperus alternifolius
Cyperus helferi
Cyperus papyrus
Damasonium alisma
Didiplis diandra (Water hedge)
Diodia kuntzei
Diodia virginiana
Echinodorus africanus
Echinodorus amazonicus (Amazon sword)
Echinodorus andrieuxii
Echinodorus angustifolius
Echinodorus argentinensis
Echinodorus aschersonianus
Echinodorus barthii
Echinodorus berteroi
Echinodorus bleheri (Broadleaved amazon)
Echinodorus brevipedicellatus
Echinodorus cordifolius (Radicans sword, spade leaf sword)
Echinodorus fluitans
Echinodorus grandiflorus (Large- flowered amazon)
Echinodorus horemanii (Black-red amazon)
Echinodorus horizontalis
Echinodorus humilis
Echinodorus latifolius
Echinodorus longiscapus
Echinodorus macrophyllus (Large- leaved amazon sword)
Echinodorus martii
Echinodorus major (Ruffled amazon sword)
Echinodorus opacus (Opaque amazon sword)
Echinodorus osiris (Red amazon sword)
Echinodorus 'Ozelot'
Echinodorus palaefolius
Echinodorus paniculatus
Echinodorus parviflorus (Black amazon sword)
Echinodorus pelliscidus
Echinodorus quadricostatus (Dwarf sword)
Echinodorus radicans
Echinodorus rigidifolius
Echinodorus 'Rubin'
Echinodorus rubra
Echinodorus schlueteri
Echinodorus subalatus
Echinodorus tunicatus
Echinodorus uruguayensis (Uruguay amazon sword)
Egeria densa (Elodea, pondweed)
Egeria najas
Egleria fluctuans
Eichhornia azurea
Eichhornia crassipes (Water hyacinth)
Eichhornia diversifolia
Elatine gussonei
Elatine hydropiper
Elatine macropoda
Elatine triandra
Eleocharis acicularis (Hairgrass)
Eleocharis dulcis
Eleocharis minima
Eleocharis obtusa
Eleocharis parvula
Eleocharis vivipara
Elodea canadensis (Canadian pondweed)
Elodea granatensis
Elodea nuttallii
Elodea occidentalis
Equisetum spp.
Eriocaulon amanoanum
Eriocaulon cinereum
Eriocaulon depressum
Eriocaulon parkeri
Eusteralis stellata (Star rotala)
Fittonia argyroneura
Fontinalis antipyretica (Willow moss)
Glossadelphus zollingeri
Glossostigma diandrum
Glossostigma elatinoides
Gratiola amphiantha
Gratiola brevefolia
Gratiola viscidula
Gymnocoronis spilanthoides (Spadeleaf plant)
Helanthium bolivianum (Bolivian sword) (Synonym - Echinodorus bolivianus)
Helanthium tenellum (Pygmy chain sword) (Synonym - Echinodorus tenellus)
Helanthium zombiense
Hemianthus callitrichoides (Dwarf helzine)
Hemianthus micranthemoides (Pearlweed)
Heteranthera dubia

COMMON AQUARIUM PLANT SPECIES CTD.

Heteranthera reniformis
Heteranthera zosterifolia (Stargrass)
Hippuris vulgaris
Hottonia inflata
Hottonia palustris (Water violet)
Hydrilla verticillata
Hydrocharis morsus-ranae
Hydrocleys martii
Hydrocleys nymphoides
Hydrocotyle leucocephala (Brazilian pennywort)
Hydrocotyle sibthorpioides
Hydrocotyle tripartita
*Hydrocotyle verticillata (*Whorled umbrella plant)
Hydrocotyle vulgaris
Hydrothrix gardneri
Hydrotriche hottoniiflora
Hygrophila angustifolia
Hygrophila corymbosa 'crispa'
Hygrophila corymbosa 'glabra' (Broadlead giant stricta)
Hygrophila corymbosa 'gracilis'
Hygrophila corymbosa 'siamensis'
Hygrophila corymbosa 'strigosa'
Hygrophila difformis (Water wisteria)
Hygrophila guianensis
Hygrophila lacustris
Hygrophila lancea
Hygrophila natalis
Hygrophila polysperma (Dwarf hygrophilia)
Hygrophila salicifolia
Hygrophila stricta (Thai stricta, green stricta)
Hygroryza aristata
Hyptis lorentziana
Iris spp.
Isoetes lacustris (quillwort)
Isoetes malinverniana
Isoetes taiwanensis
Isoetes velata
Isolepis setracea
Jasarum steyermarkii
Juncus repens
Lagarosiphon cordofanus
Lagarosiphon madagascariensis
Lagarosiphon major (Elodea crispa)
Lagenandra dewitii
Lagenandra insignis
Lagenandra koenigii
Lagenandra lancifolia
Lagenandra meeboldii
Lagenandra nairii
Lagenandra ovata
Lagenandra thwaitesii
Lemna gibba
Lemna minor (Duckweed)
Lemna paucicostata
Lemna perpusilla
Lemna trisulca
Lilaeopsis brasiliensis
Lilaeopsis carolinensis
Lilaeopsis macloviana
Lilaeopsis mauritiana
Lilaeopsis novae-zelandiae (New Zealand grassplant)
Lilaeopsis ruthiana
Limnobium laevigatum (Amazon frogbit)
Limnobium spongia
Limnocharis flava
Limnophila aquatica (Giant ambulia)
Limnophila aromatica
Limnophila glabra
Limnophila heterophylla
Limnophila indica (Indian ambulia)
Limnophila sessiliflora (Dwarf ambulia)
Limnophyton fluitans
Lindernia crustacea F. Muell.
Lindernia dubia
Lindernia grandiflora
Lindernia parviflora
Lindernia rotundifolia
Littorella uniflora
Lobelia cardinalis (Cardinal flower, scarlet lobelia)
Lobelia dortmanna
Lomariopsis sp. (Süsswassertang)
Ludwigia alternifolia
Ludwigia arcuata
*Ludwigia glandulosa (*Glandular ludwigia, red star ludwigia)
Ludwigia helminthorrhiza
Ludwigia inclinata
Ludwigia inclinata var. verticellata 'Cuba'
Ludwigia mullertii
Ludwigia natans
Ludwigia sedioides
Ludwigia palustris
Ludwigia pulvinaris
Ludwigia repens (Creeping ludwigia, narrow-leaf ludwigia)
Luronium natans
Lycopodiella inundata (Lycopodium inundatum)
Lysimachia nummularia (creeping Jenny, moneywort)
Marsilea crenata
Marsilea drummondii
Marsilea hirsuta
Marsilea pubescens
Marsilea quadrifolia (water-clover)
Mayaca fluviatilis
Mayaca madida (Synonym Mayaca sellowiana)
Mayaca vandellii
Mentha aquatica
Micranthemum umbrosum (Helzine)
Microcarpaea minima
Microsorum pteropus (Java fern)
Monochoria vaginalis
Monosolenium tenerum (commercial name; plants sold under this name are actually a fern Lomariopsis sp.)
Murdannia keisak
Myriophyllum alterniflorum
Myriophyllum aquaticum (Brazilian milfoil, milfoil)
Myriophyllum elatinoides
Myriophyllum heterophyllum
Myriophyllum hippuroides (Green milfoil, water milfoil)
Myriophyllum mattogrossense
Myriophyllum proserpinacoides
Myriophyllum scabratum (Foxtail)
Myriophyllum spicatum
Myriophyllum tuberculatum (Red myriophyllum)
Myriophyllum ussuriense
Myriophyllum verticillatum
Myriophylumm oguraense
Najas graminea
Najas guadelupensis
Najas indica
Najas marina
Najas minor
Najas pectinata
Nechamandra alternifolia
Nelumbo nucifera
Neptunia oleracea
Nitella capillaris
Nitella flexilis

COMMON AQUARIUM PLANT SPECIES CTD.

Nitella gracilis
Nomaphila siamensis
Nuphar advenum
Nuphar japonica (Spatterdock)
Nuphar lutea (Yellow water-lily)
Nuphar pumilum
Nuphar sagittifolium
Nymphaea alba
Nymphaea lotus (Tiger lotus)
Nymphaea lotus var. rubra
Nymphaea micrantha
Nymphaea pubescens
Nymphaea pygmea
Nymphaea stellata (Red and blue water lily)
Nymphaea zenkeri 'Red' (Red tiger lotus)
Nymphoides aquatica (Banana plant)
Nymphoides humboldtiana
Nymphoides indica
Nymphoides peltata
Oenanthe javanica
Oenanthe aquatica
Oldenlandia salzmannii (Synonym Hedyotis salzmannii)
Orontium aquaticum
Ottelia alismoides
Ottelia mesenterum
Ottelia ulvifolia
Penthorum sedoides
Persicaria hydropiperoides
Persicaria praetermissa
Pilularia americana
Pilularia globulifera
Pistia stratiotes (Water lettuce)
Phyllanthus fluitans
Physostegia purpurea
Pogostemon helferi
Pogostemon stellatus
Pontederia cordata
Potamogeton coloratus
Potamogeton crispus
Potamogeton densus
Potamogeton filiformis
Potamogeton gayi
Potamogeton gramineus
Potamogeton lucens
Potamogeton malaianus
Potamogeton natans
Potamogeton perfoliatus
Proserpinaca palustris
Ranunculus aquatilis
Ranunculus limosella
Regnellidium diphyllum
Riccia fluitans (Crystalwort)
Ricciocarpos natans
Rorippa aquatica
Rotala indica
Rotala macrandra (Giant red rotala)
Rotala mexicana
Rotala ramosior
Rotala rotundifolia (Dwarf rotala)
Rotala pusilla
Rotala wallichii (Whorly rotala)
Ruppia maritima
Sagittaria chapmani
Sagittaria eatonii
Sagittaria filiformis
Sagittaria graminea
Sagittaria guyanensis
Sagittaria isoëtiformis
Sagittaria latifolia
Sagittaria microfila
Sagittaria montevidensis
Sagittaria natans
Sagittaria papillosa
Sagittaria platyphylla (giant sagittaria)
Sagittaria pusilla (dwarf sagittaria)
Sagittaria sagittifolia
Sagittaria subulata (needle sagittaria, floating arrowhead)
Salvinia auriculata
Salvinia cucullata
Salvinia minima
Salvinia natans (water spangles)
Salvinia oblongifolia
Salvinia rotundifolia
Samolus valerandi (Water cabbage)
Saururus cernuus (Lizard's tail)
Selaginella sp.
Sium floridanum
Sium latifolium
Shinnersia rivularis (Mexican oak leaf)
Spiranthes romanzoffiana
Spirodela polyrhiza
Staurogyne repens
Staurogyne stolonifera
Stratiotes aloides
Stuckenia vaginata
Subularia aquatica
Syngonanthus caulescens
Synnema triflorum (out of date synonym)
Taxiphyllum barbieri (Java moss)
Tonina fluviatilis
Trapa natans (Water chestnut)
Triglochin maritima
Triglochin palustris
Triglochin striata
Trithuria austinensis
Trithuria austinensis
Trithuria australis
Trithuria inconspicua
Typha angustifolia
Typha latifolia
Utricularia bifida
Utricularia gibba
Utricularia graminifolia
Utricularia minor
Utricularia vulgaris
Vallisneria americana (Dwarf vallisneria)
Vallisneria asiatica
Vallisneria asiatica var. biwaensis (Corkscrew vallisneria)
Vallisneria gigantea (Giant vallisneria)
Vallisneria neotropicalis
Vallisneria rubra
Vallisneria spiralis (Straight vallisneria)
Vallisneria tortifolia (Twisted vallisneria, dwarf vallisneria)
Vallisneria tortissima
Vesicularia montagnei (Christmas moss, Xmas moss)
Veronica americana
Wolffia arrhiza
Wolffia microscopica
Wolffiella floridana
Zannichellia palustris

(2) Peter Hiscock's, "Encyclopedia of Aquarium Plants," (Hiscock, 2003). Peter Hiscock trained at Sparsholt College in Hampshire, one of the United Kingdom's leading schools for aquatic studies and has published widely on fish behavior and aquarium keeping.

The Plants List is composed of four groups: Flowering plants (Angiosperms), Conifers, cycads and allies (Gymnosperms), Ferns and fern allies (Pteridophytes) and Mosses and liverworts (Bryophytes). I'll deal here with the Angiosperms as they contain most of aquatic plants used by aquarists.
The status of the 951,140 species names for the Angiosperms recorded in The Plant List, are as follows:

Accepted	304,419	32.0%
Synonym	430,346	45.2%
Unassessed	216,132	22.7%
Unplaced	243	~0.0%

Unassessed names are those for which there is no evidence within any of the contributing data sources that the status of this name had been evaluated by the data owners. None had recorded that it was either 'accepted' or a 'synonym.' None had recorded that they had attempted such an evaluation.

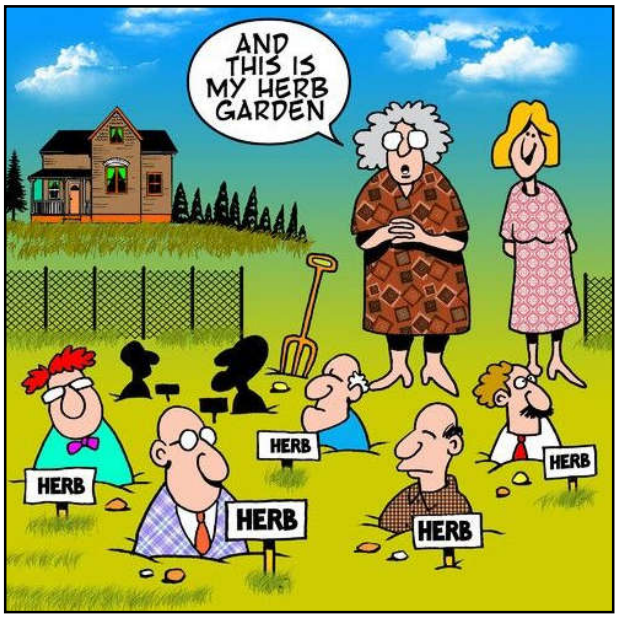
Unplaced names are those for which the data source supplying that record indicated positively that the data owners had sought to resolve its status and not been able to come to a conclusion so as to place it either in synonymy or as the accepted name of a new species. This is often the case if the name has insufficient description and no herbarium specimens are known or where one or more nomenclatural acts are required to provide the accepted name for which the unplaced name would be a synonym. Thus, unresolved names are those to which it is not yet possible to assign a Status of either 'Accepted' or 'Synonym.' The status above indicates that there is much confusion about botanical names and the taxonomy of most plant genera is not final. The scientific names listed in the table may therefore be at odds with other sources.

One of the problems with Hiscock's, Encyclopedia of Aquarium Plants is that most of the pictures in his Plant Profiles section are of emergent plants grown above water, macrophytes that are not of much interest to aquarists. Nonetheless, this is the best book on aquarium plants that I have ever seen and I recommend it highly.

E. CONCLUSIONS

Biologists have worked with the Linnaean system of naming of species for over two centuries. The deficiencies of this system to the modern user are that (a) Latin, a classical language, is the basis; (b) irregular and illogical names have entered into the picture because of the gradual evolution of rules; (c) the abundance of synonyms and homonyms which have arisen from work in independent systematic fields; and (d) the interjection of illogical or erroneous names by previous workers (in good faith) which must now stand unless invalidated for rigorous taxonomic reasons (not for reasons of nomenclature). Whilst such irregularities are accommodated by the professional taxonomist and serious amateur, they can be discouraging to the lay user. Many ordinary people choose not to use scientific naming at all, preferring popular names which carry little or no systematic meaning.

Problems in nomenclature do exist for the plant taxonomist even if they are not as severe as those facing the zoologist. In one limited area of his work, however, that dealing with ornamental



plants, the botanist cannot keep such problems to himself. Gardeners cultivating ornamental plants have to use scientific names. As they out-number the taxonomists concerned with naming, they stimulate pressure for the maintenance of acceptable and for the abandonment of ungainly names. Unfortu-nately, if an awkward name is 'correct' according to the International Code of Botanical Nomenclature, there is little hope of getting rid of it. The Code merely recommends that such names should not be created. If they are, then they have to be recognized.

Recently, for instance, a name has been published for a cactus species, the epithet being the name of the Aztec god of the sun and of war, a distinctly unpleasant deity. Admittedly, "Huitzilopochtli" is an imaginative name, but it is clearly unsuitable for speech, plant labels or in catalogues. Cactus enthusiasts will, I think, continue to use the collector's serial number (i.e., a unique identifier assigned to a plant to uniquely identify it) given on its first introduction. Again, many awkward names are derived from personal names rather than from a characteristic of the plant, which latter could be of real help to the user. As the user has to accept names which conform to the rules but ignore the spirit of the Code it is the more important that when changes are made the facts should be ascertained correctly and the Code applied properly. Unfortunately, I doubt that this will come to pass any time in the near future.

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RESEARCH AND AQUARIUM HOBBY HISTORY: CARL LINNAEUS

by Albert J. Klee, Ph.D.

(*Essays on Aquarium Hobby History*, July 1, 2022)

Some people believe that Linnaeus was the first to name plants and animals, at least in any comprehensive manner. A much greater number have the idea that he: (1) invented binomial names, i.e., two-word, names (genus and species); (2) was the first to completely classify plants and animals; (3) started the practice of creating names for all groups by compounding words from Latin and Greek roots and affixes; and (4) created an hierarchy of classification (kingdom, class, order, genus, species) and formulated names for all of these groups and (5) created pseudoscientific ideas about human biological diversity.

Actually, none of these are true; yet, his reputation was such that it is sometimes impossible to trace the actual application of ancient names because lexicographers simply quote him as an authority. It is also difficult or impossible to trace the development of plant and animal names in reference books and even biological dictionaries and encyclopedias because they start with his classification and nomenclature and discuss the development as if his treatment were the beginning. Before I start to examine these beliefs in detail, the following biographies are presented since they are relevant to this examination.

ARISTOTLE

In his *Historia Animalium* (History of Animals), Aristotle (384 BC-322 BC) was the first to attempt to classify all animal life. He grouped the types of creatures according to their similarities such as animals with blood and animals without blood, animals that live on water and animals that live on land. Aristotle's view of life was hierarchical. He assumed that creatures could be grouped in order from lowest to highest, with the human species being the highest. Subsequent commentators on Aristotle interpreted this as a "ladder of nature" (*scala naturae*) or a "Great Chain of Being," but these were not Aristotle's terms. His system of classification was not evolu-

Carl Linnaeus (1707–1778), later Carl von Linné.

Aristotle (384 BC-322).

tionary, and the various species on the ladder had no specific genetic relationship to each other. Aristotle regarded the essence of species as fixed and unchanging, and this view persisted for the next two thousand years.

His other innovation, however, *was* binomial definition. "Binomial" means "two names," and according to Aristotle's system each kind of organism could be defined by the two names of its "genus and "difference." The word "genus" comes from the Greek root for "birth," and among its meanings are "family" and "race." Aristotle's notion of definition was to place every object in a family and then to differentiate it from the other members of that family by some unique characteristic. He defined humans, for example, as the "rational animal." This is binomial nomenclature and according to Aristotelian thought, defines the essence of what it is to be human, as opposed to such what he thought were pseudo-definitions such as "featherless biped." But what Aristotle did *not* do was to methodically use binomial definition in his system of biological classification. This innovation had to await the development of modern science after the Renaissance.

Aristotle's influence was profound and long-lasting. Much of his work has not survived to the present day, so that we don't know the details of his study of plants, but his student Theophrastus (372-287 BC) continued it, becoming known as the "father of botany" is believed to have planted the first botanical garden on the grounds of Aristotle's Lyceum. Most of the text of his two botanical works, *De Historia Plantarum (On Plants)* and *De Causis Plantarum (*The Causes of Plants) still exists, although only in Latin translations. The first describes the anatomy of plants and classifies them into trees, shrubs, herbaceous perennials and herbs. The second work discusses their propagation and growth and served in part as a practical guide to farmers and gardeners. However, he introduced no new principles of classification. After Aristotle, there was little innovation in the fields of the biological sciences until the 16th century AD.

ANDREA CESALPINO

Andrea Cesalpino (Latin, Andreas Caesalpinus, 1519-1603) was an Italian physician, philosopher, and botanist who sought a philosophical and theoretical approach to plant classification based on unified and coherent principles rather than on alphabetical sequences or medicinal properties. He helped establish botany as an independent science.

Cesalpino succeeded his teacher, Luca Ghini, as professor of medicine and director of the botanical gardens at the University of Pisa. From 1592 he served as physician to Pope Clement VIII and taught at Sapienza University in Rome. His work on the anatomy and physiology of the cardiovascular system anticipated the work of William Harvey. Vol. XVI (1583) of his "*De plantis libri* (The Books of Plants)," is considered the first textbook of botany and is widely considered his most important work. He published a total of 16 books of which the first consisted of 14 chapters where he presented his principles of botany.

Andrea Cesalpino (1519-1603).

Cesalpino covered the nutrition of plants, structures of the flower, fruit, and seed and used his knowledge of Aristotle's thoughts on biological classification and Theophrastus's criteria for plant classification.

The remaining 15 books described and classified more than 1,500 plants. The basis for his classification system was philosophy. Consequently, in his botanical research he went beyond the individual description of plants and sought to find the general out of the individual, the important out of the senses and the physical. He strove to classify plants on the basis of natural conditions and, through Aristotelian philosophical deductions, came to the conclusion that only the fructification (the act of forming or producing fruit) organs were suitable for the construction of the most natural system.

This led him to highly unnatural groups. Nonetheless, he was the first scientist to establish an ordered system of plants, which he divided into 5 classifications: (1) the group of arbores (trees); (2) the group of frutices (shrubs); (3) the group of suffrutices (shrub herbs, i.e., a perennial plant woody only at the base); (4) the group of tlerhae (herbs) and (5) the group of seedless plants, to which he counted fungi, ferns, mosses and algae, among others. His innovation in basing his system of classifying plants on the basis of the structure of their fruits and seeds influenced subsequent scientists, including Linnaeus.

While his classification system anticipated Linnaeus' system of binomial nomenclature, Cesalpino retained the false classic divisions of woody and herbaceous plants and the belief that plants are not sexual. Although he profoundly influenced later botanists such as Linnaeus, he cannot be given credit for inventing biological nomenclature.

Unfortunately for Cesalpino, his major work did not receive the attention it deserved. It is said that even for contemporaries, the work was hard to read with its dense prose which relied heavily on Aristotelian principles relating to the soul of plants but left much only implied and not fully stated. Also, there were no illustrations or tables to explain Cesalpino's system. It's important to note that Cesalpino's book has no illustrations. He wrote that he didn't think they were necessary because he was less interested in differentiating among species that in illustrating ways in which they were alike.

GASPARD BAUHIN

Gaspard Bauhin (1560-1624), also called Casper Bauhin, was a Swiss physician, anatomist, and botanist. A student of the Italian anatomist Fabricius ab Aquapendente at the University of Padua, Italy, he spent most of his career at the University of Basel where he was appointed professor of Greek (1582), anatomy, botany (1588), and medicine (1614). One of the first to describe (1588) the ileocecal (Bauhin's) valve, located between the large and small intestines, Bauhin wrote the *Theatrum anatomicum* (1605; *Microcosmographia, A Description of the Body of Man*), considered the finest comprehensive anatomy text to that time. In this work he replaced the

Gaspard Bauhin (1560-1624).

ambiguous practice of numbering muscles, vessels, and nerves with a system that named parts according to their most salient features.

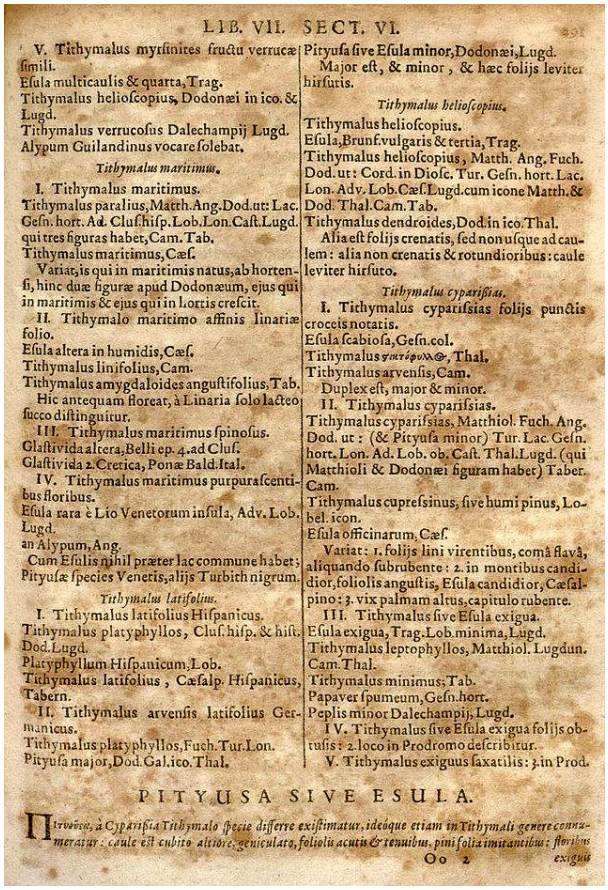
Bauhin's 1623 *Pinax theatri botanici* (Illustrated exposition of plants) described thousands of plants and classified them in a manner that draws comparisons to the later binomial nomenclature of Linnaeus. It is a landmark of botanical history, describing some 6,000 species and classifying them. Refining the principles of systematic botanical classification developed by Andrea Cesalpino, Bauhin was first to clearly delineate botanical species and groups of species, or genera, utilizing the concept of natural relationships, or "affinities," as criteria for his classifications. His 1623 *Pinax theatri botanica* was the most celebrated of the early attempts to name and catalog all known kinds of plants. He listed and described briefly about 6,000 species, while introducing the practice of naming plants by their genus and species (binomial nomenclature), a system that found wide application by the botanists John Ray and later Linnaeus.

The classification system was not particularly innovative, using traditional groups such as "trees, "shrubs" and "herbs," and other characteristics such as utilization, grouping spices into the Aromata, for instance. He did correctly group grasses, legumes and several others. His most important contribution is in the description of genera and species. He introduced many names of genera that were later adopted by Linnaeus, and remain in use. For species he carefully pruned the descriptions down to as few words as possible; in many cases a single word sufficed as description, thus giving the appearance of a two-part name. However, the single-word description was still a description intended to be diagnostic, not an arbitrarily-chosen name (in the Linnaean system, many species names honor individuals, for instance). Nonetheless, he was thus the first scientist to use binomial nomenclature in classification of species.

During this same time period, his brother Johann worked on his pioneering book *Historia plantarum universalis* ("General History of Plants") which was published after Gaspard's death. Although unfinished, it captured all the knowledge of botany that was known at the time including Gaspard's unique naming convention. It was Gaspard Bauhin, therefore, who introduced the practice of naming plants by their genus and species (binomial nomenclature), a system that found wide application by the botanists John Ray and Linnaeus. However, the idea of the binomial species name did not catch on at that time. It was Linnaeus who reintroduced usage of binomials for species names and popularized it. However, he did credit Bauhin with originating this system. Linnaeus also honored the Bauhin brothers in the genus name *Bauhinia*.

JOHN RAY

John Ray (1627-1705) was a Christian English naturalist widely regarded as one of the earliest of the English parson-naturalists. Until 1670, he wrote his name as John Wray. From then on, he used "Ray" after "having ascertained that such had been the practice of his family before him."



LIB. VII. SECT. VI. 291

V. Tithymalus myrſinites fructu verrucæ ſimili.
Eſula multicaulis & quarta, Trag.
Tithymalus helioſcopius, Dodonæi in ico. & Lugd.
Tithymalus verrucoſus Dalechampij Lugd.
Alypum Guilandinus vocare ſolebat.

Tithymalus maritimus.

I. Tithymalus maritimus.
Tithymalus paralius, Matth. Ang. Dod. ut: Lac. Geſn. hort. Ad. Cluſ. hiſp. Lob. Lon. Caſt. Lugd. qui tres figuras habet, Cam. Tab.
Tithymalus maritimus, Cæſ.
Variat, is qui in maritimis natus, ab hortenſi, hinc duæ figuræ apud Dodonæum, ejus qui in maritimis & ejus qui in hortis creſcit.
II. Tithymalo maritimo affinis linariæ folio.
Eſula altera in humidis, Cæſ.
Tithymalus linifolius, Cam.
Tithymalus amygdaloides anguſtifolius, Tab.
Hic antequam floreat, à Linaria ſolo lacteo ſucco diſtinguitur.
III. Tithymalus maritimus ſpinoſus.
Glaſtivida altera, Belli ep. 4. ad Cluſ.
Glaſtivida 2. Cretica, Ponæ Bald. Ital.
IV. Tithymalus maritimus purpura ſcentibus floribus.
Eſula rara è Lio Venetorum inſula, Adv. Lob. Lugd.
an Alypum, Ang.
Cum Eſulis nihil præter lac commune habet; Pityuſæ ſpecies Veneris, alijs Turbith nigrum.

Tithymalus latifolius.

I. Tithymalus latifolius Hiſpanicus.
Tithymalus platyphyllos, Cluſ. hiſp. & hiſt. Dod. Lugd.
Platyphyllum Hiſpanicum, Lob.
Tithymalus latifolius, Cæſalp. Hiſpanicus, Tabern.
II. Tithymalus arvenſis latifolius Germanicus.
Tithymalus platyphyllos, Fuch. Tur. Lon.
Pityuſa major, Dod. Gal. ico. Thal.
Pityuſa ſive Eſula minor, Dodonæi, Lugd.
Major eſt, & minor, & hæc folijs leviter hirſutis.

Tithymalus helioſcopius.

Tithymalus helioſcopius.
Eſula, Brunf. vulgaris & tertia, Trag.
Tithymalus helioſcopius, Matth. Ang. Fuch. Dod. ut: Cord. in Dioſc. Tur. Geſn. hort. Lac. Lon. Adv. Lob. Cæſ. Lugd. cum icone Matth. & Dod. Thal. Cam. Tab.
Tithymalus dendroides, Dod. in ico. Thal.
Alia eſt folijs crenatis, ſed non uſque ad caulem: alia non crenatis & rotundioribus: caule leviter hirſuto.

Tithymalus cypariſſias.

I. Tithymalus cypariſſias folijs punctis croceis notatis.
Eſula ſcabioſa, Geſn. col.
Tithymalus σπαθοφυλλος, Thal.
Tithymalus arvenſis, Cam.
Duplex eſt, major & minor.
II. Tithymalus cypariſſias.
Tithymalus cypariſſias, Matthiol. Fuch. Ang. Dod. ut: (& Pityuſa minor) Tur. Lac. Geſn. hort. Lon. Ad. Lob. ob. Caſt. Thal. Lugd. (qui Matthioli & Dodonæi figuram habet) Taber. Cam.
Tithymalus cupreſſinus, ſive humi pinus, Lobel. icon.
Eſula officinarum, Cæſ.
Variat: 1. folijs lini virentibus, comâ flavâ, aliquando ſubrubente: 2. in montibus candidior, foliolis anguſtis, Eſula candidior, Cæſalpino: 3. vix palmam altus, capitulo rubente.
III. Tithymalus ſive Eſula exigua.
Eſula exigua, Trag. Lob. minima, Lugd.
Tithymalus leptophyllos, Matthiol. Lugdun. Cam. Thal.
Tithymalus minimus, Tab.
Papaver ſpumeum, Geſn. hort.
Peplis minor Dalechampij, Lugd.
IV. Tithymalus ſive Eſula exigua folijs obtuſis: 2. loco in Prodromo deſcribitur.
V. Tithymalus exiguus ſaxatilis: 3. in Prod.

PITYUSA SIVE ESULA.

Πιτυώδες, à Cypariſſia Tithymalo ſpecie differre exiſtimatur, ideóque etiam in Tithymali genere connumeratur. caule eſt cubito altiore, geniculato, foliolis acutis & tenuibus, pini folia imitantibus: floribus exiguis

Oo 2

Bauhin Pinax, 1623, page 291showing binomial examples of the genus *Tithymalus*.

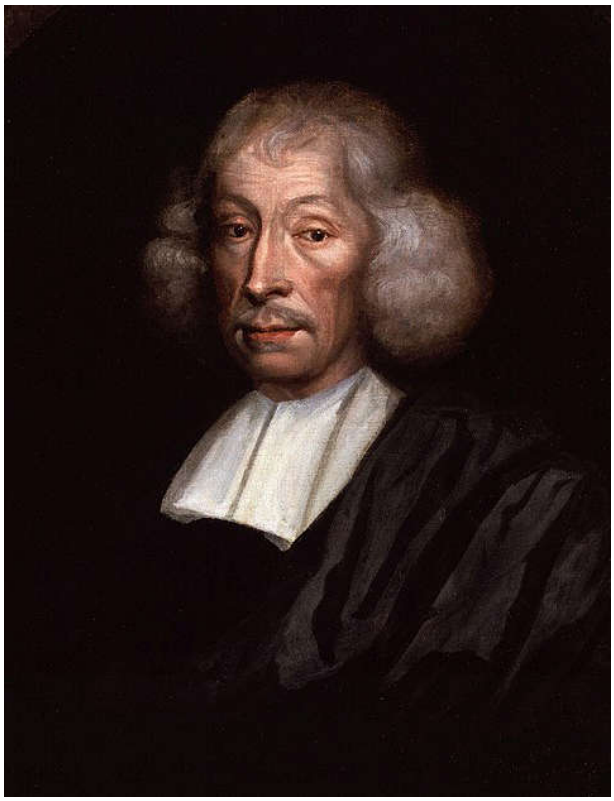
He published important works on botany, zoology, and natural theology.

One of the most eminent naturalists of his time, John Ray (1627-1705) was also an influential philosopher and theologian. Ray is often referred to as the father of natural history in Britain. He was born in the village of Black Notley, Essex, England. His father was a blacksmith, and his mother was known as a healer and herbalist; perhaps it was from her that Ray gained his love of nature, and especially of plants. Entering Cambridge University in 1644, Ray rapidly became expert in languages, mathematics and natural science; he became a Fellow in 1649, a Lecturer in 1651, and a junior Dean in 1658. In 1660 he was ordained a priest in the Anglican Church.

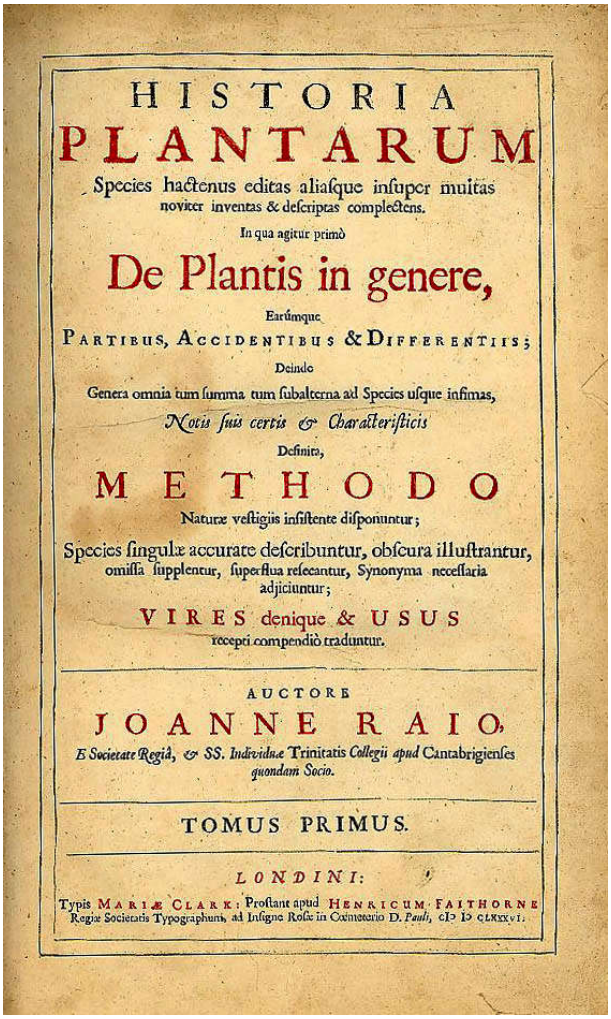
Soon after, for political reasons, he left Cambridge. Between 1660 and 1671 he made many trips throughout England and one trip to Europe, to collect plants, animals, and rocks. He also did experimental work in embryology and plant physiology; among other things, he proved that the wood of a living tree conducts water. His researches received so much renown that Ray was inducted into the newly-formed Royal Society of London, one of the world's first scientific societies, in 1667.

His classification of plants in his *Historia Plantarum*, was an important step towards modern taxonomy. Ray rejected the system of dichotomous division by which species were classified according to a preconceived, either/or type system, and instead classified plants according to similarities and differences that emerged from observation. He was among the first to attempt a biological definition for the concept of species, as “as a group of morphologically similar organisms arising from a common ancestor.”

Another significant contribution to taxonomy was his division of plants into those with two seedling leaves (dicotyledons) or only one



John Ray (1627-1705).



HISTORIA
PLANTARUM
Species hactenus editas aliasque insuper multas noviter inventas & descriptas complectens.
In qua agitur primò
De Plantis in genere,
Earúmque
PARTIBUS, ACCIDENTIBUS & DIFFERENTIIS;
Deinde
Genera omnia tum summa tum subalterna ad Species usque infimas,
Notis suis certis & Characteristicis
Definita,
METHODO
Naturæ vestigiis insistente disponuntur;
Species singulæ accurate describuntur, obscura illustrantur, omissa supplentur, superflua resecantur, Synonyma necessaria adjiciuntur;
VIRES denique & USUS
recepti compendiò traduntur.
AUCTORE
JOANNE RAIO,
E Societate Regiâ, & SS. Individuæ Trinitatis Collegii apud Cantabrigienses quondam Socio.
TOMUS PRIMUS.
LONDINI:
Typis MARIÆ CLARK: Prostant apud HENRICUM FAITHORNE Regiæ Societatis Typographum, ad Insigne Rosæ in Cœmeterio D. Pauli, CIↃ IↃ CLXXXVI.

Cover page of *Historia Plantarum*, volume three, published by John Ray in 1704.

(monocotyledons), a division used in taxonomy today.

Ray's classification of plants in his *Historia Plantarum* was an important step towards modern taxonomy. In these volumes he delineated 18,600 plants, giving information on structure, physiology, distribution and habits. The main divisions of classification recognized today were laid out on the basis of a natural system. He did almost as much for animals.

He remarked, in particular, that classification must proceed upwards, beginning with the description of species, to proceed then with the comparisons upon which the species may be grouped into genera, the genera into families, and so on. This was a basic upside down revolution in respect to Cesalpino's where he classified plants according to their fruits and seeds, rather than alphabetically or by medicinal properties, in which Aristotle's logic was applied by dividing the whole of the plant kingdom into progressively smaller subgroups, down to the individual species.

He was the first to give a biological definition of the term species. In his 1686 *Historia Plantarum he wrote:*

No surer criterion for determining species has occurred to me than the distinguishing features that perpetuate themselves in propagation from seed. Thus, no matter what variations occur in the individuals or the species, if they spring from the seed of one and the same plant, they are accidental variations and not such as to distinguish a species…Animals likewise that differ specifically preserve their distinct species permanently; one species never springs from the seed of another nor vice versa.

JOSEPH PITTON DE TOURNEFORT

Joseph Pitton de Tournefort (1656-1708) was a pioneer in systematic botany, whose system of plant classification represented a major advance in his day and remains, in some respects, valid to the present time. His interest in botany began early, but only after the death of his father, who was forcing him toward the priesthood, was he able to drop theology and study botany. He became a physician to support himself but continued his botanical studies. In 1688 he received an appointment as professor at the Jardin des Plantes in Paris, a position he held until his death. He collected many plant species on scientific expeditions to the Pyrenees, Asia Minor, and Greece and acquired a wide reputation for his botanical works, particularly the beautifully illustrated 1694 *Éléments de botanique* (Botanical Elements).

Tournefort placed primary emphasis on the classification of genera, basing his classification entirely upon the structure of the flower and fruit. He excelled in observation and description, and

Joseph Pitton de Tournefort (1656-1708).

some of his generic descriptions are still acceptable. He was less innovative in theory, however, for he denied the sexuality of plants, and the classifications that he put forward above the level of the genus were often artificial. As the first to make a clear definition of the concept of genus for plants he provided a major step in the development of the binomial nomenclature.

HISTORY OF BINOMIAL NAMES FOR PLANTS

Stearn (1957) pointed out that binomial names for plants may be found in ancient Greek, Latin, German and English long before they were used by Linnaeus. Furthermore, as I have pointed out, Gaspard Bauhin in 1623 published a review of all known plants, about 6,000 species, using a system of classification based upon genus and species, essentially the binomial system. This has been traced back to the ancients, as it is an attribute of the human mind to group like things, and then distinguish them from each other. This can frequently be done with only two words. As pointed out in my short biography of John Ray, in his "*Historia Generalis Plantarum*" he described 18,600 plants, giving information on their structure, physiology, distribution and habits. The main divisions of his classification recognized today were laid out on the basis of a natural system and he did this almost as much for animals.

The insect generic names of Linnaeus were largely (91%) Latin and Greek words adopted almost without change, and some of the compounding from roots and affixes can be traced back as far as Sophocles in the 5th Century B.C. (Montgomery, 1973). Linnaeus named seven orders of insects, Aptera, Diptera, Coleoptera, Hemiptera, Lepidoptera, Neuroptera and Hymenoptera. These names are elegant expressions of the wing characters and it would seem that he did a fine job in formulating them. However, three, Aptera, Diptera and Coleoptera, were used by Aristotle and Hymenoptera appears in the writing of Strabo (Liddell et al., 1940).

LINNAEUS AND PLANT NAMES

Linnaeus' first knowledge of the names of plants and their classification came from the works of Tournefort. Tournefort was notable as the first to make a clear definition of the concept of genus for plants. Most likely for this reason Linnaeus was inclined to use Tournefort's names, attributing to him many which had been in use for a long time, some since antiquity.

Linnaeus said that Latin and Greek names were the best and a great proportion of his names, especially those of animals, are just that. This was shown for insects (Montgomery, 1973) and the same appears to be true for other animals, especially mammals and birds, although no exact percentages have been calculated. As his knowledge of plants was much greater than that of animals, his need for names for plant genera was correspondingly greater and this is why this essay is concerned more with botany than zoology (although John Ray also was important in the field of ichthyology).

In addition to the adoption of the names of others and the compounding of some from roots and affixes, Linnaeus turned to patronymics. A patronymic, or patronym, is generally formed by add-

ing a prefix or suffix to a name. Thus, a few centuries ago, the male patronymic of Patrick was Fitzpatrick ("Patrick's son") that of Peter was Peterson or Petersen, that of Donald was MacDonald or McDonald, and that of Hernando was Hernández.

Today, of course, each of these is an ordinary family name, or surname. (In Russia, both a patronymic and a surname are still used; in the name Peter Ilyich Tchaikovsky, for example, Ilyich is a patronymic meaning "son of Ilya.") Linnaeus named plant genera for his father-in-law, most of his former teachers, many of his students, famous botanists and a host of others. No patronymic has been detected among his names for animals.

Linnaeus had no idea of selecting a name on the basis of priority. He merely wanted what he considered the best name. If he found none that satisfied him he selected new ones; his selections were seldom, if ever, without reason. He rejected names with more than 12 letters, those ending in -oidea, obviously double names, etc. It has been those following him who made him the "second Adam" by decreeing through the Codes of Nomenclature that whatever name Linnaeus used would be the name of the plant or animal.

Such features of nomenclature were not formulated for over 100 years; the exact dates for such "beginnings" came even later. The Kew Index (Jackson, 1895) cites papers of Linnaeus from 1735 to 1753 for the origin of his generic names. Gray's Manual (Gray, 1890) cites the older authors rather than Linnaeus for the names which he adopted from them. The citation of authors for these names of Linnaeus has led to the dual system of credit in citing authors in botanical work, Linnaeus and the author from whom he took the name for Linnean genera, and the author of the species name plus the name of the authority who placed it in the genus to which it is assigned for species. This double citation is not followed in zoology.

Linnaeus wrote in Latin because that was the universal language of the universities of his time. His use of it, however, was far from classical, and he virtually created a new language, taxonomic Latin—descriptions in a telegraphic style, almost entirely without verbs, employing only a few nouns and depending chiefly on adjectives. He did retain one feature, gender, which has little intrinsic value to nomenclature, and which is one of the most troublesome problems in nomenclature to the average American biology student today. As gender is an essential property of both Latin and his native Swedish, the thought that it might not be necessary could never occur to Linnaeus.

CRITICISMS OF LINNAEUS

His contemporaries charged Linnaeus with two particular faults (Blunt, 1971). Haller, the Swiss naturalist, accused him of trying to be a second Adam and name all plants and animals; and Dillenius, Professor of Botany at Oxford, objected to his system of classification and his use of the Greek names of Theophrastus and Dioscorides. Dillenius noted that the day might come when the plants to which the ancients applied these names would be identified and if the names were used for other plants the confusion would be great. A later botanist, J. van Sachs, observed that Linnaeus "was content to know all his species exactly by name and never made a single important discovery throwing light on the nature of the vegetable or animal kingdom" (Stearn, 1957).

Linnaeus increased his knowledge greatly between 1735 and 1758/59. Although he was interested primarily in botany he listed only genera of

Linnaeus' house at the Uppsala Gardens.

plants in 1735. However, he had a most elegant chart, snowing classes, orders, genera and species of animals. A close examination reveals that his actual classification of animals was considerably less impressive than the treatment would indicate. Species names were quite variable in form—one word which was sometimes the same as the genus name, or two words one of which was frequently, but not always the same as the genus name. The development of a true binary nomenclature in his publications came much later, reaching completeness only in 1753 for plants (Linnaeus, 1753) and 1758 for animals (Linnaeus, 1758). Although folk names tend to be single words, or binomials to distinguish related species as pointed out above, rarely trinomials, names had become much longer as the knowledge of plants and animals grew. The naming followed the rule of Aristotle for defining or distinguishing anything—place it in its lowest possible group (genus) and differentiate it from other members of that group (differentia, or specific name).

This practice of naming a species—genus plus differentia—had been more or less the practice since antiquity. With the increase in the number of species known, the "species names" necessarily became longer. These were the "species names" referred to by Linnaeus when he first formulated his rules of classification. He expressed the opinion that they should not exceed 12 words in length! Heller (1964) suggested that the adoption of a two-word name by Linnaeus was not a direct development from the frequent use of such names in the past. It was adapted from the type of citation he used for literature in his publications almost from the beginning. Many of the "trivial names" (so-called since the differentia were still referred to as the true specific names) of plants were selected from some feature of the specific discussion—a word from the differentia, i.e., one referring to habitat, locus (country), etc. Others were obtained from various other sources.

Frequently the names of genera placed in synonymy by Linnaeus were used for trivial names — Tulipifera of Catesby became a species of Liriodendron, Blatteria of Bauhin one of Verbascum, and Chamaedrys Bauhin (in which several species had been placed) and Bonatota Micheli both were made species of Veronica. The common American corn was named Mays by Tournefort, but suppressed by Linnaeus in favor of Zea, and used as the trivial name.

The specific names chosen by Linnaeus for animals were more varied than those for plants. For mammals there were frequently enough classical names for both genus and all of the species. The Latin name Felis was selected for the genus of "cats," another, catus, for one species, and most of the other species had Latin or Greek names which he used, i.e., leo, tigris, pardus and lynx. Only 465 different names were used for the 544 species of birds listed in 1758, as some names were used several times. Some were classical names of mythological characters, others names of other birds and animals. Most appear to be adjectives, indicating country or region as orientalis, lapponica, canadensis, habitat as montana, sylvatica, alpina, color as alba, chloris, fuscus, anatomical features as cristus (used 11 times), curvirostra, etc. In the Insecta, names of all the types previously mentioned were used, sometimes after some method, but usually indiscriminately mixed.

Heller (1945) published an excellent analysis of the use of mythological names in the genus Papilio. Names of individuals of groups such as "Trojan and Greek horsemen," the nymphs, the graces, the muses, the Argonauts, etc., were used for species of the systematic groups of the genus. However, the animal names of Linnaeus have been studied far less than his plant names and many interesting areas probably remain to be explored.

An interior room of Linnaeus' house.

PLUSES AND MINUSES

Linnaeus, in an autobiographical sketch begun in early life and frequently updated and written in the third person, declared (Blunt, 1971):

No one before him had pursued his profession with greater zeal and had more hearers; made more observations in natural history; had fuller insight into the three kingdoms of nature; been a greater botanist or zoologist; so well described the natural history of his own country—its flora, fauna and topography; written more books, more correctly, more methodically, from his own experience; so completely reformed a whole science and inaugurated a new era; sent out his disciples to so many parts of the world; written his name on more plants and insects, indeed on the whole of Nature; become more famous the whole world over; listed so many animals—and yes, as many as all the others put together; been a member of more scientific societies.

In view of these divergent criticisms and assessments of Linnaeus, one may well ask the true character and value of his contribution to biology. While he did not contribute any new discoveries, or even invent any nomenclatural schemes, his compilation and organization of all known species of plants and animals, neatly arranged in a system of categories, instituted a major epoch in the history of biology. The introduction of a uniform scheme of names for known biological units enabled the proper integration of the vast numbers of new plants and animals which were discovered during the century following his work. This era of systematic growth dominated biology until the appearance of Darwin's theory of evolution. The systematic arrangement of living things probably made the discovery of evolution inevitable, although nothing could have been further from the idea and beliefs of Linnaeus.

THE WOKE GENERATION AND LINNAEUS

The Gustavus Adolphus College (Minnesota) Board of Trustees made the decision to remove the name "Linnaeus" from its campus arboretum. The 125-acre greenspace located on the southwest corner of the Saint Peter campus was renamed "The Arboretum at Gustavus Adolphus College."

In recent years, Linnaeus' writings on human taxonomy have come under scrutiny as an example of scientific racism based on his classification and description of human varieties in his seminal work, *Systema Naturae*. Board Chair Scott Anderson stated:

I'd like to publicly thank the students, faculty, and staff who encouraged the College to reexamine the name of the arboretum and the broad cross-section of our community who engaged in intentional, deliberate, and thorough reflection over the last several months," Anderson said. "The Board of Trustees has made the decision to remove Linnaeus' name from the arboretum. Moving forward, Gustavus will embrace the educational opportunity to tell a more complete history of Carl Linnaeus, examining not only his contributions to science but also the problematic elements of his work.

Enlightenment thinkers inherited a very hierarchical view of the natural world from the Middle Ages and the Renaissance: a 'Great chain of beings' arranged in a series of gradients or steps, with God at the very top, man underneath, and down through animals and vegetables to inorganic minerals at the bottom. Linnaeus' taxonomic work partly upset this linear hierarchy of more or less 'perfect' natural beings. The alignment of races with four continents, for example, put them all on the same level as 'natural' varieties. But the idea of a graded scale of nature also survived in the linear arrangement of human varieties. Linnaeus' classification of man was certainly viewed by contemporaries in a hierarchical manner, and carried on being used in such a way through the following decades. Thus Linnaeus' hierarchy, with black people at the very bottom, associated with negative moral and physical attributes, stuck.

Linnaeus was not the only naturalist writing about the human species in the eighteenth century. In

fact, he wrote comparatively less on the subject than his contemporaries, such as the Comte de Buffon and Maupertuis in France, or the German physician Johan Friedrich Blumenbach, all of whom would influence later writers such as Immanuel Kant and Charles Darwin.

Linnaeus unfortunately used his nomenclature to classify humans by "variety," ascribing inherently positive traits to lighter-skinned Europeans and negative traits to darker-skinned Africans and Asians, thereby laying a pseudoscientific foundation for racism that persists today. Linnaeus's classification of humankind according to skin color (Linnaeus, 1735) is often taken as the starting point of the anthropological study of race (Sloan, 1995). Right next to the genus *Homo* and its definition—"*Nosce te ipsum" (*Know thyself) —he presents human diversity in the following, apparently straightforward way as part of the animal kingdom:

Europaeus albescens
Americanus rubescens
Asiaticus fuscus
Africanus nigriculus

In literal translation, Europeans are said to be "whitish," Americans "reddish," Asians "tawny" and Africans "blackish. The terms are rather vague and broadly applicable, and hence indicate that Linnaeus did not mean to draw sharp distinctions. And indeed, in a discussion of the difference between species and varieties in *Critica botanica* (1737), we find the following statement about the variation of traits in humans (Linnaeus 1738, 153):

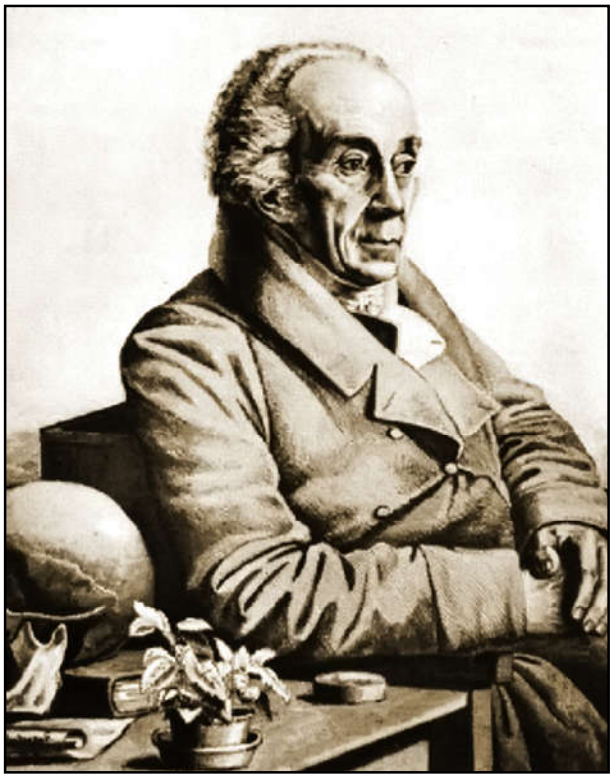
God created one man only, dictates Scripture to us, yet if the slightest trait [difference] was enough, there would easily stick out thousands of different species of man: they display, namely, white, red, black and grey hair; white, rosy, tawny and black faces; straight, stubby, crooked, flattened, and aquiline noses; among them we find giants and pygmies, fat and skinny people, erect, humpy, brittle, and lame people etc. etc. But who with a sane mind would be so frivolous as to call these distinct species?

Linnaeus classified people into different races just as he divided other living creatures into groups. But he based that classification on geography – Asian, European etc. – and not on skin color. Linnaeus did have stereotypical ideas, such as that Africans were more volatile, but he did not make that a hierarchical judgement. On the contrary, he was more inclined to find the culture of the French court inferior to that of the Scandinavian Sami Laplanders, for example. The former led an incestuous and decadent life, according to him, while the Sami were still uncorrupted.

While it is true, as many scholars argue, that Linnaeus did not promote the idea of distinct human species, unfortunately his concepts of human classification helped pave the way for pseudoscientific ideas about human biological diversity—the consequences of which are still felt today.

However, Johann Blumenbach, a German physician, naturalist, physiologist, and anthropologist. considered to be a main founder of zoology and anthropology as comparative, scientific disci-

A view of the botanical gardens in Uppsala during Linnaeus' time.



Johann Friedrich Blumenbach (1752-1840).

plines, laid out the scientific template for contemporary race categories in his "On the Natural Varieties of Mankind." Blumenbach strongly opposed slavery and believed in the potential equality of all people. Nevertheless, he mapped a hierarchical pyramid of five human types, placing "Caucasians" at the top because he believed a skull found in the Caucasus Mountains was the "most beautiful form of the skull, from which...the others diverge." This model was widely embraced, and Blumenbach inadvertently paved the way for scientific claims about white superiority.

Another view of the botanical gardens during Linnaeus' time.

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THE DRAGON MURDER CASE, A DETECTIVE STORY FOR AQUARISTS

by Albert J. Klee, Ph.D.

(*Essays on Aquarium Hobby History*, January 14, 2023)

My mother was extremely fond of reading mystery books and as a young boy I followed her lead avidly. Although I have never counted them, I have probably read well over a thousand or so mystery books in my lifetime. When I was in OCS (Officer Candidate School) in the 1950's I attended a required a speed-reading course where I increased my reading speed by an order of magnitude. As an example, I was trained to look at the paragraphs or even the complete pages in a book as opposed to the habit of reading a single line used by most people. As a result I could read the average mystery in 20 minutes and still maintain all its details. In any event, of the American authors I liked best, the Philo Vance Mysteries led the way.

A. WILLARD HUNTINGTON WRIGHT

Although this essay is not intended as an autobiography, a brief summary of his life is helpful in understanding his mystery books, one of which is of historical interest to those interested in aquarium hobby history. Willard Huntington Wright, (born Oct. 15, 1888, Charlottesville, Va., and died April 11, 1939, New York, N.Y.), was an American critic, editor, and author of a series of best-selling detective novels featuring the brilliant but arrogant sleuth Philo Vance. Wright was educated at St. Vincent and Pomona colleges in California, at Harvard University, and in Munich and Paris. Pursuing a career as a writer,

Wright became literary editor of the *Los Angeles Times* in 1907 and in 1912 moved to New York to become editor of *Town Topics* and *The Smart Set*, where he remained with the latter until 1914. With H.L. Mencken and George Jean Nathan he published a book of travel essays called Europe after 8:15 (1914). He also wrote the poetry collection Songs of Youth (1913), the novel The Man of Promise (1916), and several critical works on art and philosophy, including Modern Painting (1915) and What Nietzsche Taught (1915). Wright also edited the anthology The Great Detective Stories (1927) and wrote the essays "Twenty Rules for Writing Detective Stories," which appeared in the *American Magazine* (1928), and "I Used to Be a Highbrow but Look at Me Now" (1929).

Well into the fall of 1917, indifferent to those who were listening closely, Willard continued to speak loudly and disdainfully about the President, the Allies, and the informant- mentality that was pervasive even in New York. Again like Oscar Wilde, Willard was to pay a large price for overlooking certain hard, crass social realities. One individual who was paying particular attention to Willard's politics was Genevieve Matthews, the freelance stenographer he sometimes employed when he found himself behind in his work for his paper, the Mail. An efficient secretary, Miss Matthews was also a vigilant patriot. At first, his secretary's humorless ideas about German evil and

Willard Huntington Wright in 1907, about 19 years old.

British saintliness tickled Willard. When she would come for an afternoon session of dictation in his apartment, he would be apt to take a break at the piano, selecting a German Lied and singing softly in the all-but- forbidden language of the Kaiser.

Genevieve Matthews was easily goaded, apparently, and none too subtle. When Willard was out of the room or left the building on an errand, she would use her break from typing Willard's copy to rifle his desk and files for the incriminating evidence of espionage she was sure she would find. Visions of heroism and delight at seeing the Mail's most notorious writer in jail got the better of her. Earnest and unimaginative, Genevieve Matthews was a woman of her time, caught up in the fervor of the Allied cause.

When he became alert to his secretary's eagerness to prove his treachery, Willard decided not to dismiss her but to play along. It was just the kind of situation that appealed to him. He took to leaving odd papers on his desk to see if they had been moved in his absence. They often were. One day in early October Willard pushed the game further and dictated to Matthews a bizarre, cryptic letter hinting at clandestine meetings with unnamed persons on the Mail, the implications being that they were in touch with German agents in the United States. At this point Willard's "amateur spy-hunter" needed nothing more definitive and, once her employer's back was turned, darted from the apartment out into the street with the letter in hand.

What followed should have been the stuff of mildly humorous recollection in later years—the material for a silly anecdote Willard might have told as an old man. Matthews took refuge in a drugstore phone booth on the corner of Lexington Avenue and 63rd Street, clutching the document while she tried to reach the Secret Service. Willard, exasperated, cornered her in the phone booth. A small crowd gathered to see what the commotion was all about, and at the cries of "German spy" someone got the police. Willard was escorted back to his rooms by two Secret Service men. By the time he was able to explain the truth of the matter, enough of a row had taken place to alert the city newsrooms. A headline in the next morning's Times read: **Writer and Secretary in German Spy Mix-Up**. The Sun was less benign: **Editor Is Accused by Woman as a Spy**.

The editors of the Mail were horrified. It was the last kind of publicity the Mail wanted. That week Willard was curtly informed that his services were no longer needed at the paper. Protestations of innocence got him nowhere, and he was told to leave the building. Living as he did from paycheck to paycheck, without any savings to fall back on, Willard very quickly found himself in desperate straits. He referred the episode as "that comedy," but each day brought him new evidence that his joke had been a grotesque miscalculation. Professional and social acquaintances shunned him, interviews with editors at other papers were impossible to get, and even many of his old friends kept a safe distance. For that matter, not everyone in New York was convinced, in the light of Willard's writings about Germany and

Wright's photo in 1913, considerably retouched by him to appear older than his real age of twenty years.

Nietzsche, that he wasn't in the pay of the Wilhelmstrasse. The resulting scandal, though, cost him his career in journalism, and he spent several years mooching off friends and doing drugs, before deciding to write mysteries.

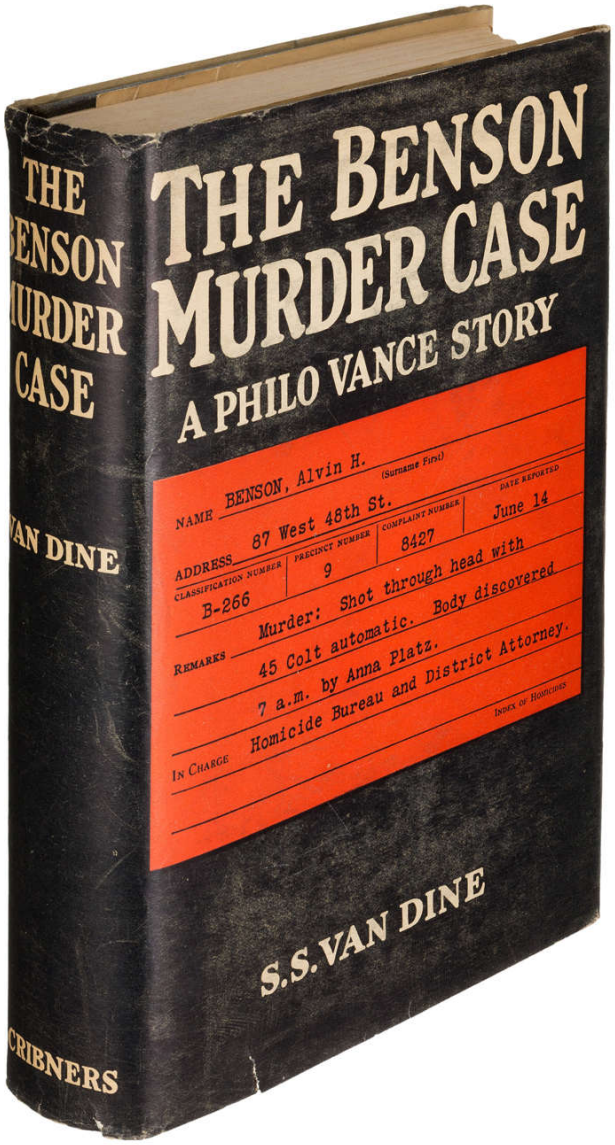
Although Wright continued writing as a minor cultural critic and journalist until 1923, he became ill from overwork. He was confined to bed because of a heart ailment for more than two years. To occupy him, his doctor suggested light reading, such as detective fiction. For someone who had once written, "There are few punishments too severe for a popular novel writer," it sounded like a dubious proposition, but to Wright's surprise, he found mystery novels challenging and entertaining and in frustration, he began collecting thousands of volumes of crime and detection.

In 1926, all this work paid off with the publication of his first S.S. Van Dine novel, "The Benson Murder Case," that had everyone even remotely interested in detective fiction wondering who S.S. Van Dine was. (Wright was outed as being the author after publication in 1928 of his The Greene Murder Case). His aristocratic amateur sleuth, Philo Vance (who shared a love of aesthetics like Wright), was so popular that Wright became wealthy for the first time in his life. Mysteries featuring his detective Philo Vance, *The Benson Murder* Case, *The Canary Murder Case* and *The Bishop Murder Case* among others, sold more than a million copies by the end of the decade, and dominated book sales dur-ing the first rough months of the Great Depression.

Even by the standards of the Jazz Age, Wright lived an outsized life but by the late 1930s, he was a broken, desperate man consumed by the fear of failure that had shadowed him all his life. The fashions of detective fic-tion had changed—Wright deplored the "all booze and erections style" of his competitor Dashiell Hammett—and he was reduced to writing novelizations of his failed screenplays in order to get by.

B. S.S. VAN DINE

Regarding the name he chose, of the "S.S.," Van Dine commented that the steamship abbreviation would be easy for readers (and booksellers) to remember; of the "Van Dine," that it was an old family name on his mother's side. The first point is true, but the second is not. There are no Van Dines to be found in the family tree. At another time Van Dine remarked that he selected the "Dine" with some ironic thought to his years of living on less food the he cared to, and there is probably more seriousness than not in that bit of humor. It is also the case that "S.S." was the common abbreviation for the Smart Set—echoes of Van Dine's happiest days—and that Van Dine



was very close to Van Dyck, Ruben's peer, with all the associations with painting, aristocratic living and accomplishments that the Van Dyck name reverberates.

Note that Van Dine had a title formula, The "¥" Case," where "¥" was a six letter name for the book. The Gracie Allen Murder Case (1938) was the only one to break the title formula, and The Winter Murder Case (1939) was a novella that Van Dine intended to expand into his twelfth full-length book, a project cut short by his death. Both had actually begun as treatments for Hollywood vehicles, the first for radio comedienne Gracie Allen (George Burns' other half) and the second for ice skater-turned-movie-star Sonja Henie. Wright later novelized the scripts, inadvertently pioneering the concept of the movie tie-in. Both books were poorly received.

What interests me here are his novels (and one in particular). The following are the twelve he wrote using the name "S.S. Van Dine."

1. The Benson Murder Case (1926)
2. The Canary Murder Case (1927)
3. The Greene Murder Case (1928)
4. The Bishop Murder Case (1929)
5. The Scarab Murder Case (1930)
6. The Kennel Murder Case (1933)
7. The Dragon Murder Case (1933)
8. The Casino Murder Case (1934)
9. The Garden Murder Case (1936)
10. The Kidnap Murder Case (1936)
11. The Gracie Allen Murder Case (1938)
12. The Winter Murder Case (1939)

The Philo Vance novels were particularly well suited for films, where the more unpleasantly affected aspects of the main character could be toned down and the complex plots given more prominence. One of these films, The Kennel Murder Case, has been called a masterpiece by renowned film historian, William K. Everson. In fact, in a very interesting chapter of his 1972 survey of screen sleuths, "The Detective in Film ," he grouped Kennel Murder amongst the best of the genre, with Green for Danger (a 1946 British thriller film, based on the 1944 detective novel of the same name by Christianna Brand) and The Maltese Falcon (a 1941 American film noir directed and scripted by John Huston in his directorial debut, based on the 1930 novel of the same name by Dashiell Hammett), and in this I agree.

1. The Canary Murder Case (1929) with William Powell
2. The Greene Murder Case (1929) with William Powell
3. The Bishop Murder Case (1929) with Basil Rathbone
4. The Benson Murder Case (1930) with William Powell
5. The Kennel Murder Case (1933) with William Powell
6. The Dragon Murder Case (1934) with Warren William
7. The Casino Murder Case (1935) with Paul Lukas
8. The Garden Murder Case (1936) with Edmund Lowe
9. The Scarab Murder Case (1936) with Wilfrid Hyde-White (a lost film)
10. Night of Mystery (1937) (based on The Greene Murder Case) with Grant Richards
11. The Gracie Allen Murder Case (1939) with Warren William as Philo Vance, billed below Gracie Allen
12. Calling Philo Vance (1940), a remake of The Kennel Murder Case with an altered setting with James Stephenson

C. PHILO VANCE

One innovation of Wright's was to also give the name S.S. Van Dine to the first-person narrator of the books, a trick that would later be used in a similar way by Ellery Queen. Even the name Philo Vance was a pseudonym. The real detective, we are told, has only permitted publication of his solutions to "impossible crimes" on the condition of anonymity. The following is taken from his first novel, The Benson Murder Case and is the first time Van Dine himself was used as a first-person narrator of his books:

If you will refer to the municipal statistics of the City of New York, you will find that the number of unsolved major crimes during the four years that John F.-X. Markham was District Attorney, was far smaller than under any of his predecessors' administrations. Markham projected the District Attorney's office into all manner of criminal investigations; and, as a result, many abstruse crimes on which the Police had hopelessly gone aground, were eventually disposed of. But although he was personally credited with the many important indictments and subsequent convictions that he secured, the truth is that he was only an instrument in many of his most famous cases. The man who actually solved them and supplied the evidence for their prosecution, was in no way connected with the city's administration, and never once came into the public eye. At that time I happened to be both legal advisor and personal friend of this other man; and it was thus that the strange and amazing facts of the situation became known to me. But not until recently have I been at liberty to make them public. Even now I am not permitted to divulge the man's name, and, for that reason, I have chosen, arbitrarily, to refer to him throughout these *ex-officio* reports as Philo Vance.

Whatever his true name, the wealthy dilettante lived in a posh two-floor apartment on East 38th Street in Manhattan. When not hobnobbing with his personal lawyer Van Dine, whom he calls "Van," or helping New York District Attorney John F.X. Markham, and the bluff, boneheaded Sergeant Heath of the homicide department keep their jobs, Vance spends his time studying art and aesthetics. Educated in Europe, he still carries the mannered speech of an upper-class Englishman, habitually referring to his colleagues as "old thing" or "old dear," and punctuating nearly every other sentence with "don't y'know." Latin spills from Vance's mouth in almost every page, the following example being taken from The Benson Murder case:

"No, Van old dear," he explained languidly. "I am not becoming sentimental or even human, as that word is erroneously used to-day. I cannot say with Terence, '*Homo sum, humani nihil a me alienum puto*', because I regard most things that are human as decidedly alien to myself."

Vance does not translate his Latin or explain who Terence was, leaving the average reader wondering what Vance meant (it can be translated as "I

**From the Benson Murder case:
Left Philo Vance (Dick Powell),
Right Sgt. Heath (Eugene Pallette).**

am human, and I think that nothing of that which is human is alien to me" from his play *Heauton Timorumenos* written in 163 B.C. by Terence, i.e. Publius Terentius Afer, a dramatist of the Roman Republic. Another example from the Benson Murder case combines some French with a goodly dose of Latin, all sans translation:

Rousseau wrote, La patience est amère mais son fruit est doux. But peerhps your legal taste runs to Latin. Superanda amnis fortuna ferendo est, quoth Virgil. And Horace also spoke on the subject. Durum! said he, sed levius fit patiencia—.

(The French means "Patience is bitter, but its fruit is sweet"; the quote from Virgil is "Every misfortune is to be subdued by patience" and from Horace the full saying is "Durum! sed levius fit patiencia quicquid corrigere est nefas" or "It is Hard! But that which we are not permitted to correct is made lighter by patience.") The monocle-wearing Vance is remarkably indolent and frequently yawns his way through conversations. In truth, about the only thing that saves him from total insufferability is a droll sense of humor. This air of condescension is not surprising since Vance appears to be an authority on every subject on the face of the earth, knowledge that he shares with his associates at every opportunity. In solving crimes, however, he puts more stock in understanding a suspect's personal psychology than he does in picking up tangible clues. "When material facts and psychological facts conflict, the material facts are wrong," he blithely tells Markham:

Basil Rathbone played Philo Vance in The Bishop Murder Case.

"I say, Markham," he drawled; "it has always been a source of amazement to me how easily you investigators of crime are misled by what you call clues. You find a footprint, or a parked automobile, or a monogrammed handkerchief, and then dash off on a wild chase with your eternal *Ecce signum*! 'Pon my word, it's as if you chaps were all under the spell of shillin' shockers. Won't you ever learn that crimes can't be solved by deductions based merely on material clues and circumst'ntial evidence?"

I think Markham was as much surprised as I at this sudden criticism; yet we both knew Vance well enough to realize that, despite his placid and almost flippant tone, there was a serious purpose behind his words.

"Would you advocate ignoring all the tangible evidence of a crime?" asked Markham, a bit patronizingly. "Most emphatically," Vance declared calmly. "It's not only worthless but dangerous. The great trouble with you chaps, d' ye see, is that you approach every crime with a fixed and unshakable assumption that the criminal is either half-witted or a colossal bungler. I say, has it never by any chance occurred to you that if a detective could see a clue, the criminal would also have seen it, and would either have concealed it or disguised it, if he had not wanted it found? And have you never paused to consider that anyone clever enough to plan and execute a successful crime these days, is, *ipso facto*, clever enough to manufacture whatever clues suit his purpose? Your detective seems wholly unwilling to admit that the surface appearance of a crime may be delib'rately deceptive, or that the clues may have been planted for the def'nite purpose of misleading him.

D. VAN DINE'S HUMOR

Since the early novels were stiff reading for

Eugene Pallette as Sgt Earnest Heath in The Dragon Murder Case.

some, some humor was provided, especially in the movie versions, by the characters of Sgt. Heath of the Homicide Bureau (played by Eugene Pallette) and Dr. Emanual Doremus, the coroner's physician (played by Etienne Girardot). Eugene William Pallette was an American actor who worked in both the silent and sound eras, performing in more than 240 productions between 1913 and 1946. After an early career as a slender leading man, he became a stout character actor. Physically, he was often called roly-poly, though we'll go with the more respectful heavyset. No actor was more immediately recognizable by his voice than Eugene Pallette. It is variously described as gravelly, sounding like a bullfrog or a foghorn, and several octaves below this, that or the other. He appeared as the detective, Ernest Heath, in five different Philo Vance movies, more than any actor who played Vance himself.

Of Anglo/French parentage, birdlike comic actor Etienne Girardot was an established theatrical favorite long before the turn of the century. He was an actor, known for his portrayal of the crotchety New York City Coroner's physician in The Kennel Murder Case, The Garden Murder Case and The Dragon Murder Case. The following are some quotes from the Philo Vance movies:

Vance to Doremus: How about a warm cup of embalming fluid?
Doremus: Never mind the levity.

Doremus to Markham and Vance [to the butler who's showing him in]: I don't need an usher to lead me to a corpse.

Dr. Doremus: Evening, Mr. Markham. Evening, Mr. Vance.
Heath [sarcastically]: What! No kiss for me, honey?
Dr. Doremus: Ah!

Vance [as Doremus takes a sandwich out of his bag]: My dear doctor, what is that?
Doremus: My dinner.
Markham: You're not going to eat in here?
Doremus: Why not? For fourteen years you've called me from my soup to look at some dissipated cadaver. From now on, I'll eat with some corpse.

Heath: Don't forget, Doc, Christmas dinner at the morgue.

Etienne Girardot as as Dr. Emanual Doremus in The Dragon Murder Case.

Doremus [Deadpan]: I hope to see you there.

Doremus to Markham [angered that there is no body]: I can't perform an autopsy on a theory! I'm a coroner, not a philosopher!

Doremus to Heath [arriving at the crime scene]: Well, where's the body?
Heath: I'm afraid there ain't any, Doc.
Doremus: [annoyed]: You called me away from my breakfast for nothing?
Heath: Well, at least you got a sniff at it. That's more than we've had.

Doremus: Well, where was the body when you phoned?
Heath: We thought it was in the pool.
Doremus: [annoyed]: I don't want thoughts; I want bodies, and when there aren't any bodies, I want to be left alone!

Doremus: Ernest, it's clear that you don't know much about women. Now I'll tell you, women are, generally speaking...
Heath: You certainly said it! They ARE generally speaking!

Doremus: [leaving the scene, thoroughly annoyed that the body was not dead]: Now I'm going to get some breakfast [turning for one last word]... and, Heath, don't you call me out here again unless you've got a corpse. I'm here as a coroner, not as a doctor!
Heath: [shouting after him sarcastically]: Why don't you learn to carry a hard-boiled egg in your pocket?

Doremus: [Heath has been called to the phone], If it's my wife, tell her I've gone.
Heath: That'll please her! Now you take my wife...

Heath: You keep her. I can't use her!

Punctuated with frequent footnotes and elaborate diagrams, the Philo Vance novels were well-crafted puzzlers that captivated readers. The first two novels, 1926's The Benson Murder Case (which was trumpeted by Scribner's with the ad line, "At Last—A Detective Story for the Intelligent!") and 1927's The Canary Murder Case, were based on real crimes: the 1920 unsolved murder of stockbroker Joseph Elwell and the 1923 killing of Dorothy King (also known as the "Broadway Butterfly). Benson sold well, but it was Canary that launched the Philo Vance phenomenon, selling 60,000 copies in its first month and making Willard Wright a wealthy man.

E. CLAIRE DE LISLE, DOGS AND FISH

In the spring of 1929, at a party aboard an ocean liner docked in New York Harbor, Wright had met an attractive, well-dressed young woman who worked as an illustrator for a local paper and seemed to know something about art. She was several years Wright's junior and had the appealing name of Claire de Lisle. Wright later told the

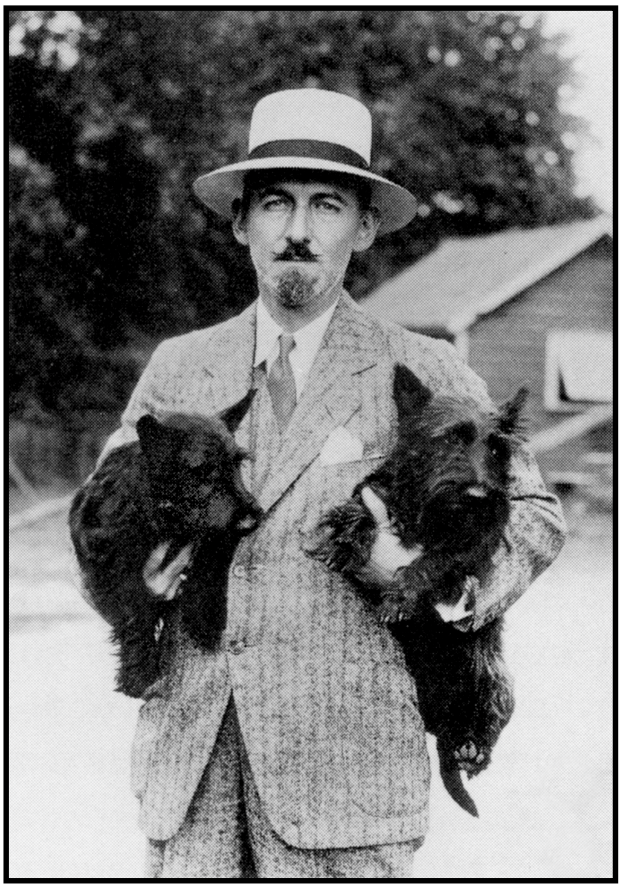
Willard Wright with his second wife, Claire de Lisle1930.

story, undoubtedly fictitious, of overhearing her in conversation with another woman disparaging the trashy novels of S. S. Van Dine. Agreeing with her vehemently, he introduced himself and asked for a date. It was a perfect match from the start, and Claire became that rare presence in Willard's life—a woman he wanted to see more than a few times, whom he regarded as congenial as well as sexually desirable. She had some of the qualities that made the first Claire interesting to him, like her worldliness, charm, and eagerness for experience, all of which was tempered by a greater gentleness and reserve.

This was an opportunity for Willard to be the unquestionably dominant one—the rich older man instead of the "kept" boyfriend—but dominant in relation to a strong, confident woman who had already made her way in the world, unlike his wife, Katharine. For S. S. Van Dine, the self-created detective writer, there was also something intriguing about Claire's smaller efforts to construct a name and an identity for herself in New York. She had been born Eleanor Rulapaugh in Philadelphia and, with an equally adventurous girlfriend, had taken herself to Europe after high school to study art. In Paris in the early Twenties she was a student of Cubist painter Andre Lhote and a fairly typical young American expatriate intent on having a good time. Back in New York, she landed her newspaper job, forgot about painting and cultivated a full social life, and devised her own professional name.

With her, he was able to relax and forget the strange frustrations of his position. His new mistress, the only woman in his life in 1929 and 1930 who hadn't known Willard as an aspiring critic and editor, was content with her lover as he was—and more than content to help him spend the money that was pouring in. She wore clothes well, enjoyed dining out, was a sparkling conversationalist ("a quick study" was a friend's comment), and when Willard wasn't in one of his truculent moods while driving himself to meet a manuscript deadline, she knew how to be the On October 24th, 1930, Wright's the divorce decree from his first wife, Katherine, was finalized. A disastrous marriage of twenty-three years and three months, during which time Willard and Katharine had lived together for no more than six years, was over. Three days after the divorce became final, exhausted by the anxiety but relieved at the outcome, Willard and Claire de Lisle left Manhattan to be married without publicity in Hoboken, New Jersey.

Wright had a warm feeling for dogs, but his transient urban life never seemed suited to the owning of one. Now, in contrast to so many of the problems that money couldn't rectify, Wright's desire for a pet was given full rein. But it wasn't only a pet Wright wanted; he wanted the best dog, or dogs, that a man of his means could find or breed. Through the spring and summer of 1930 Wright intensively, maniacally, investigated dog breeds and bloodlines. He had decided on Scottish terriers—they were, he felt, the most loyal, tenacious, inquisitive, and forthright dogs in his experience—and was determined to know every-



Willard Wright with his Scottish Terriers at the S.S. Van Dine Kennels in New Jersey, 1932.

thing there was to know about them before embarking on his quest for the perfect dogs. By the end of the summer he had added to his growing library more than two hundred books about canine care, breeding conditions, lineage, and professional showing, he had talked to all of the breeders, trainers, owners, and authorities he could find, and subscribed to every periodical on the subject that existed.

Early in the next year Wright was in the market for his own kennels and full-time trainer outside the city, which he eventually found across the Hudson in Haworth, New Jersey. With his new wife, Claire, he began traveling the length of the northeast coast from New England to Washington, D.C., to enter his Scottish terriers in all of the prestigious area dog shows. For Heather Reveller, his great champion, he reportedly paid $2,000. Before he retired from showing and breeding terriers, Wright saw his dogs claim all of the top prizes in the American competitions, and he came to esteem those honors as highly as his modern paintings and his Chinese ceramics. By mid-September, 1931 Wright and Claire entered not only a new home in New York but a whole style of living that they could never have imagined for themselves only a few years earlier.

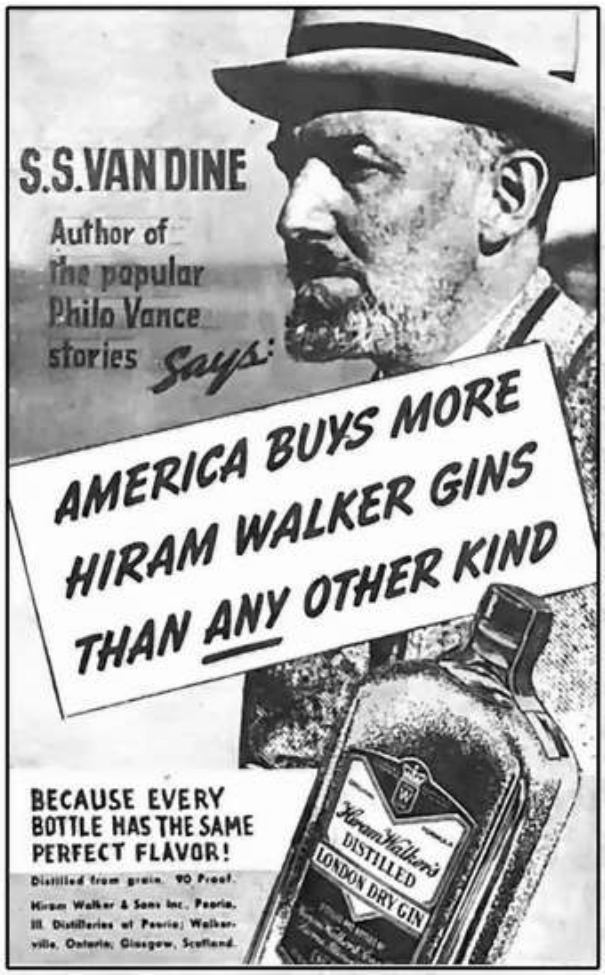
The two-floor penthouse at 241 Central Park West on the corner of 84th Street overlooked a splendid stretch of the park. From the balcony of this late-Twenties building with a vaguely Art Deco flair to it, Wright could see the Metropolitan Museum on Fifth Avenue and, to the south, the skyline of midtown. The rooms were large and accommodated quarters for the servants the Wrights now employed principally a cook and but -ler. Wright installed floor-to-ceiling bookcases, gratified his taste for expensive Chinese ceramics, and eventually purchased a black-jack table and roulette wheel for the amusement of his guests inclined to gambling.

For getting around town and out to New Jersey to the ten-acre Van Dine Kennels, Wright and Claire now had their own car and chauffeur. In all, it was the life of a successful industrialist or Wall Street tycoon that Wright had decided to cultivate.

F. THE BEGINNING OF THE END

But by the end of 1931, Wright had commenced the practice of spending almost every-thing he made on a given book or screenplay and, most danger-ously, of dipping into the advances Scribner's would give for the next Van Dine novel. His restaurant and clothing bills alone were astronomical, and his home might have been more appriate as a showplace for a great capitalist than a popular writer who never knew how much his income might fluctuate from one year to the next, but Wright was determined he wouldn't succumb to the virtues of prudence and economy.

Within a few months, his exaggerated level of comfort proved too much even for Willard to sustain. Spending money like mad throughout the first half of the year, he was angrily and reluctant-



Van Dine's opulent life style forced him during the Great Depression to take minor jobs, such as touting this brand of gin.

ly looking to make cutbacks by June. The Wrights, therefore, were forced to cut back on their entertaining for a time and put the New Jersey kennels on the market. The original scheme to make money by breeding the finest terriers in the country hadn't brought in the anticipated buyers, not in the third horrendous year of economic catastrophe, and it seemed wisest to let go of the property and the full-time manager and keep just a few of the best dogs. Then, too, Willard had already achieved his dream of showmanship and was ready to move on to another hobby, another obsession, tropical fish.

With regard to The Dragon Murder Case, the New York Times noted, "The piscatorial side of this book, at least, is authentic. The author is on the Board of Governors of the Aquarium Society of New York, and has won many prizes with his fish." Actually, the new hobby of exotic fish was at first more Claire's than Willard's. In 1932 one newspaper account reported: "Some of them (i.e., referring to *Betta splendens*) belonged to Mrs. S. S. Van Dyne (Mrs. W. H. Wright), who won the cup in the novice class for the best young fish raised by an exhibitor." Note that The Times got Van Dine's name wrong, pretty careless of the reporter for such a prodigious newspaper. In any event, it was also a good deal less costly in the beginning than dog breeding, though it eventually consumed thousands of dollars anyway, as did every pastime the Wrights enjoyed. There was space in the study for the sixty-eight aquaria, built

Male Bettas fighting, taken from the 1934 Dragon Murder Case movie.

The Dragon Murder Case movie: Left Sgt. Earnest Heath (Eugene Pallette), Middle Philo Vance (Warren Williams) and Right, District Attorney John F.X. Markham.

to hold more than a thousand exotic fish that the room even-tually contained. Its justification for Willard (if one was needed) was that, just as their dog phase proved to be the inspiration behind the Van Dine novel *The Kennel Murder Case,* the passion for fish gave rise to the book that followed.

G. THE DRAGON MURDER CASE

Tropical fish were not as yet popular in Southern California where the movie was filmed. Pet stores did not stock Bettas as there was no demand. At one time Wright had turned his sun-parlor into an aquarium and devoted several years to breeding Bettas. He succeeded in producing cornflower blue, deep maroon and even black specimens; and he won several awards with them at the exhibitions of the New York Aquarium Society at the Museum of Natural History. They were therefore called for in the script as one of the film's most important sets was a solarium filled with fish tanks, including Bettas or "fighting fish" as they were called then. To obtain the necessary tanks and fish, an advanced collector located in the San Fernando Valley agreed to have his collection rented. The appearance of tropical fish in "The Dragon Murder Case" was the spark that boosted tropical fish sales nationwide and when Philip Vance says he has bred tropical fish, he is actually echoing the experience of Willard Wright.

The Dragon Murder Case showcases Vance at his most supremely irritating. The book is set at a mansion owned by Rudolph Stamm—a well-known aquarist—in the northern reaches of Manhattan, complete with a picturesque pool. Into that pool dives Sanford Montague—the fiancé of Stamm's sister—never to be seen again. Fools (and as usual, they are thick on the ground in Van Dines' mysteries) rush to blame the supernatural. They note that the pool is known as "The Dragon Pool," home to a monster known to the Lenape Indians. Philo's not so sure: He is (of course) an expert on both dragons and the Lenape Indians, with a sort of sideline expertise in pools and fish.

It would be tempting to sympathize with Ogden Nash's claim that "Philo Vance needs a kick in the pance." Philo may be a know-it-all, but apparently he comes by it honestly. By the time you reach the end of Dragon, you will almost certainly want to aim your boot at Vance's posterior, but you will have had a swell time getting there. Still, Philo Vance is an objectionable character. He continues to flaunt his Oxford accent, to lift his eyebrows whimsically, and to speak disagreeably when he tries to be humorous. Yet as always the book presents a good puzzle, and that, according to a New York Times review, Mr. Vance and his tens of thousands of readers, is what murder mystery books are for."

H. RUDOLPH STAMM AND HIS FISH

The following is a comment by Sgt. Heath to Markham where Vance offered some information about Stamm.

"I don't like those fish!" he blurted. "Fish?" repeated Markham in astonishment. "What fish?" Heath hesitated and contemplated the end of his cigar sheepishly. "I think I can answer that question, Markham," Vance put in. "Rudolph Stamm is one of the foremost aquarists in America. He has a most amazin' collection of tropical fish—strange and little-known varieties which he has succeeded in breeding. It's been his hobby for twenty years, and he is constantly going on expeditions to the Amazon, Siam, India, the Paraguay basin, Brazil and Bermuda. He has also made trips to China and has scoured the Orinoco. Only a year or so ago the papers were full of his trip from Liberia to the Congo. . . ." "They're queer-looking things," Heath supplemented. "Some of 'em look like sea-monsters that haven't grown up." "Their shapes and their colorings are very beautiful, however," commented Vance with a faint smile.

The following is a comment made by Trainor, Stamm's butler, to Vance. He makes a mistake in the name of the scat that amuses Vance.

"Oh, yes, sir. I am very fond of the fish, sir. And I'm something of an authority on the subject—if I do say so myself. In fact, I disagree with the master quite frequently on the care of some of his rarer varieties. Without his knowing it I have made chemical tests of the water, for acidity and alkalinity—if you know what I mean, sir. And I took it upon myself to increase the alkalinity of the water in the tanks in which the Scatophagies argus are kept. Since then, sir, the master has had much better luck with them." "I myself am partial to brackish water for the Scatophagus," Vance commented, with an amused smile.

This last quote occurs when Stamm is showing Vance his aquaria and equipment. It is a lengthy bit but it shows that Van Dine knew what he was

The Dragon Murder Case movie showing an aquarium with a discus.

The Dragon Murder Case movie : Left to right: Markham, Vance and Dr. Doremus

talking about when it came to tropical fish.

Stamm led the way across the library and into the first aquarium. This room was even larger than the library, and had an enormous skylight as well as a row of high windows along both walls to the east and west. Beyond, through a second archway was still another aquarium, similar to the first; and beyond that was the terrarium with windows on three sides. The aquarium in which we stood was lined with fish tanks of all sizes, reaching to the base of the high windows; and half-way between the walls, running the entire length of the room, were two double rows of additional tanks, set on a long metal rack. There were more than a hundred such tanks in the room, ranging in capacity from five to one hundred gallons.

Stamm, beginning at the tank nearest the door, on the left, led us about the room commenting on his living treasures. He pointed out the various types of *Platypœcilus maculatus—pulcher*, *ruber*, *auratus*, *sanguineus*, and *niger*; various *Xiphophorus hellerii* (the Mexican Swordtail) and the Red Helleri (a cross between the Swordtail and the Red Platy); *Mollienisia latipinna*, with their dotted mother-of-pearl sides; and Black Mollies, perfectly line-bred to enhance their original black mottled coloring. His collection of the genus *Barbus* was extensive: he had beautiful specimens of the opalescent red-finned *oligolepis*; the rosy *conchonius*; the *lateristriga*, with its chameleonlike golden, black and carmine coloring; the black-banded *pentazona*; the silvery *ticto*; and many others.

After these came the species of the genus *Rasbora*, especially *heteromorpha* and *tœniata*; and still further were beautiful specimens of the Characinidæ, particularly of the subfamily Tetragonopterinæ—the Yellow, Red, Glass, Bronze, and Flag Tetras, and the *Hemigrammus ocellifer*, or Head and Tail Light fish. In a series of tanks down the centre of the room Stamm pointed with pride to his specimens of the Cichlidæ—*Cichlasoma facetum*, *severum*, *nigrofasciatum*, *festivum* (the Flag Cichlid), *urophthalmus*, *aureum*, and so on. He also showed us several specimens of that enigmatical *Symphysodon discus*, about which so little is known, either as to its sex distinction or its habits. "I'm working on this species," Stamm said, proudly indicating the blue-green brassy specimens. "They are closely related to the *Pterophyllum* and are the only one of their genus. I'll surprise the oldtime aquarists yet."

"Have you succeeded in breeding any of the *Pterophyllum*?" Vance asked with interest. Stamm chuckled. "I was one of the first aq-

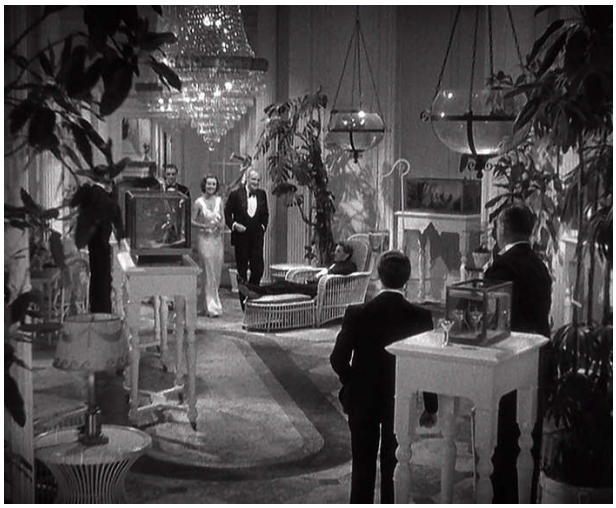
The Dragon Murder Case movie showing one of the larger aquariums.

The Dragon Murder Case movie showing a tank of Tilapia.

uarists in the country to find out that secret. . . . Look here." He pointed to an enormous tank of at least one hundred gallons. "That's the explanation. Plenty of swimming space, with heavy-stemmed Sagittaria for the eggs, and a good warm temperature." (There were many beautiful specimens in the tank, some of them twelve inches from dorsal to anal fin.) He moved along the west wall, talking proudly and fluently of his fish, with the enthusiasm of a fanatic. Before we had completed the circuit he had shown us specimens of the *Æquidens portalegrensis* (the Blue Acara); tiny transparent glass fish (*Ambassis lala*); many species of *Panchax*, especially *lineatus* and the rare Nigerian species, *grahami*; a pair of pike-like *Belonesox belizanus*; the usual *Danio malabaricus*; such mouthbreeders as *Haplochromis multicolor*, *Astatotilapia moffati*, *Tilapia heudeloti*, and *Etroplus maculatus*; labyrinthine fishes, such as *Osphromenus*, *Macropodus*, *Anabas*, and *Ctenopoma*; and hundreds of *Lebistes reticulatus*.

"Still," said Vance, "despite their commonness, there aren't many fish among the tropicals more beautiful than the Guppies." Stamm snorted and moved on toward the room beyond. "In here are the fish that really count," he said. This second aquarium was similar to the one we had just quitted and contained quite as many tanks, but they were arranged differently. "Here, for instance," said Stamm, standing before a tank at the right, "is the *Monodactylus argenteus*." "Brakish water, of course," Vance remarked. "Oh, yes." Stamm shot him a curious look. "Many of the tanks in this room are really marine aquaria, and, of course, I use brakish water also for my *Toxotes jaculator*—the Shooting Fish—and the *Mugil oligolepis*." Vance leaned over the tank that Stamm had indicated. "The *Mugil oligolepis* resembles the Barb, but it has two dorsals instead of one," he observed.

"Quite right." Stamm again looked at him curiously. "You've spent some time with fish yourself, haven't you?" "Oh, I've dabbled a bit," returned Vance, moving on. "Here are some of my best," Stamm said, going to a series of tanks in the middle of the room. And he pointed out to us some *Colossoma nigripinnis*, *Mylossoma duriventris*, and *Metynnis roosevelti*. "How do you manage to keep these rare Characins in such apparently good condition?" Vance asked. "Ah, that's my secret," returned Stamm with a shrewd smile. "High temperatures, of course, and large tanks and live food . . . and other things," he added enigmatically, turning to another series of tanks along the west wall.



The Dragon Murder Case movie: The solarium containing the aquariums. Note the hanging aquariums

"But here are a few fish about which even less is known."

He put his hands in his pockets and regarded the tanks with satisfaction. "These are the Hatchet Fishes: the *Gasteropelecus sternicla*, the *Carnegiella strigata*, and the *Thoracocharax securis*. The so-called experts will tell you that the breeding habits of these species are not known, and that they cannot be bred in aquaria. Tommy-rot! I've done it successfully." He moved further down the room. "Here's an interesting one." He tapped on the front wall of a particularly attractive tank. "The Blow Fish—*Tetrodon cucutia*. Watch this." He took one of the fish out of the water in a small net, and it inflated itself into the shape of a ball. "Curious idea," Stamm commented, "—blowing oneself up to keep from being swallowed." Stamm grinned. "I never thought of that," he chuckled.

"And right next door here," he went on, "is the *Pantodon buchholzi*. Just look at those large transparent pectoral fins. I brought these Butterfly Fish with me from West Africa. . . . And here are some beauties—the *Scatophagus*." He pointed to two tanks containing fairly large hexagonal fish—one tank of the spotted *argus* and the other of the striped *rubrifrons*. "And just here," Stamm continued, moving along the wall, "are a couple of *Luciocephalus pulcher*." Vance looked at this fish closely and inquiringly. "I've heard of them," he commented. "They are related to the Anabantidæ, I believe. But I didn't know any one was versed in their habits and care." "No one but me," Stamm boasted. "And I might add that they are not bubble-nest breeders, as many believe, but viviparous—live-bearers." "Astonishin'," Vance murmured.

Stamm directed our attention to a series of small individual tanks on the shelf above. "Piranhas," he said. "A rare species. And savage devils:—take a squint at those wicked teeth. I believe these are the first ever to come to the United States alive. Brought them back myself from Brazil—in separate cans, of course: they'd kill each other if they were put together. Damned cannibals—the *Serrasalmus*. I had a couple that were nearly twenty inches long,—not the *spilopleura*: they rarely grow over a foot in length. . . . And here," he went on, moving away, "is a nice collection of Sea-horses—the *Hippocampus punctulatus*. Better than those in the New York Aquarium. . . ." Stamm moved a little further on. "Here's an interesting fish—pugnacious and dangerous. The *Gymnotus carapo*. Have to be kept separately. Known as the 'Electric Eel'—*Electrophorus electricus*. But that's all wrong, really. Though they have eel-like bodies, they are not eels at all, but related to the Characinidæ. These are only about eight inches long, but they grow to three feet."

Vance looked at the queer specimens closely: they were vicious looking and repulsive. "I have heard," he remarked, "that they are actually capable of electrocuting a man by a moment'ry contact." Stamm pursed his lips. "So they say, so they say."

At this point Tatum and Mrs. McAdam came into the room. "How about a little battle?" Tatum asked of Stamm with a smirk. "Teeny

Dragon Murder Case movie: Some of Stamm's guests watching male bettas fight. Other guests thought it was cruel.

and I are bored." Stamm hesitated. "I've wasted eight of my biggest Bettas on you now. . . . Oh, all right." He went to a wide niche in the east wall, where there were numerous quart tanks each containing one Siamese Fighting Fish. From the ceiling hung a globe of water, on three slender chains, at a height of about five feet from the floor. He took up a small round Brussels net and transferred two veil-tail fish—a beautiful blue-green and a purple one—to the suspended globe. The two fish appeared to look at each other cautiously before attacking. Then, with brilliantly heightened color and with fins and tails twitching and spreading furiously, they rushed about. Coming close together and nearly parallel, they slowly rose, side by side, to the surface. Soon they seemed to relax, and sank to the bottom of the globe. These preliminary manœuvres continued for a few minutes. Then, with lightning swiftness, the fight was on.

They dashed at each other viciously, ripping off scales, mutilating each other's tails and fins, and tearing bloody bits from the sides. Tatum was offering odds on the purple Betta, but no one paid any attention to him. The blue-green one fastened on the other's gill with a terrific grip, hanging on until he was compelled to rise to the surface for air. The other then attached himself savagely to his antagonist's mouth and relinquished his hold only when forced to go up for air himself. It was a terrible, but beautiful, sight.

Vance looked toward Tatum. "You enjoy this sort of thing?" he asked. "Too tame," Tatum complained, with an unpleasant laugh. "I prefer cock-fighting myself; but when there's nothing else to do. . . ." Leland had entered the room without our hearing him. He stood just behind Vance. "I think it is a brutal sport," he said, his smoldering eyes on Tatum. "It is beastly." The purple Betta was now at the bottom of the globe, mutilated and almost entirely stripped of its scales; and the other was attacking it to give the *coup de grâce*. Leland quickly picked up a small net and, reaching into the globe, removed the wounded loser and placed him in a small tank of Mercuro-chrome water. Then he went back to the library.

The Dragon Murder Case movie: Vance and Markham behind one of the tanks.

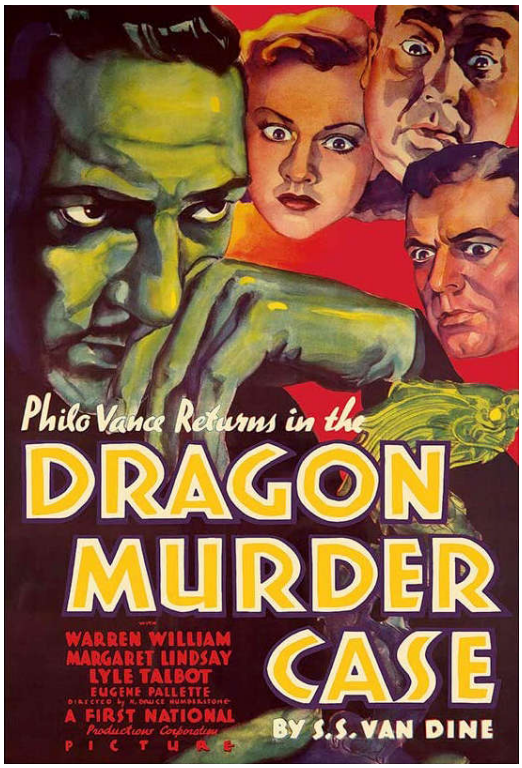
It is interesting to note that in the discussions by aquarists of The Dragon Murder Case, aquarists were more interested in the movie version that the book is was based upon. This is understandable because for the first time, aquarists were able to view the tanks and live fish of the early 1930s.

I. ADDENDUM

All the novels by S.S. Van Dine are available for free on-line in PDF format. Just enter the name of the case and look for the hits that offer downloadable copies. With regard to the movies, Amazon has "The Philo Vance Murder Case Collection" that contains the following DVDs: The Bishop Murder Case, The Kennel Murder Case, The Dragon Murder Case, The Casino Murder Case, The Garden Murder Case and Calling Philo Vance.

Amazon also has a collection called "The Philo Vance Lost films Collection" that contains the following DVDs: The Canary Murder Case, The Greene Murder Case, The Benson Murder Case, The Kennel Murder Case and The Gracie Allen Murder Case.

Finally, for those interested in an exhaustive biography of Willard Wright, I recommend the book (296 pages) "Alias S.S. Van Dine" by John Loughery, Charles Scribner's Sons, 1992.



Philo Vance holding a dragon statue in The Dragon Murder Case movie.

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