ANTHOLOGICA AQUATICA

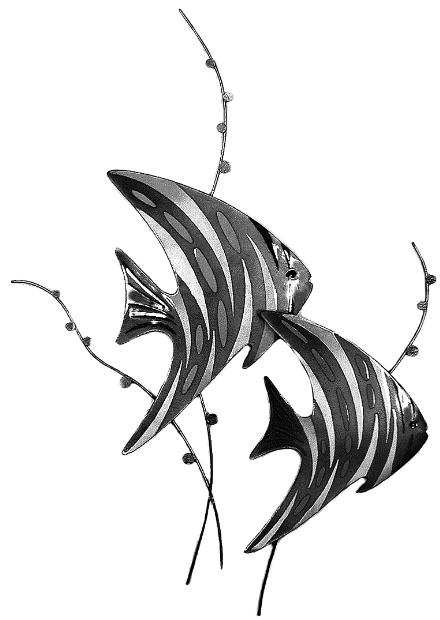
A Collection of Aquarium Articles by Albert J. Klee

VOLUME I

Dedicated to the members of the Aquarium Hobby History Society.

(http://groups.yahoo.com/group/AquariumHobbyHistoricalSociety)

In all of the history of a pastime,
There's nothing greater than sharing a history.
Roots that reach back into yesteryears
Have grown entwined through laughter and tears
Are stronger than any new growth.
And while beginning anew may seem enticingly appealing
There's no better feeling
Than the closeness of an old, familiar love,
A love of history.†



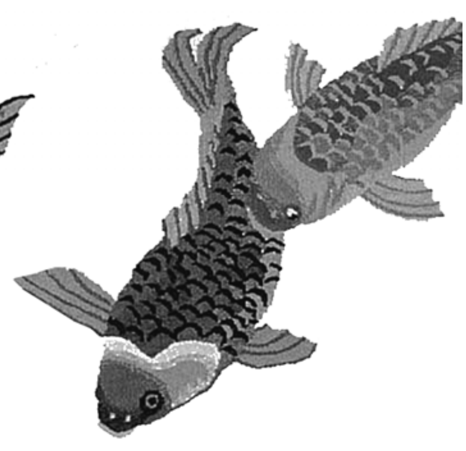
Layout and design by Albert J. Klee

†**Based upon a poem by Arthur Wallace**

ANTHOLOGICA AQUATICA

VOLUME I

The Aquarium
Aquarium Journal
(Feature Articles)
All-Pets Magazine
Aquarium Journal
(Beginner's Corner)
Cartoons



INTRODUCTION

Genesis

This project began when I was on the verge of discarding a number of folders containing articles and columns I had written during the decades of the 1950's, '60's and '70's, in the form of pages I had torn from various aquarium publications. The thought struck me that members of the Aquarium Hobby History Society (AHHS) might be interested in this material since much of it is no longer available. I therefore decided I would scan the articles, arrange them into a suitable format, place them into book form, and offer it to the AHHS as a gift.

"All work and no play…"

Naively, I had anticipated simply scanning the text into a Microsoft Word file, scanning the images into their own separate files using Adobe Photoshop, dropping the text and images into Microsoft Publisher (a layout program), and then converting the Publisher file into a PDF file (using Adobe Acrobat) that could then be distributed to the AHHS on a CD. If I were to simply Xerox the pages, the accompanying advertisements and parts of other-authored articles on the pages would not only have increased the bulk to a unmanageable level, but the quality of the copies would have left much to be desired (to say nothing of the expense). Furthermore, there would have been no way to correct printed errors.

I say "naively" because it turns out nothing is as simple as it looks like at first glance. Although I was using a fairly state-of-the-art OCR (optical character resolution) program (Omni Page Pro 14), unwanted artifacts - such as the notorious "optional hyphen," a character used to control where a word or phrase breaks - were introduced into the scanning process and had to be removed. Whenever a word was hyphenated the OCR program preserved the hyphen so I would, for example, wind up with a word that would look like "re-quest" or "quest-tioned," so that these also had to be removed. Other odd things cropped up in the scanning process, such as quotes being superscripted, making them so small that one had to use a magnifying glass to see them. Ironically, the OCR program would routinely remove subscripting making an F_1, for example, look like F1. Other remedial steps had to be taken, such as paragraph reformatting, font changes, converting straight quotes into curly quotes, etc., all quite time-consuming and tedious. It was necessary for me to develop correctional procedures that varied between 5 and 8 steps, depending upon the level of OCR I needed to use for a particular article, i.e., the less scientific the article, the fewer the number of steps needed.

This would not have been overly onerous until I got to the first article that contained a table. In Gilbert & Sullivan's *Mikado*, the Mikado describes how he would treat prisoners. He would have the billiard player, for example, play **"… on a cloth untrue with a twisted cue and elliptical billiard balls."** The Mikado could have added scanning a table to his list, since trying to get it to resemble what it looked like on the original printed page is something I would not wish on my worst enemy. Unfortunately, I was a great believer in using as many tables as possible in my articles. In any event, they had to be scanned separately from body text, as did the captions. All this added up to more work and so in for a penny, in for a pound!

"To err is human…"

One thing that took me by surprise was the many errors in the scanned text, particularly in scientific names. This was not the fault of the OCR program whose accuracy was amazing.

The only time it had any trouble (and it happened only a few times) was when the type on the original was smudged or otherwise printed imperfectly, or when some idiot placed white type over a colored photograph in the layout (form is supposed to follow function, not the other way around). Although I was ready to accept responsibility for my fair share of errors in the originally-published material, I wondered how it was possible for me to make so many of them until I noticed that on some articles where I had supplied drawings with the correct names painstakingly included using a LeRoy India ink lettering pen, the names in the body of the text were incorrect. As the AQUARIUM JOURNAL was the prime offender in this respect, I recalled that Dr. Stanley Weitzman was its Technical Editor and immediately realized that there was no way he would have allowed such errors to slip by, or not to have noticed them in the first place.

The answer was simple – typesetting. These early magazines were all offset paste-ups, using the following procedure when preparing text for the printer: (1) Since the origin of an article was almost always typewritten text, the editor would read it and make any necessary corrections; (2) The corrected pages would go to the typesetter who, unfortunately, was not familiar with the material he was setting up (I can image his reaction when encountering such words as *Chaenothorax semiscutatus* or *Atopochilus savorgnani*); (3) After the typesetter produced what were known as galleys" (the galleys were ultimately used in the paste-ups that formed the camera-ready pages for the printer), the editor would examine them for any errors introduced during the typesetting process; (4) The galleys would be returned to the typesetter for corrections (the editor was given about a week to get this done; otherwise the type was re-melted); and (5) The corrected galleys would be returned to the editor who then forwarded them to the person responsible for the layout for the magazine. This was the procedure I followed when I edited AQUARIUM ILLUSTRATED.

Evidently what happened was that no one ever looked at the corrected galleys, and I am making a giant leap of faith here in assuming that even the first galleys were examined. This reminds me of what Koko tells the Mikado: **"When your Majesty says, "Let a thing be done," it's as good as done - practically, it is done – because your Majesty's will is law. Your Majesty says, "Kill a gentleman," and a gentleman is told off to be killed. Consequently, that gentleman is as good as dead - practically, he is dead - and if he is dead, why not say so?"** In a similar vein, perhaps the thinking was that if the galleys were supposed to be checked, why not simply assume they had been? The Mikado found no fault with this thinking process as his reply was, **"Nothing could possibly be more satisfactory!"**

Seriously, I suspect that there just wasn't enough time for a volunteer publication like the AQUARIUM JOURNAL to check galleys, or if they did, it was done by those with an inadequate technical background. In any event, The AQUARIUM JOURNAL had by far the greatest percentage of errors, followed by TROPICALS MAGAZINE. ALL-PETS MAGAZINE, PET SHOP, MANAGEMENT, AQUARIUM ILLUSTRATED, and THE AQUARIUM. Incidentally, THE AQUARIUM, under the editorship of Innes and then Fletcher, did a very good job of reproducing complicated tables with a minimum of errors.

One thing I noticed that was particularly irksome was the carelessness sometimes displayed in the layout of images, especially sketches and drawings. Often the sides of such images were cut off because whoever did the layouts overstepped the printable boundaries (Oops! There goes part of the nose!). Although this wasn't a critical problem it was annoying and I had to restore the missing bits. In one article, a table was missing and since it was a complex one and couldn't be reconstructed without expending a great deal of time, I had to re-write a small portion of the ending.

All text was spell-checked, using a special dictionary of my own containing a list of scientific names. Grammar checkers are in the main worthless, but they do catch most punctuation errors.

If text was a problem, so also were the photographs. In those days illustrations were printed in black and white. Since most of my photographs were submitted as Kodachrome color slides, the magazines were forced to drop the color from the slides, converting them to grayscale. However, although a red fish may be clearly distinguished from a green background, the red and the green color may be of the same tonality, a quality independent of color. When color is dropped out and replaced by gray, the fish and the background often wind up the same level of gray. I was forced, therefore, to remove the background on many of these images and replace them with pure white in order to make the subject stand out. Another problem was the poor quality of the black and white reproduction. Most were of low resolution and insufficient contrast, forcing me to spend time in Photoshop trying to resuscitate them. The "CPR" was not always successful.

Although these were the sorts of problems encountered, I am not criticizing the editors of these now out-of-print publications. Before one judges a man he should walk a mile in his shoes (although one wag said that then you can show that you were right all along, and you get to keep the shoes!). In any event, I join the crowd by pointing out that in the very first issue of AQUARIUM ILLUSTRATED I pasted the first image upside down. Since I did the layout, I can't dodge the culpability! Ah, well. George Bernard Shaw once wrote that, **"A life spent in making mistakes is not only more honorable but more useful than a life spent in doing nothing."** I hope he was right!

What's in and what's out

Although this anthology contains over half of my work (in general, Letters to the Editor, stand-alone book reviews, and other short contributions were omitted, as were articles that appeared in foreign language publications), there are some omissions. For one thing, the cut-off point for inclusion of an article in this Anthology was December 1971 when my editorship of THE AQUARIUM came to an end, although I continued to write articles after that date up to the present-day, a span of over fifty-four years. Since the material was later published in book form, the extensive series of articles I wrote on the history of the aquarium hobby is not included either. The following material also was excluded: The AQUARIST'S NOTEBOOK, which I wrote during the period 1967-1975. Even without these inclusions, this Anthology consists of 326 articles containing 322,947 words, 635 images, and 128 tables. There are over 100 cartoons in this Anthology, since the original intention was to provide visual relief to the text, or else their themes related closely to the text.

There are other omissions, mostly a result of the way in which I filed my material. When an article was published I usually cut it from the magazine and filed it using a sort of Library of Congress system. There were two ways, however, in which an article could be lost: (1) Carelessness, since sometimes I failed to include all the pages, especially when the article was continued on another page or pages; and (2) If an article was written by someone else and my article was on the back of one of its pages, then sometimes the article would be filed under the other author's name (or their topic). Since these files were later discarded, so were my articles that were on their backs. Fortunately, if they were continuation articles for which I had one or more of the parts, the missing pieces were supplied by a number of AHHS members and I therefore gratefully acknowledge (in alphabetical order) the help of the following in providing this missing material: missing material: Bobby Ellermann, Lee Finley, Neil Frank, Steve Guyger, and Ray Wetzel.

This Anthology consists of two volumes, since a single volume would be unwieldy. The order of the magazines presented in the two volumes is semi-chronological in that they are listed in order of the first of my articles published in them. THE AQUARIUM, for example, leads the way since the very first article of mine ever published appeared in that magazine. However, within each magazine section if one or more articles on a different subject appeared during the publication of a multipart piece, these were placed after the last in the multipart series in order that readers will not have to search for the parts.

There is one additional matter that bears explanation. It may come as a surprise to some, but I was not particularly happy editing THE AQUARIUM. This was for four reasons: (1) Since I had a full-time job (later followed by full-time attendance at a university), the time pressure imposed by a monthly magazine with a large circulation was enormous (unlike AQUARIUM ILLUSTRATED, which was a bi-monthly and had a much smaller publication); (2) Since I was located 650 miles away from where the magazine was produced, I did not see any of the galleys and had no control whatsoever over layout; (3) I wanted to write, not edit; and (4) The publishers placed certain restrictions on context and editorial matters that I had to observe.

With regard to the last point I had to balance the magazine's content and, to this end, roughly classified the material into 14 areas, each of which had to be present in any two consecutive issues of the magazine. However, although an editor can always ask writers to provide specific material, it is not always forthcoming. In such cases I had to write the material myself. This posed another problem, however. Since the desire to write far outstripped my desire to edit, I frequently had two articles of my own in a single issue, and a third would have raised more than an eyebrow. One must remember that during my most productive years I was writing for as many as six aquarium magazines in a single year – and this is not counting foreign publications - and now my only outlet was THE AQUARIUM. My solution was to write under a pseudonym and the one I choose was "Harriet Connelly," my wife's maiden name (to those who know her as "Joy," this is her middle name), a sort of "George Sand" in reverse. There were five such articles and I have identified them in this Anthology.

Because this is an anthology and not a reference work there is no index as such, although there is a chronological list of titles within publications in the Appendix. Because many of my Beginner's Corner and Under the Cover Glass columns in the AQUARIUM JOURNAL did not have subtitles, I have supplied made-up ones so that the reader may have some idea of what they contain. Except where noted (and I hope I have caught all the exceptions), the photographs and drawings accompanying these articles are my own. Finally, I coauthored a number of articles with others where it is noted that I am the "Senior Author." All this means is that I was the one who actually wrote the article, nothing more. My co-authors not only provided material for these articles, but also reviewed the drafts and the final copy.

Sic transit Gloria…

It was interesting for me to re-visit this material written 35 to almost 55 years ago. I remembered old friends, too many of whom are no longer with us, and recalled how I got started writing. The actual starting point was in 1951 when I wrote an article for THE AQUARIUM about carbon dioxide. This was followed by two more articles in THE AQUARIUM before serving in the Korean War.

After my Army discharge I enrolled in New York University and while there wrote an article on metals in the aquarium and submitted it to TROPICAL FISH HOBBYIST. 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.

In May of 1956, ALL-PETS MAGAZINE published my article, "The Graceful Cats," thus starting a long relationship with Frank Dietrich, its editor and publisher. Shortly afterwards Jim Crawford asked me if I would consider writing a beginner's column for the JOURNAL and I agreed, the first of which ("On Mixing Fishes") appeared in August that year. Simultaneously, I took up writing for THE AQUARIUM again with an article ("The Pike Livebearer") that appeared in the same month. August of 1956 was a fruitful month for me as my first overseas article was published, "African Fishes of the Genus *Distichodus*," in the British magazine, THE AQUARIST.

In November-December of 1960 I wrote my first article for TROPICALS MAGAZINE ("An Apparatus for Fungus Prevention of Killifish Eggs"), starting a long-standing relationship with its editor, Earl Lyons. Although these articles were written for the general hobby, I also wanted to do more technical material. Therefore, in the Spring 1961 issue of TROPICALS my first Ichthyologica column appeared ("The Penguin or Hockeystick Fishes").

The beginner's column in the AQUARIUM JOURNAL, however, was not what I really wanted to do, viz., a more advanced column that dealt with current issues and material from foreign sources. I approached Jim Crawford with the idea and he agreed to publish my column called, "Under the Cover Glass." In December 1962 the last Beginner's Corner was published and the only column I did for the JOURNAL after that date was the Under the Cover Glass column.

In 1963 my first article for PET SHOP MANAGEMENT (another of Frank Dietrich's publications) appeared.

In March-April 1965 the last issue of TROPICALS MAGAZINE appeared and in September 1965 the AQUARIUM JOURNAL also ceased publication. Jim Crawford, knowing that I (along with two friends) wanted to start up a magazine as a replacement for these two unique publications, tried to convince the Board of Directors of the San Francisco Aquarium Society to let me take over the publication of the magazine. They decided, however, to turn it over to Herbert R. Axelrod instead. As with ALL-PETS MAGAZINE and PET SHOP MANAGEMENT, once into the Axelrod maw the magazine disappeared forever.

At the time of its demise, the AQUARIUM JOURNAL had a circulation of 1,600. My two partners and I then approached Earl Lyons with a view to taking over publication of TROPICALS but as he was asking too much for a subscription list of less than 1,000, we decided to start up a new magazine from scratch. The first issue of AQUARIUM ILLUSTRATED appeared in January-February of 1966.

Towards the end of the summer of 1967 I was approached by Metaframe and asked if I would edit THE AQUARIUM, the rights to which they had just purchased (if they had not done this, another great magazine would have disappeared within the span of two years). I agreed to edit the magazine for a period of five years, provided they would buy out my two partners. This they agreed to, but it was not necessary to adhere to my five-year contract since Mattel subsequently bought out Metaframe and the magazine ceased publication at the end of 1971, the cutoff point for this Anthology.

It was fun writing about aquarium matters, and I met many people and made many friends along the way. Although there might have been a great deal of work involved, it always was, however a labor of love and based upon a great passion for the aquarium hobby.

Albert J. Klee
October 18, 2005

CONTENTS OF VOLUME I

Carbon Dioxide in the Aquarium

[The Aquarium, January 1951]

Much has been said in the past of the importance of oxygen in the aquarium, but little has been mentioned of the role of carbon dioxide in its life and death relationship with aquarium fishes. This carbon dioxide relationship is of far greater importance than all the speculation about oxygen in the aquarium put together. In fact, the concern of many aquarists over the oxygen contents in their tanks is virtually needless.

How many of us have seen the occupants of an overcrowded tank congregated at the surface, gasping, as it might seem, for air? The usual remark heard is that the fish are dying from lack of oxygen. The fact of the matter is, that nothing could be further from the truth! There is plenty of oxygen in an overcrowded tank and now we shall see why.

There are three gases commonly found in any quantity dissolved in aquarium water, namely, oxygen (O_2), nitrogen (N,), and carbon dioxide (CO_2). Except for the action of some bacteria upon it, nitrogen is relatively inert and plays no active part in the aquarium. Although carbon dioxide occurs in air to the extent of only 0.03% by weight, it is found in much greater concentrations in the aquarium. The reverse is true for oxygen, and water dissolves less oxygen than is found in the air. There is one other important consideration in a discussion of CO_2 and aquarium water and that is this, CO_2 is more slowly absorbed and given off by the water than is O_2. In fact, the absorption of oxygen by water is practically instantaneous. Now what does this imply?

It means that aquarium water is always* saturated with O_2, no matter what the temperature may be, or what the concentration is of other gases present. The instant a fish converts O_2 into CO_2 through its breathing apparatus and momentarily creates an unsaturated condition in the water with respect to oxygen, oxygen is absorbed from the air through the water surface thereby making up the deficiency. Although as the CO_2 concentration rises in the water, it can hold less oxygen, there is no way a fish can use up all the O_2 dissolved in the water, as the air immediately replaces it. It has been found that if all the fish in a tank die from overcrowding, there will still be some O_2 in the water.

On the other hand, CO_2 is very slowly given off to the atmosphere and tends to accumulate in the aquarium water until it builds up enough pressure to escape. We all know that carbon monoxide is poisonous in small quantities, but what is not generally realized is that carbon dioxide, If only concentrated to a few percent, is sufficient to poison man himself and fishes too. In effect, this is exactly what happens when fish are crowded. They die, not because of lack of oxygen, but from being poisoned by carbon dioxide.

Since the escape of CO_2 from the aquarium is a surface phenomenon, aerating creates a vastly larger air surface and permits the CO_2 to diffuse into the air bubbles and be carried away to the atmosphere. A greater surface area also permits more fish in a tank for similar reasons. Theoretically speaking, the smaller the air bubbles from a releaser, the greater the air surface and hence, the more CO_2 removed. In practice, however, it is found that medium size bubbles start a circulation that, in effect, increases the surface of the water exposed to the air, thus again facilitating the removal of carbon dioxide.

Probably the most difficult question to answer is why less fish can be placed in a tank of similar dimensions but of higher temperature than another one. The point is frequently made that the CO_2 content of the water decreases as the temperature rises and should, according to theory, permit a greater fish population. This is, of course, not the case, as fewer fish can be maintained in a tank of higher temperature and is inconsistent with our earlier discussion unless the fishes own metabolism is taken into consideration. Since there is less O_2 in the water of higher temperatures, fish must work much harder to extract the same amount of oxygen from it. It has been found that fish approximately double their production of CO_2 for every 18° F rise in temperature. Therefore, although the CO_2 originally present in the water is decreasing as the temperatures rises, the fish themselves are producing it at a greater rate and thus to their own detriment, reach a concentration sufficient to poison them.

Bettas and other air-breathing fish can withstand overcrowding that would kill other fish, not because they obtain all the oxygen they need at the surface of the water, but rather because they do not breathe in the poisonous carbon dioxide that they produce.* These fish originally came from polluted pools and streams so choked with rotting plants and bacteria that the O_2 content of the water was practically nil, and air-breathing at the surface was a necessary device of nature for survival. This condition, we hope, is not found in the average aquarium.

This is why it is so important to supply a large surface area and/or aeration for our fishes in the aquarium. For if the aquarist himself is wary of the dangerous exhaust fumes from his automobile, there is no reason why he shouldn't be equally concerned for the safety of his aquarium occupants when the just as dangerous exhaust fumes, Carbon dioxide, is forever menacing.

This is not true for rare instances in which a tank is so badly polluted the fish have since died and growth of bacteria is so great that the water contains little oxygen and a great deal of harmful gases.

***At least, they do not breathe in as much. This is also true of partial air-breathers like *Corydoras*.**

Geography and Science of the Fundulopanchax Group

[The Aquarium, December 1951]

The Fundulopanchax group can be roughly split into two smaller subgroups, viz., those fish that spawn in plant thickets, and those that place their eggs in mud, soil, or sand to hatch. The division is a natural one since, in their natural habitats these two subgroups are found in two distinctly different types of climate zones.

The plant spawners are represented in the aquarium by such fish as *Aphyosemion australe. A. gardneri, A. bivittatum, A. arnoldi, A. loennbergii,* and *A. roloffi*. If we examine a map of Africa and mark the habitats of the above fishes on it, we find that the marks fall within the boundaries of a climate zone termed a Rainforest. This Rainforest climate is characterized by lack of a dry season, great rainfall, and a rather high constant temperature. By constant temperature is meant the annual temperature that usually varies no more than 5° F from month to month. The daily temperature range is something else again and varies from about 90° F (in the shade) at noontime to about 70° F at night. These temperatures are the thermometer readings and, because of the high humidity, are not the sensible temperatures. The sensible temperatures are the temperatures felt by animals and depend both on actual temperature and humidity. These sensible temperatures are very high and are responsible for the oppressive and sultry feeling of the tropics.

This saps one's vitality and, indirectly, contributes to the sluggishness of the Fundulopanchax. The humidity above the water has a direct bearing on the rate at which carbon dioxide passes out of the water to the air. Thus, the greater the humidity, the greater the carbon dioxide buildup in the water, which is oppressive to the fish and tends to make them sluggish.

It was mentioned before that a Rainforest has no dry season, however, during some months there is roughly two to three times the rainfall of other periods. North of the equator and slightly South of it, the rainier season starts about November and lasts until April. Although the plant thicket spawners will spawn all year around in the aquarium, they usually spawn best in the winter months. In their natural habitat, this is their usual breeding season due, no doubt, to the effect of the greater amounts of minerals washed into the streams in the increased rains of winter. This wash water is acid and so intensifies the leaching process whereby the soluble minerals are carried from the soil to the rivers. Due to the high humidity and high temperatures the destruction of leaves and other organic matter by bacteria is very rapid and by the constant rain the products are washed away into the rivers before they have a chance to become imbedded in the soil. Thus, the brown coloring matter of these streams is attributable to a large extent to oxidized organic material in the water. No wonder these fishes prefer old water, which is merely water which has adjusted itself to oxygen, carbon dioxide, and organic content.

Although the jungle itself may not have much ground vegetation due to the shading effect of taller plant growth, the banks along streams and the streams themselves are always choked with plants. Thus, the Fundulopanchax are well shaded from the light and intense seat of the noonday sun.

The soil breeders like *Aphyosemion coeruleum, A. gulare, A. sjoestedti, Nothobranchius rachovii, Cynolebias marmoratus, C. splendens, C. bellottii,* and *C. opalescens* are found in a climate zone known as a Savanna which, unlike the Rainforest, has a distinct dry season and less rain in general. During the rainy season, which, for the fish under consideration occurs in the winter months, the Savanna is much like the Rainforest in climate, but in the dry season, things are very much different. It is then that the Savanna is parched and brown, the trees lose their leaves, the rivers become low and all nature appears dormant. The temperature is higher during the dry season but since the humidity is much lower, the heat is not as oppressive. When the rains come in November, the temperature is lowered, the streams begin to fill, and nature again blooms.

These fish breed throughout the winter months, laying their eggs at the bottom of streams or rivers. Depending upon conditions, the eggs will hatch in ant time between a month and a year. At the end of the wet season the streams dry up and the temperature slowly falls. If the eggs laid towards the end of the wet season were to hatch during the drought, it would be disastrous for the fry, since food and cover are more difficult to obtain then. It has been found that these eggs take longer to hatch at 80° F than at 70° F. This is to be expected, since it is necessary for the eggs to remain dormant during the dry, hot summer months and then to hatch under the influence, of the cooler, rainy season. There is another consideration that somewhat adds to the complexity of this egg-hatching business. Other eggs are stimulated by an increasing concentration of minerals in the water. The Medaka (*Orizias latipes*) is related somewhat to the Fundulopanchax group and is found in fresh and brackish waters in Japan. A Japanese scientist, Ikeda, found that the hatching time at 82° F could be lowered, for these eggs, from two weeks in tap water to 8 days in a mild salt solution. But it had been shown by Loeb years before, that an increasing concentration on the eggs of these soil breeders increases the time required for hatching. The explanation of the mechanism by which this is so is not within the scope of this article but why this should be so is explained in this manner. The Medaka comes from a rainfall environment where there is no dry season. Rain washes minerals to the rice paddys where this fish is found thus increasing the concentration of minerals in the water. On the other hand, when the streams of the soil-breeders start to dry up, the evaporation tends to increase the concentration of soluble minerals and organic matter in the water. Thus, under the influence of increasing concentration, the eggs take longer to hatch, which is fortunate for the fry. They hatch in the next wet season when the rains dilute the concentrated streams and thus stimulate the eggs and the fry hatch in the most favorable environment.

It may be mentioned that according to conditions, a plant spawner may decide to lay her eggs in the sand. Some of the Fundulopanchax have overlying habitats and may very well be so versatile as to spawn in a manner that environment dictates.

In consideration of the salient points discussed in this article, the following suggestions are offered to the fanciers who would like to maintain and breed members of the Fundulopanchax group with a maximum of success.

1 Due to the shaded habitat and humid atmosphere, these fish do not need high temperatures. About 75° F is ideal.
2 The Fundulopanchax need a well-planted tank, weak light, and generally should be kept with fish of their own type.
3 Their water should be slightly acid and, most important, old with plenty of settlings on the bottom.
4. If breeding of the soil breeders is attempted, use a mud bottom (the mud from a stream containing fish), keep the eggs no higher than 72° F, remove parents after spawning and add distilled water to replace that evaporated to hasten hatching time. Even so, prepare for a long wait.

The Fleischmann Aquarium in Cincinnati

[The Aquarium, August 1952]

A probably unique public aquarium is the new Fleischmann Aquarium at the Cincinnati Zoological Gardens. The unique factor is that almost 50% of the exhibit space is allotted to tropical fish. The other 50% is devoted to native freshwater species. This is unusual, as most other public aquariums devote much less space to tropicals.

The larger tanks are located in the coldwater room and range from 85 to 1250 gallons, all filtered through a pressure system. The balanced aquarium room uses tanks of between 10- and 30-gallon capacities. These tanks have individual filtration and aerating facilities. Both rooms are always crowded with people when the zoo is opened, proving the worth of a public aquarium to a city. In addition, schools use the aquarium as a visual aid to education.

The rooms are paneled in Weltex and equipped with stainless steel rails and sunken lighting. As beautiful as the rooms are, the fish of course are the main attraction. A favorite with the public are the archer fish and the *Astronotus*. The archers knock down food from the keeper's hand and the *Astronotus* have been trained to jump at least six inches out of the water for their food. The author was liberally splashed while watching the attendant feed his pet *Astronotus*!

The Fleischmann Aquarium is small, but large ones can profit by the excellent management of this aquarium. All tanks are well marked with plastic nameplates of the fish. Plans are under way to supplement these with photographs. In addition, all of the tropical tanks have a clever and unique background arrangement using rocks, potted plants, colored and wax paper. Breeding is carried out with a large number of the tropicals. Even bass and sunfish have been bred here.

The yearly number of visitors to the Fleischmann attests to its popularity and we like to think that the tropical fish are one of the reasons for this enthusiasm.

The Pike Livebearer

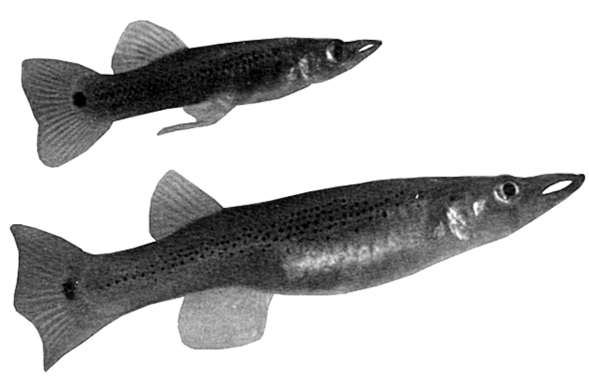
[The Aquarium, August 1956. Note: This article was co-authored with Arthur R. Hopkins, AJK being the Senior Author.]

Among the fresh and brackish waters of the Atlantic coast of South Mexico, British Honduras, Honduras and Nicaragua lurks one of the aquarist's most unusual livebearing fishes, *Belonesox belizanus*. Its large size, bizarre appearance and ominous reputation always draws a large crowd of hobbyists when on public display.

In most cases, the wicked-looking jaws are the first part of the fish to attract attention. The substantial curve to both the upper and lower jaws does not permit the Belonesox to close them. As a result, row after row of fine teeth are easily visible, enhancing its appearance as a "mean" fish. The overall coloration is olive-green, flecked with regular rows of small black spots. In reflected light the sides show an iridescent green. The large black area at the base of the tail is complemented by a large eye. The dorsal fin is set far back on the fish, but otherwise the fins are not outstanding. The anal fin of the male serves, as in all livebearers, as a gonopodium, but in *Belonesox* it is rather large and well defined.

Our specimens ranged in size from 4 to 6 inches for the females, to 3 to 4 inches for the males. (The largest size reported for this fish is 8 inches and 5 inches for females and males respectively.) At first they were kept in a 29-gallon aquarium, but, needing the space, we transferred them to a 10-gallon tank. During an effort to feed them earthworms, white worms, dry and frozen foods, the *Belonesox* took no food for almost two weeks. At no time did they molest each other despite the disparity in sizes. Finally, it was considered advisable to resume their normal fare of adult guppies. Fortunately, our work in line breeding various strains of guppies provided us with enough culls to feed the Belonesox.

In their natural habitat, *Belonesox* are found in neither fast nor stagnant waters, but along the banks of slowly moving streams, mangrove and reed swamps, and inlets to salty bays. They seem to prefer dirty to clean waters and' well planted to open ones. Belonesox have even been found in areas completely covered with algae and in cattle watering holes. In these ubiquitous surroundings, *Belonesox* are discovered near the water surface preying on small characin-like fishes. In the aquarium, an addition of salt is sometimes helpful to prevent fungusing of bruises, but we did not find it necessary with our fish.
The temperature of the aquarium that housed our *Belonesox* fluctuated between 75° and 90 °



***Belonesox belizanus*.**
Photograph by Albert J. Klee

A baby pike livebearer, enlarged several times. Even the small ones will quickly seize another fish nearly as large as itself. Photograph by Albert J. Klee.

F, with no discomfort to the fish. Two of the females presented us with batches of young, enabling us to study them under aquarium conditions. The first batch was not long in being devoured by the parents, but the second was saved by the concealment afforded by a handful of Anacharis thrown in for just that purpose. Each batch numbered about 40 3/4-inch baby *Belonesox*. Resembling little sticks, their sides were marked with a black stripe. The dorsal and anal fins were orange-tinted, and although they lacked the huge jaws of the parents, they did have an enormous eye.

The feeding problem was easy in this case, for the young ate frozen brine shrimp and frozen daphnia from the start. German aquarists, who have known this fish from 1909, have stated the young to be compatible, but our observations indicate otherwise. We paused from a photographing session in time to see a week-old *Belonesox* grab a companion by the middle of the body. After struggling for over 20 seconds, the victim managed to free itself - minus quite a few scales.

As an experiment we placed a young guppy two-thirds the size of the *Belonesox* in their tank. Within a minute, a baby *Belonesox* grabbed it about the middle, tossed it and had it swallowed. After this demonstration we decided to donate our *Belonesox* to the Fleischman Aquarium at the Cincinnati Zoo. Enough was enough!

Wood In The Aquarium

[The Aquarium, December 1956]

The display aquarium is often at its best when it presents a reflection or concentration of nature using her own materials. The potentialities of one such material, a material that is especially endowed with the capacity of adding character to the aquarium, have been unexplainably overlooked by most aquarists. This material is wood in its many shapes and forms.

It is true that not all woods are suited to the aquarium. Many aquarists have been disappointed when the much admired gnarled branch or twist of root they have chosen to fit in with a particular aquascape initiated a cloud of infusoria and a host of dead fishes. If asked to enumerate the important principles in selecting wood for our purposes, the following would certainly be included in the author's list:

1. Green (unseasoned) woods are wholly unsuitable.
2. The longer wood has lain under water the better it becomes for aquarium use.
3. Acid woods are to be preferred to all others.

The last point deserves some amplification. Botanists have recognized the relationships between plants and pH in various ways. The acid woods refer, in this case, to those trees and shrubs that are most closely associated with acid soils. Unfortunately for aquarists, the majority of trees and shrubs do not fall into this classification. Very desirable woods, from the hobbyist's point of view, are Birch, Oak, Alder, some of the Willows, Cypress, Magnolia, Chinese Chestnut, Holly and Carolina Hemlock. "Alkaline" trees would include various fruit trees (Apple, Plum, Pear, etc.), Maple, Ash, Black Walnut, Elm, and a host of others. The aquarist can glean more complete information concerning, the pH of woods from the various handbooks on trees and shrubs that are available.

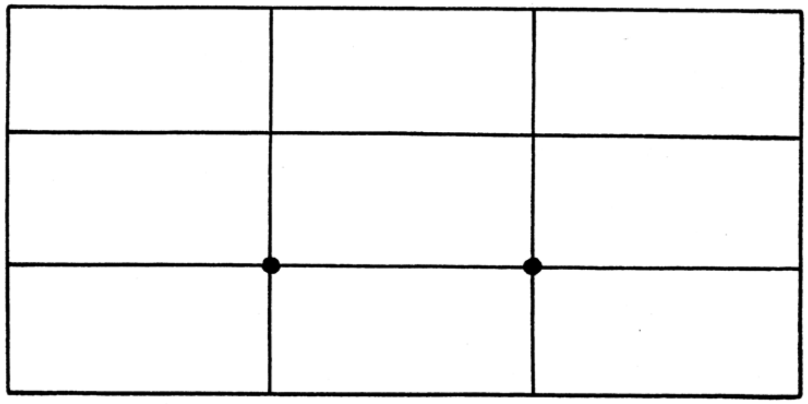


FIGURE 1

formed about old stone walls are especially useful. In bogs and swamps of the United States are found many pieces of wood and roots in various degrees of decay. Once the decayed parts are removed, the remainder is well suited to the aquarium. Cocoanut shells and the bamboo of old fishing rods are two little-thought-of sources.

No matter what the choice of wood, it is advisable that it be "cured" by the aquarist. This consists of boiling it in a strong salt solution for several hours, the longer the better. The boiling is followed by a soaking period (discard the salt water and replace with fresh non-salted water) of from one to two weeks. This treatment will leach the soluble organic and inorganic matter from the wood, coloring the water a dark brown. In the case of those woods that have been immersed in water for a long period of time, the curing may be omitted. However, if the wood produced any appreciable amount of infusoria in the aquarium, it must be removed and cured.

The tendency for woods to pollute or cloud aquarium water is reduced when the water is acid and soft. Bacteria and infusoria are much less likely to develop under these conditions. Filtration is also a valuable help. It is encouraging to note that once the soluble materials are removed from wood, it will not decay while continuously immersed in water.

The hobbyist can find many sources of wood for his aquarium. Pieces found floating in natural bodies of water, depending upon the length of time they have been immersed, have much of their toxic material leached out. Besides twigs and branches found above the ground, roots are also valuable. Cypress, Alder, Willow and Mangrove roots are recommended. The dried stems of ivy that are

Sometimes, wood will not stay put when it is first placed into the aquarium. The dry substance of wood weighs about 50% more than water and if all the air in the wood is replaced by water, the wood will sink. This is only accomplished with prolonged soaking, however, so the wood must usually be weighted with various materials. Lead can be used if the aquarium water is hard and alkaline. In very soft water, lead is dangerous to fishes and stones are better. The stones can be wedged into holes drilled where they will not be seen. For slender pieces of wood, such as bamboo, that are stuck vertically in the aquarium sand, the tops can be supported by a piece of plastic by thrusting them into holes in the plastic drilled for this purpose. Wood can be tied or lashed together with either nylon or glass thread. Other devices will undoubtedly suggest themselves to the reader but care should be exercised that all materials used are non-toxic to fishes.

The time expended in selecting and preparing wood can be wasted if this material is haphazardly arranged in the aquarium. Mr. Harry V. Lacey, writing in the English magazine, "Water Life" (Oct. 1955), outlined several principles in applying artistry to aquascaping. Although the principles are valid for all materials used in the aquarium, the author has found them especially adapted to the use of wood. Perhaps the least obvious principle to aquarists is the "Dominant Third." Imagine a

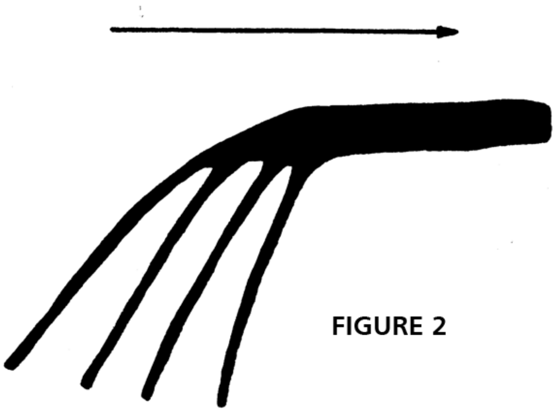


FIGURE 2

tic-tac-toe grid drawn upon and fitting the front glass of the aquarium (figure 1). The eye, when looking at this picture, seems to rest naturally upon either of the two lower corners of the middle rectangle. Surprisingly, the center spot does not draw our eye like the two dominant third spots. It is at these latter two points that our center of interest lays. Although a center plant could be used in both spots, a more effective display is created by placing wood in one of them. The wood selected should preferably be one of detailed design, such as the gnarled and knurled roots of trees discussed previously. The aquarist should not make the error of being miserly in his use of wood in this spot. Here, the concentration of wood must be forceful with detail massed. Numerous plants placed in and around the root will aid in the massing of detail and help make it the dominating area in the aquarium.

Our second principle is concerned with leading the viewer's eye into rather than out of the aquarium. Consider, for a moment, a piece of alder root consisting of a single, heavy piece with several smaller parts projecting like curled "fingers" from one end (figure 2). The eye naturally follows this piece of wood from its "fingers" to the main branch. If the branch were placed at one side of the aquarium, the eye would tend to be led out of the picture formed by the aquarium. Placed with the "fingers" at the side glass, however, the wood would point into the aquarium, leading the eye back.

Wood is valuable in another way in stopping the eye from wandering out of the aquarium picture. When placed at the side of an aquarium, it can act as a reflector to bring the eye back to the interior of the aquarium by means of its rather massive form and heavy color. This is especially effective if the interior is brighter or lighter.

Up to now, this discussion has not considered the placing of wood in the aquarium with regard to depth*. Increasing depth is something the aquarist is always striving towards, for depth lends realism to our living picture. Unfortunately, many hobbyists place their wood so that it is parallel to the front of the aquarium. This is a practice that actually robs depth from the aquarium. Illusion can be put to work for us by placing the wood obliquely from front to rear. The effect is quite surprising to those who try it for the first time.
There is one particular type of wood arrangement that the author feels merits special comment. This is the bamboo forest, seldom seen, but a most effective use of aquarium wood. It is a perfectly natural arrangement, for many of our aquarium fishes are found in reed banks or papyrus marshes. An excellent location for the "forest" is to the rear and along one side of the aquarium. Hygrophila or Am b u Ii a, planted between the vertical sticks of bamboo, form a perfect complement for the wood.

Last but not least, the lowly cocoanut shell deserves a place in the decor of the aquarium. The shell is also a woody material and is easily broken to desired shapes. Many cocoanut shells are available with a hemp-like material adhering to its outer surface that adds to its decorative value. Cocoanut shells are especially desirable in the aquarium as refuges for shy or bullied fishes. Since holes are easily made in them, plants can be arranged in and around the shell flattering them both.

The use of wood in the aquarium is not, as we have seen, without its careful preparation and selection. Perhaps the strongest argument for wood is that it permits the hobbyist the use of an additional dimension in which to frame and complement his aquarium fishes. In effect, it makes the possibilities for an outstanding aquarium display virtually limitless.

*** Refers, in this instance, to the distance from front to rear of the aquarium.**

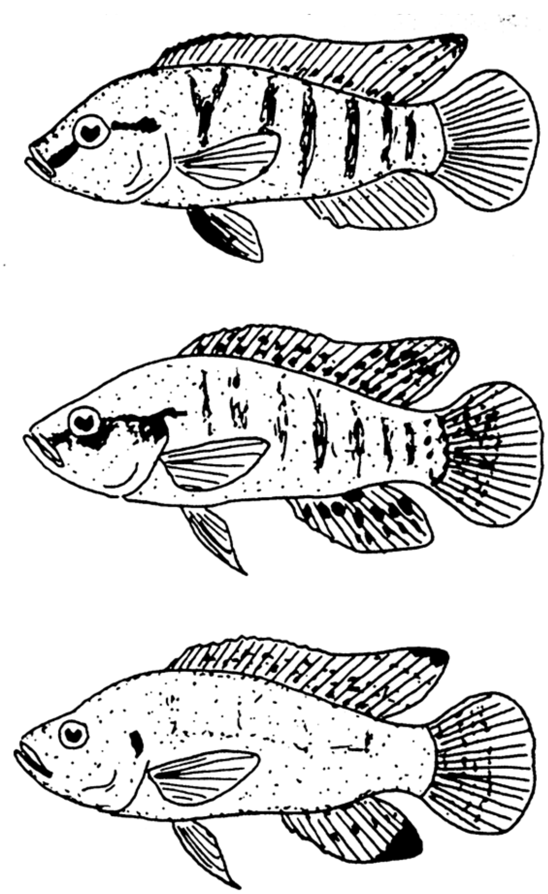
An Old Friend Changes its Name

[The Aquarium, June 1963]

Recently, there has been some animated discussion within the hobby concerning the validity of the scientific names of two mouth breeding cichlids, *Haplochromis multicolor* and *Haplochromis strigigena.* The latest aquarium reference books treat them as separate and distinct species; however, the question has been raised as to whether or not they are one and the same species. The very outstanding club magazine, The Boston Aquarium News, has discussed this problem in considerable detail [1,2]. *Haplochromis multicolor is,* of course, an old aquarium standby, popularly known as the Egyptian mouthbreeder.

Assuaging my desire to learn more about nomenclatural problems connected with aquarium fishes is more easily said than done but in this instance, I was privileged to obtain the counsel of probably one of the world's outstanding authorities for this genus, Dr. P. H. Greenwood of the British Museum of Natural History. According to Dr. Greenwood[3], *Haplochromis multicolor* and *Haplochromis strigigena* are very definitely, separate and distinct species. The confusion originally arose because the great British ichthyologist Boulenger in 1915 considered that *H. multicolor* was a synonym of *H. strigigena*[4]. Certainly, Boulenger was incorrect in this action. It is of interest to killie fanciers, by the way, to note that Boulenger's monumental work, *Catalogue of the Fresh Water Fishes of Africa*, from which through the years aquarists (and ichthyologists as well) have derived much of their fish nomenclature, contains a number of errors in killifish identification. In part, Boulenger is to blame for a portion of the confusion existing re the genus *Nothobranchius today.* This is not to detract from Boulenger's accomplishments, however, for he was without doubt, a great ichthyologist.

The first ichthyologist to recognize the fact that *H. multicolor* and *H. strigigena* were not conspecific (i.e., not the same species) was another distinguished Britisher, C. Tate Regan. In 1922, Regan made an interesting discovery, i.e., that *Haplochromis strigigena* was a synonym for *H. bloyeti (H. bloyeti* having priority



FROM TOP TO BOTTOM:
Hemihaplochromis philander,
Haplochromis bloyete,
Hemihaplochromis multicolor.

over *H. strigigena,* 1883 vs. 1893). Unfortunately, Regan's correction[5] is not as well known as Boulenger's catalogue so not only has the invalid name *H. strigigena* been continued in use by aquarists, but the confusion involving *H. multicolor* also has persisted.

Interestingly enough, the fish pictured in Boulenger's catalogue as *"H. strigigena"* is really *H. multicolor.* The natural distribution of *H. bloyeti is* much farther south and west of the area occupied by *H. multicolor.* As Dr. Greenwood points out, *H. multicolor* seems to be restricted to the Nile, Lake Victoria, Lake Kyogo and affluent rivers flowing into these lakes. There are areas where both *H. bloyeti* and *H. multicolor* occur together but this is the result of man's interference with their natural distribution.

Although the foregoing removes the mystery concerning these two species, there is a bit more to be told. Aquarists interested in the genus *Haplochromis* are familiar with the interesting and important work of Dr. Wolfgang Wickler of Germany in which he has shown that the anal fin ocelli (these are the large spots present there (Dr. Wickler refers to them as "egg dummies") in this genus play a most important role in the spawning process. In brief, the female lays her eggs and then picks them up in her mouth. Then, the male spreads his anal fin before her and the female, thinking these egg dummies to be real eggs, tries to pick them up also. At this time, the male releases his sperm that gets thoroughly mixed in the female's mouth, and fertilization is ensured.

Now *Haplochromis multicolor* does not possess anal fin ocelli and therefore its breeding behavior differs from that of other species in the genus. Consequently, Dr. Wickler has recently proposed that it be placed in a separate genus, *Hemihaplochromis.* His research has been intensive and thorough and Dr. Greenwood fully supports the transfer to this new genus. Therefore, the new name for the Egyptian mouthbreeder is now *Hemihaplochromis multicolor.* Incidentally, there is one other species which must be placed in this new genus also and this is *Hemihaplochromis philander*, a fish which has appeared in the aquarium from time to time.

To sum up then,
(1) *Haplochromis strigigena is* a synonym of *H. bloyeti,* the former name not being valid.
(2) *Haplochromis bloyeti is* a species distinct from *H. multicolor,* the latter being a "good" (ichthyologically speaking) species.
(3) *H. multicolor is* transferred to a new genus, *Hemihaplochromis,* along with *H. philander.*

ACKNOWLEDGEMENT

My heartfelt thanks go to Dr. P. H. Greenwood for his invaluable counsel in this matter, and for the aid he has rendered to the hobby thereby.

REFERENCES

(1) Hagner, Albert, "The Egyptian Mouthbreeder", THE BOSTON AQUARIUM NEWS, Vol. 14, No. 5, Pg. 3, December 1962.
(2) Sprague, Theodore W., "The Nigerian Mouthbreeder", THE BOSTON AQUARIUM NEWS, Vol. 15, No. 1, February 1963.
(3) Greenwood, P. H. to Albert J. Klee, personal communication, April 2, 1963.
(4) Boulenger, G. A., *Catalogue of Fresh Water Fishes of Africa,* Vol. 3, pg. 299, 1915.
(5) Regan, C. Tate, "Classification of the Fishes of the Family Cichlidae, Part 2: African and Syrian Genera Not Restricted to the Great Lakes", Ann. Mag. Nat. Hist., *(9)* 10, pg. 249, 1922.
(6) Wickler, W., SENCK. BIOL., 44, pgs. 83-96, 1963.

A Beautiful Backyard "Import" The Bayou Killifish

[The Aquarium, August 1963. Note: This article was co-authored with Dorothy Blackburn, AJK being the Senior Author]

The genus *Fundulus* contains roughly half of the native killifishes of the United States (the

FIGURE 1: *Fundulus pulvereus* male. Photograph by Albert J. Klee

genus *Cyprinodon* comes in a distant second with about 25% of the total). A majority of the species of this genus inhabit the lowland fresh and brackish waters of the eastern United States and by this we mean a majority of all species in the genus since certain of them are found outside of the Continental United States (i.e., Bermuda Islands, Cuba, Mexico and Canada). As the genus proceeds farther south, it is replaced by *Profundulus*, a genus little known to aquarists, however. The distribution, habitat, and relationships of recent species of *Fundulus* (at least seven fossil species are known) are in a somewhat confused state presently, although authorities like Dr. Robert R. Miller of the University of Michigan have simplified the picture to a great extent. One problem is that many species tend to marked sexual differences, age changes, and highly variable color patterns. Thus, the problems of subspecies within the genus is still with us. Unfortunately, the subject of our article is one of those in a somewhat doubtful status. There is a possibility that *Fundulus pulvereus* and *F. confluentus* are one and the same species but so far, intergrades have not been found (an intergrade is a cross between two subspecies of the same fish … they have rather definite characteristics vis-à-vis the parent fish). In view of the fact that their natural habitats, in general, do not overlap (ichthyologists term this “allopatric”) and that aquarists have no difficulty in distinguishing them, we will follow Dr. Miller’s lead and consider the two species as distinct.

Primarily, the distribution of *F. pulvereus* is to be considered as running from Texas to Alabama, with *F. confluentus* picking up in Alabama (or Louisiana) and ranging down to Florida and up to Maryland. In 1960, the Committee on Names of Fishes of the American Fisheries Society published a revised “List of Common and Scientific Names of Fishes From the United States and Canada.” Since the list is also sanctioned by the American Society of Ichthyologists and Herpetologists, we will follow its nomenclature and indeed, urge all American and Canadian aquarists to follow suit both in the subject of this article and for other native fishes as well. Such distinguished aquarists as Mr. C. Basil Jordan have already used this guide in their writings. Accordingly, the popular name of *F. pulvereus* is the bayou killifish, a very descriptive and applicable term.

The bayou killifish is a robust killie reaching a length of approximately 2½ inches. It exhibits a high degree of sexual dimorphism, i.e., males differ outwardly from females. Basically, males are a dark-olive to light, brownish-yellow with about 15 silvery vertical bars on the sides (figure 1). The general impression is that of an alternation of brown and silvery bars. The dorsal is very impressive fin in the male. First to gain attention is a rather large, elongated spot. This is bordered by a broad, bright orange band. In addition, there are numerous smaller spots of black or white. The anal fin is similarly marked, also having a broad, orange border. A number of silvery spangles range along the back into the base of the tailfin. In some specimens, these spangles

FIGURE 2: *Fundulus pulvereus* female. Photograph by Albert J. Klee

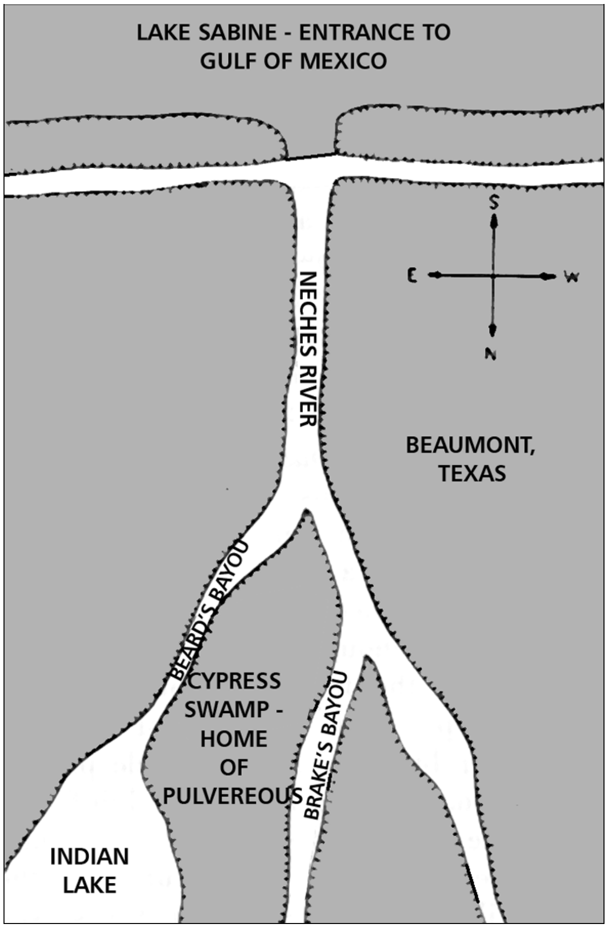


FIGURE 3: The location of Beard's Bayou, the habitat of *Fundulus pulvereus*.

continue into that fin. In their warm-weather spawning colors, there is also an orange hue suffusing the belly and anal fin.

Females, on the other hand, lack the vertical bars on the body (figure 2). Their basic coloration is brownish-yellow and this is overlaid with numerous spots, blotches, dots, and streaks. These markings vary greatly from one specimen to the next. Most present the impression that the streaks are more or less horizontal. The dorsal fin sports a few large and indistinct dark spots, while caudal and anal fins are decorated with a limited number of smaller spots and/or streaks. The whole body of the female pulvereus suggests a fine dusting or powdering. Indeed, the very name "*pulvereus*" means "full of dust." "*Fundulus*," of course, means "bottom" and mistakenly (as a generality, that is) refers to a suggestion that the genus is characterized by bottom-loving species, although this is true enough in this species. The complete scientific name is pronounced, **FUN'**-DU-LUS PUL-**VER'**-EE-US. The preceding description of the bayou killifish should not be misinterpreted to mean that all specimens be patterned and colored exactly as we have described them. Indeed, the authors have encountered several color types (a bluish variety in particular) in their travels and must conclude that the fish is to be considered as somewhat variable in these characteristics.

Figure 3 shows the approximate location of Beard's Bayou, located near the home of one of the authors. It forms a part of the great Sabine River watershed that abounds in plant and animal life. There are many species of trees, thousands of species of shrubs, and hundreds of species of grasses. This is the middle belt of climatic change where the East meets the West, and the flora and fauna of both regions intermingle here. A colorful note is added by the wild yellow jasmine and the trumpet vine.

Between Beard's Bayou and the Neches River is a cypress swamp, an excellent source of *Fundulus pulvereus*. Figure 4 maps this general area and the road leading into it. Marsh grass and cypress trees abound everywhere. There are two main water channels but the depth of water over the swamp is dependent upon the tides. At high tide, most of the swamp is under water while at low tide, many pools are left behind. The water is of a dark, amber color, practically free of vegetation, and the bottom is covered with deposits of mud and silt. As might be expected, many places in the swamp are inaccessible.

This particular *F. pulvereus* habitat, in which they are often found traveling in schools, yields other fishes as well. Among the aquarium fishes there are huge green sail fin mollies

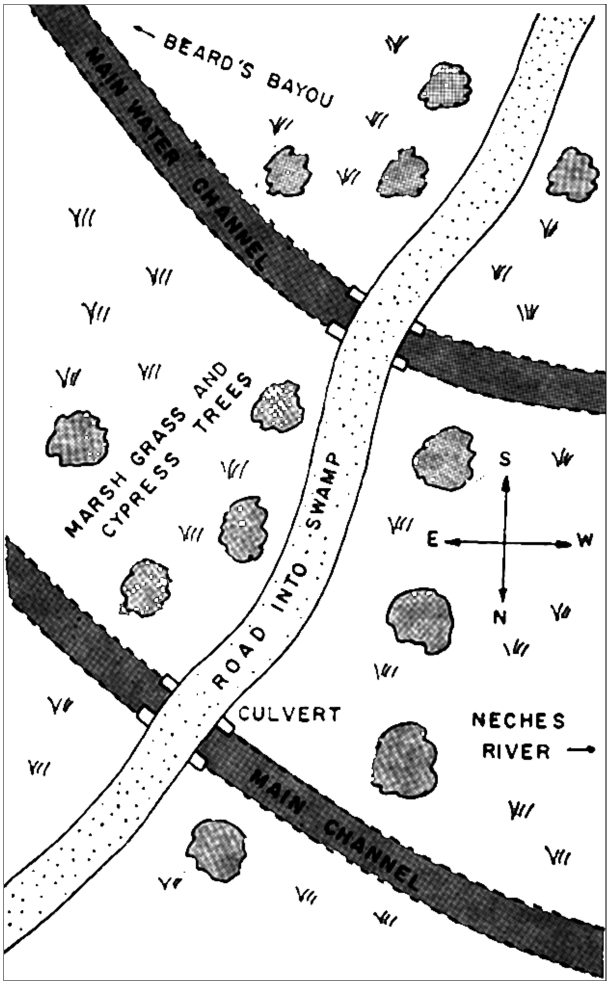


FIGURE 4: The cypress swamp in which many *Fundulus pulvereus* were caught.

(most of them females), mosquito fish, *Cyprinodon nevadensis* by the thousands, Lucania parva, the fat sleeper (*Dormitator maculatus*), melanistic mollies and a very few Fundulus notti. In addition, there are "fishermen's fishes" such as perch (there is quite a bit, of perch fishing here), mullet, shad, and even large garfish. The last-named are shot for sport.

The bayou killifish is, as we have said, a robust animal that may suggest a pugnacious nature; however, it is congenial with other fishes and with its own kind. This is not to say, however, that delicate fishes should be placed with them in the same tank. They are undemanding about eating and will greedily (piggishly in fact!) consume fry, worms, canned shrimp, crabmeat, frozen adult brine shrimp, and frozen daphnia. Individuals become quite tame and will swim to the top to meet their owner at feeding time. Indeed, they are quite amiable and will even jump out of the water for a bit of food! At other times, they prefer the bottom stratum of the aquarium.

Fundulus pulvereus is readily spawned using nylon mops (Mrs. Blackburn spawned them in an aerated, 3-gallon tank, containing a mop, top and bottom, plus a few petrified rocks). The spawning play is lively enough with the male swimming below the female, encouraging her to the mop. There is none of the tail ripping or bullying of the female present with so many other species of killifishes. Near the mop, the female sometimes turns over on her back, vent up, with the male still beneath. At other times, she will assume a more normal position. In either case, the eggs are expelled. The male does an excellent and complete job of fertilizing the eggs, which are the size of those of *Rivulus cylindraceus*. Forty or so eggs may be laid in one day, with many of them winding up on the bottom of the tank. The eggs (diameter - 1.7 mm) are certainly sticky, but nowhere attain the adhesiveness of say, lyretail eggs. We have not dwelled upon water conditions since this fish will adapt to a variety of circumstances. However, a sample of its natural habitat water measured in the range, 288 to 320 ppm of sodium chloride. This is 4 to 6 times the salt content of most soft to hard waters found inland, but only a hundredth part of the salinity of typical seawater. We may conclude, therefore, that its natural waters are slightly brackish.

To return to the spawning act, it also occurs that *F. pulvereus* will lay its eggs in and about the large pores of the cork to which the nylon mop is usually attached. Eggs are also found in quantity where the mop is gathered together to attach it to the cork. Such eggs are difficult to

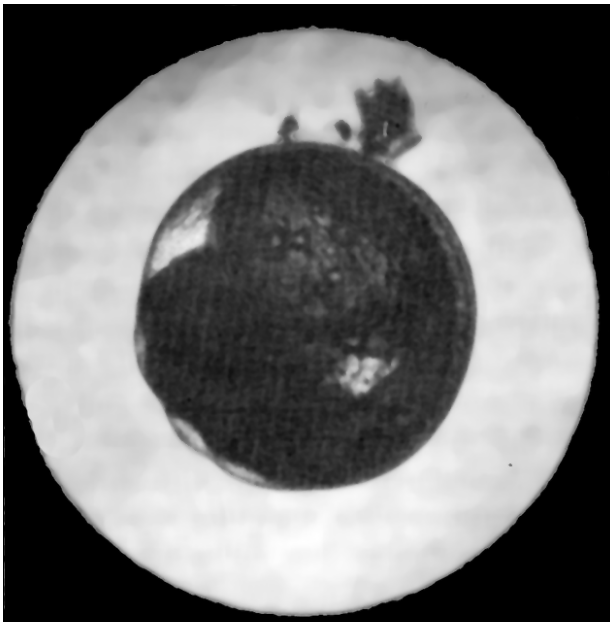


FIGURE 5: An egg of *Fundulus pulvereus* ready to hatch. Photograph by Albert J. Klee

extract and must be dug out with a needle (being careful not to break the eggs). Therefore, the circular spawning mop that uses for its flotation a ring of airline tubing (connected with a piece of rigid stock), is recommended. Since *F. pulvereus* is a bottom fish inhabiting an area lacking in vegetation but plentiful in submerged logs, perhaps their eggs are laid in the crevices of these logs in nature. This would provide considerable protection to the eggs.

The development time for the eggs of the bayou killifish is somewhat longer than for species such as *F. olivaceus*, for example. We have not determined whether or not *F. pulvereus* can be treated as an annual like its close cousin, *F. confluentus*, but the time to hatching may frequently take from 3 to 4 weeks. The fry, however, pose no problems in rearing and standard procedures starting with newly hatched brine shrimp may be followed.

It has long been a truism that American aquarists have treated native species rather shabbily. One result has been that foreign aquarists are more familiar with these fishes than we are. Now and then when an American author does bring up a matter of a native fish, the subject is frequently not done justice. Ironically, if *Fundulus pulvereus* had originated from Columbia, Thailand, or some other far away place, aquarists would be falling all over themselves trying to obtain specimens for their own tanks. They have few, if any, adverse points; are lively and colorful. In the final analysis, what more could the aquarist desire?

A Frog-Eating *Rivulus* From Panama

[The Aquarium, September 1963]

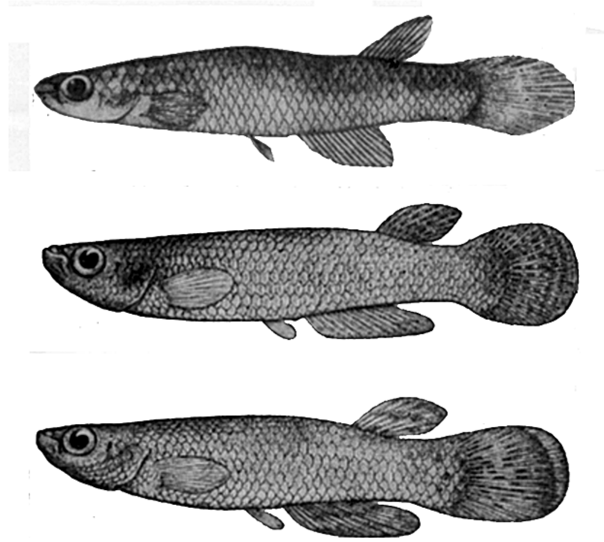
Unlike the situation with respect to livebearers, the killifish population of Panama is meager, to say the least. In fact, only a single genus (i.e., *Rivulus*) is known to date although future, more intensive exploration might make this statement obsolete. Until now, aquarists have not had access to Panamanian killies so it was with distinct pleasure that I received a live rivulid specimen from Mr. Harvey Siegal of Brooklyn, New York, who in his own turn had received the fish from a correspondent in Panama. The experience proved worthwhile enough to chronicle some pertinent facts and observations.

The following species comprises the known rivulid population of Panama: *brunneus, chucunaque, volcanus, hildebrandi*, and *montium*. Available descriptions of these fishes are mostly of preserved specimens and consequently, leave much to be desired by aquarist's standards. If one were to read such descriptions, the general impression would be that of a collection of drab, uninteresting fishes. I have found from experience, however, that one can easily be misled should the decision to ignore such an assemblage be based upon this kind of information. Frequently, the "drab, uninteresting" fishes of the literature turn out to be anything but that.

Fishes of the genus *Rivulus* can be, for convenience' sake, arranged into three groups: breviceps group, marmoratus group and the cylindraceus group. As a further subdivision, the cylindraceus group may be divided into three complexes: cylindraceus complex, micropus complex and the elegans complex. I was not long in placing the new fish in the elegans complex which contains the following species: *brunneus, chucunaque, montium, tenuis, godmani, elegans, milesi, leucuris and magdalenae*; *Rivulus milesi* is, of course, well known to aquarists (popularly as the "goldentail rivulus"). Only the first three are Panamanian fishes, however. The fish came to me (rather doubtfully) as *Rivulus brunneus* but an analysis of Table I indicates that it is much closer to *Rivulus chucunaque* (pronounced CHOO-**COON'**-AH-KAY).

The confusion between these two species is quite understandable since, morphologically speaking, they are indeed close. The chief difference appears to be in coloration, *brunneus* being brownish with black dots whereas *chucunaque* is somewhat greenish-blue with reddish-brown dots (see Figures 1, 2 and 3). The latter is, also, a somewhat more slender fish. Two subspecies of *chucunaque* have been described, viz., *R. chucunaque chucunaque* and *R. chucunaque sucubti*. The latter subspecies is slightly more robust than the typical subspecies and the spots on dorsal, anal and tail are somewhat fewer and larger. The species I received appears to be closer to *R. chucunaque sucubti* but in light of the lack of more exact locality information, no more will be said about subspecies. Moreover, I suspect that ichthyological work in the future may show that both *brunneus* and *chucunaque* are perhaps, the same species.

A complete description of this fish (a male) is as follows (see Figure 4): Total length, including tail—3 inches. Basic coloration—brownish on back changing to violet ventrally. Large reddish-brown spots in more or less regular rows superimposed over greenish-blue flanks. Dorsal fin shows a number of light-brown spots near its base on a darker-brown background. Anal fin is greenish at its base, brownish-red otherwise; there are a number of dark-red spots liberally sprinkled over this fin. Finally, the tailfin is quite pretty. The bulk of the fin is colored brownish-green, tending towards yellow-brown at its upper edge. There is a narrow brownish-red band in the lower portion of the fin, contrasting nicely with the yellow that colors the entire fin below it. In summary, although it is not a brilliant or a gaudy fish, it is attractive.



FROM TOP TO BOTTOM:

FIGURE 1: *Rivulus brunneus* (after Hildebrandt).
FIGURE 2: *Rivulus chucunaque* (after Breder).
FIGURE 3: *Rivulus chucunaque* sucubti (after Breder).

Under aquarium conditions, *Rivulus chucunaque* readily eats frozen brine shrimp, chopped beef, and other foods normally fed to fishes of this genus. When at rest, it assumes the typical arched-back pose of the genus.

FIGURE 4: *Rivulus chucunaque* (a male). Photo by Albert J. Klee

In 1924, C. M. Breder, Jr. of the American Museum of Natural History, explored the Rio Chucunaque Drainage, located in Eastern Panama. Although this is well away from the reported location of the fish I received, there is no reason to deny that the species has a very wide range, especially should *chucunaque* prove to be conspecific with *brunneus*. In any event, it was on this trip that he discovered *Rivulus chucunaque*, naming it after the drainage involved. The expedition lasted from the beginning of February to the beginning of May, i.e., well into the dry season. Judging from the size of the younger fish and the condition of the adults, it appeared that spawning was over, having commenced some time towards the end of the rainy season. The chief occurrence of *R. chucunaque* was found to be in potholes containing water left by the receding dry-season streams. Such potholes are located in the beds of creeks and are fairly free of surrounding vegetation. Their edges are rounded and the holes themselves may vary from 5 to 14 inches or so in diameter, and in depth up to 2 feet. The temperature of such creeks varied during the dry season between about 76° and 83° F.

Breder occasionally found *Rivulus chucunaque* flipping along the land, presumably in search of water. More startling, however, is the fact that he also found them buried in damp jungle debris to a depth of up to 2 inches! In this state, they spent the summer in estivation, a form of hibernation. The ability of *Rivulus chucunaque* to survive under difficult conditions was remarkable indeed.

Breder also comments that the lagoon-like nests of the frog, *Hyla rosenbergi*, were common along the stretches of the creeks inhabited by *R. chucunaque*. It was postulated that one of the purposes of the nest was to thwart the predatory attacks of this fish. In one recently-constructed nest, a specimen each of both frog and fish was found and although *R. chucunaque* was not at all concerned about the presence of the frog, the latter was quite upset over the appearance of the fish, so much so that the nest was not used even though in the following day, the fish was gone.

The mouths of the creeks along the Chucunaque are affected, of course, by the tides. Tidal forms such as *Dormitator latifrons* are found here. Above this (in the dry season) are found a series of stagnant or nearly stagnant pools in which the concentration of fish life is very great. Understandably, the mortality is heavy both from asphyxiation and from the

TABLE I

	brunneus	New fish	chucunaque
Standard depth	4.5-5.2	5.5	5.5-6
Depth of caudal peduncle	7.7-7.5	8	8.2-9
Dorsal rays	9-10	8	8-9
Anal rays	12-14	14	13-14
Habitat (drainage)	Atlantic	Pacific	Pacific

"easy pickins" that predators upon fishes have. A typical inhabitant of this area would be the catfish, *Hoplosternum thoracatum*, a fish that because of its ability to breath atmospheric oxygen, adapts well to these harsh conditions. Farther on, there is a change in elevation, resulting in cataracts, drops, and deeper pools. The pools continue, mostly in the potholes mentioned previously, accommodating the sparse fish fauna in relative comfort. *Rivulus chucunaque* was found mostly above the falls although some specimens were found below, presumably swept over accidentally. Due to the presence of larger fishes in the *Hoplosternum* area that consume the *Rivulus*, none were found deep into this lower level.

As a concluding thought, it is interesting to note that, of the three native groups located in the area, only the most advanced of them, i.e., the Cuna Indians, have a word to describe cyprinodonts in general. They refer to such fishes as AV-OO (phonetic pronunciation). Some of the natives have rather queer ideas about the local fishes insisting, for example, that cichlids are the young of marine fishes and that when they return to the sea, they become "dangerously large"!

REFERENCES

Breder, C. M., Jr., "New Loricariate, characin and poeciliid fishes from the Rio Chucunaque, Panama", AMERICAN MUSEUM NOVITATES. No. 180, 1925.

"The fishes in the Rio Chucunaque drainage, Eastern Panama", BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY, Vol. LVII, Art. III, Pgs. 91-176, 1927.

Hildebrand, S., "New Catalogue of the Freshwater Fishes of Panama", ZOOLOGICAL SERIES, FIELD MUSEUM OF NATURAL HISTORY, Vol. XXII, No. 4, 1938.

Hildebrand, S. and S. E. Meek, "The Fishes of the Fresh Waters of Panama", ZOOLOGICAL SERIES, FIELD MUSEUM OF NATURAL HISTORY, Vol. X, No. 15, 1916.

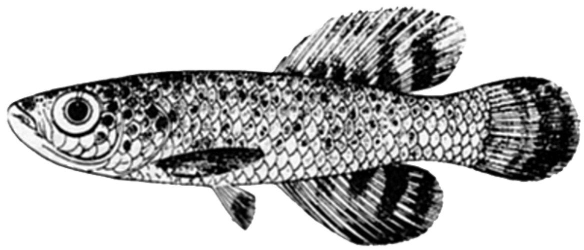
Hoedeman, J. J., "Preliminary key to the species and subspecies of the genus *Rivulus*", BULLETIN OF AQUATIC BIOLOGY, Vol. 2, No. 18, Pgs. 65-81, 1961.

Thirty-Eight Years with *Nothobranchius orthonotus* in Aquaria

[The Aquarium, February 1964. Note: This article was co-authored with James E. Thomerson, AJK being the Senior Author.]

The first *Nothobranchius* known to science, although not the first one to be kept by aquarists, was *Nothobranchius orthonotus.* In 1844, the pioneer colonist and African specialist, W. C. H. Peters, named a new fish, i.e., *"Cyprinodon orthonotus."* Twenty-four years later, in 1868, Peters decided that *orthonotus* was improperly placed in *Cyprinodon* and devised a new genus, *Nothobranchius.* However, neither science nor the aquarium world (be the latter as it may in those days) took much notice of this new generic notation at the time. The great British ichthyologist, Boulenger, had lumped *Nothobranchius* (and a good many other genera, as well) under the name *Fundulus,* and this was the generic term most frequently used.

In 1924, Dr. George S. Myers proposed a subdivision of *Aphyosemion,* a genus he had just erected, into three subgenera: *Aphyosemion, Fundulopanchax* and *Adinops* (Dr. Myers subsequently made another, somewhat different subdivision that more or less stands even to this day but that is another story). He distinguished *Adinops* from the other subgenera by its chubby form and rounded fins (the word *Adinops* was taken from Adinia, an American genus of killifish and literally means, "resembling *Adinia").* One of the difficulties Dr. Myers had at the time was that the available preserved specimens were in rather poor condition (Peters type for *orthonotus,* for example, had badly damaged jaws). The name *Adinops* then, was used by hobbyists and ichthyologists (even to the extent of using it as a strictly generic name) during the 1920's and 1930's Aquarists using very old reference texts should be prepared to encounter the name frequently.



Nothobranchius mkuziensis **(after Fowler).**

In 1928, Dr. Ernst Ahl (German ichthyologist and pioneer aquarist) referred all of Dr. Myer's *Adinops* to *Nothobranchius.* In 1933 Dr. Myers, having obtained additional specimens, agreed. However, the classification picture of *Nothobranchius* species is confused even today and there appears to be no ready solution. The original authors of these fishes inadequately described their fishes, partly because they never expected other closely related species to be discovered. If, for example, only two fishes in a genus are known, say a red one and a blue one, it may be adequate at that time to describe them merely by saying, "This fish is red and that one is blue." But if six more "red" fishes are discovered subsequently, and five more "blue" ones, the aquarist can easily see that the original descriptions are next to worthless. As Dr. Stanley Weitzman points out, all of the type specimens (mostly residing now in European museums) need to be re-examined by an ichthyologist, and adequate drawings and descriptions made.

Unfortunately, this would only clear part of the fog from the *Nothobranchius* situation. The genus contains species that are closely related and in the light of our present knowledge, it is not known where species stop and subspecies or races begin. Some of the species are very variable and local forms abound. To treat these problems, more than just a trip to European museums must be made. Studies of populations of these fishes in nature must be made if we are to learn the answers to the many provoking problems concerning subspecies. To emphasize the shaky taxonomic foundations of these fishes, we quote (with permission) from Dr. Myers directly:

"Moreover, I would think a long time before I would recognize the genus *Aphyosemion* at all. It probably grades into *Nothobranchius so* gradually that the genera are not easily separable. But please note that I say 'probably'; we don't know yet."

That we bring up the subject at all stems from the fact that there are some aquarists who have serious doubts concerning a number of *Aphyosemion-Nothobranchius* species as to:

(1) which genus they belong or,
(2) whether or not a third, intermediate genus is needed.

A case in point would be *Aphyosemion walkeri.* One ichthyologist, for example, has even suggested recently placing this fish in a new subgenus of *Aphyosemion* to be called, *"Heminothobranchius."*

At the present, there are three groups of *Nothobranchius* species that are giving aquarists (and ichthyologists) headaches as far as forms and/or subspecies are concerned, viz., the *guentheri-palmquisti* group, the *rachovii-taeniopygus* group and the *orthonotus* group. Our concern here is presently with the last-named.

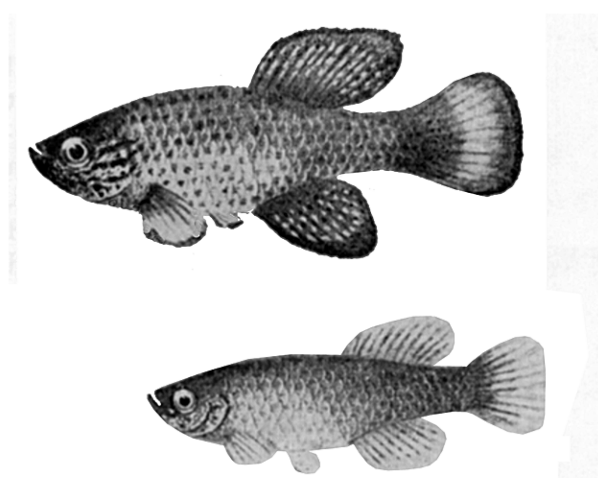
The history of *Nothobranchius orthonotus* has been an unusual one indeed. For many years, aquarists studying east African killies of this genus have been stymied by a multiplicity of forms without, however, reliable information as to their natural distribution or relationships. It is highly unusual but nevertheless true that aquarists have been more interested in these problems of late than have been ichthyologists. Consequently, the partial solution to what might be called the *"orthonotus* problem" must be credited in part at least, to serious killifish fanciers inasmuch as they have carried their enthusiasm over to ichthyologists and persuaded then to devote some time to what is admittedly, a very difficult business. To such ichthyologists, of course, the hobby owes much (examples of such men would be Drs. Myers, Greenwood, Miller, Weitzman, among many others). It is definitely an accommodation when an ichthyologist takes time off from his more important work to attempt to find solutions to aquarium problems that are not easily re solved.

Through the years, *Nothobranchius orthonotus* has appeared under many different names, Peters himself even providing an aberrant one in 1855 (i.e., "*Hydraegrya maculata").* In 1926, Dr. Ahl named a blue-green variety with wine-red spots, *"Fundulus kuhntae"* (see figure 1). In the same year, Dr. Myers described *"Adinops troemneri"* and in 1935, Dr. Ahl described a violet form as *"Nothobranchius mayeri"* (see figure 2). Recently, *"Nothobranchius melanospilus" is* the name by which most aquarists have known a red form of the species. All, however, are merely forms or subspecies of *Nothobranchius orthonotus.*

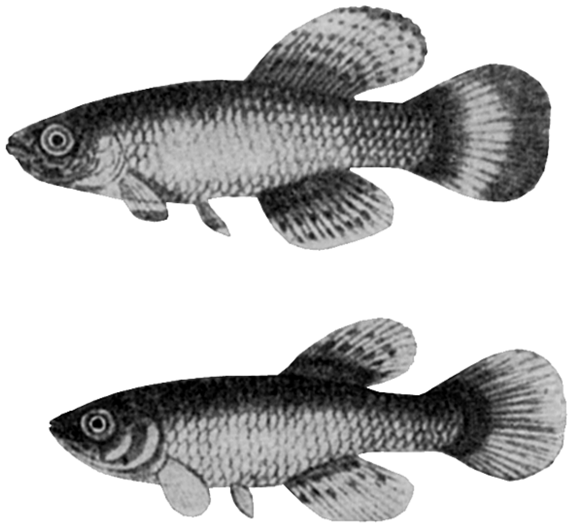
The distribution of *N. orthonotus is* shown in figure 3 (as it is known today). This map indicates the tremendous range of the species, from Kenya to the Congo, down through the Limpopo and Zambesi drainages to Natal (although due to mosquito control measures, this fish has been virtually eliminated from the southern portion of its range except for Swaziland and Krueger National Park.) Three basic types of *orthonotus* may be described (following a suggestion by Bruce Turner of New York City, a pioneer aquarist in the study of this species). Type I is the "typical" form, inhabiting the eastern portion of its range and featuring a bluish to bluish-green body and reddish fins. This fish in its lighter phases (basically light-blue) has been referred to directly in the aquarium literature as *N. orthonotus.*

The form with wine-red dots formerly was, as we have stated, known to German aquarists as "*N. kuhntae*." In addition, a violet form (also mentioned previously) is described in German handbooks as "*N. mayeri."* These wine-red and violet forms are not so widely distributed as to merit the assignation of type numbers at the present. In general, they suggest forms intermediate between Types I and III (Type III to be discussed shortly).

Type II is a golden form, those inhabiting the Congo area being of a bluish-gold body coloration (the ventral area especially, being golden). This type has carmine fins and a blue border on anal and dorsal fins … in addition, there are many red dots on the body, some forms having a black border on the tailfin also. However, those fishes found farther south are of a richer golden color. Specimens in the extreme southern portion of its range may even have the gold so dark that the body appears chocolate in coloration. The Limpopo forms are blue-green dorsally, golden ventrally with golden anal and dorsal fins, spotted with mauve. Very few Type II *orthonotus,* if any, have ever reached aquarists alive.



Nothobranchius kuhnate
(after Arnold & Ahl)



Nothobranchius mayeri
(after Arnold & Ahl)

Type III is a reddish form with a dark caudal band, inhabiting the northeastern portion of its range. It is the "*melanospilus*" of present-day aquarists and perhaps the "*Adinops troemneri"* of Dr. Myers. We cannot agree with those German authorities who have considered that *"kuhntae"* and "*troemneri"* were identical forms. At the time Dr. Myers described the letter, he had in his hands "*Adinops rachovii"* and also "another unpublished species of Dr. Ahl's, of which Mr. Rachow has also sent me a specimen." About *"troemneri,"* Dr. Myers continues: "It seems closest to *Adinops melanospilus,* known only by five females from the Seychelles in the British Museum. It differs, however, in the fewer anal rays, more numerous scales around the body, and probably in the coloration of the male." The "unpublished species of Dr. Ahl's was *"kuhntae"* and therefore, the conclusion is that Dr. Myers' "*troemneri"* was not *"kuhntae,*" but most likely close to Type III *orthonotus.*

When the authors first studied the distribution of these types, it appeared that as one traveled along the east coast of Africa from north to south, the basic body coloration of *orthonotus* changed from red to blue. Somewhere in the middle (actually south of Beira) there was even an intermediate form, violet in color (i.e., *"mayeri").* On the western side of its range, body coloration changed from blue-gold to gold, and then even to chocolate as one traveled from north to south. However, the recent discovery of Type I *orthonotus* in Kenya has invalidated this generalization as far as the east coast is concerned. The west coast generalization, however, seems to be valid enough at the present.

Naturally enough, such generalizations bring up the question of subspecies. A species is termed "polytypic" by scientists when it has more than one subspecies. A species is termed "polymorphic," on the other hand, when two or more forms (such as color forms) are found within the same brood. *Nothobranchius neumanni,* for example, is polymorphic since red and blue tailed forms are found within the same hatch. *Aphyosemion nigerianam* is another example of a polymorphic species. There is no doubt that *N. orthonotus is* polymorphic to some degree for at least some nuances (such as presence or absence of caudal edging) exist, but is it polytypic? The definition of a subspecies is "An aggregate of local populations of a species, inhabiting a geographic subdivision of the range of the species and differing taxonomically from other populations of the same species."

Certainly, there are some taxonomic differences among *orthonotus* forms. An example would be the tiny scales found on the *"mayeri"* form, vis-à-vis the large scales found on the typical, bluish-green form. A resolution of this question, however, awaits further research on the variability of the species. Geographic variation is present in almost all animal species, especially where their ranges are great. It seems likely that Types II and III would be bona fide candidates foe subspecies since they are separated by natural barriers, viz. the great lakes and also the high-lands. The apparent gradation of Type III into Type I and the recent reports of sympatry between them (sympatry is the occurring together of two animals) leaves that relationship unclear, however. Whether this is polymorphism or polytypism still remains to be seen. Most likely, additional study should demonstrate that at least two good subspecies exist within Type I *orthonotus.* Although we have not said anything about the island forms of *orthonotus* (the Seychelles and Zanzibar), it should be mentioned again that *N. melanospilus* was described from the Seychelles on the basis of only female specimens. It is probable that this is nothing more than a form of *orthonotus* and in view of its isolation, perhaps another candidate for subspecies. The reports of orthonotus-like fishes from Zanzibar, for example, indicate that some basis may exist for the recognition of a subspecies there, also. They are described as "like *rachovii"* in coloration. One should be warned, however, that it is too easy to run away with the subspecies concept, and competent ichthyologists may decide that very few subspecies can be justified.

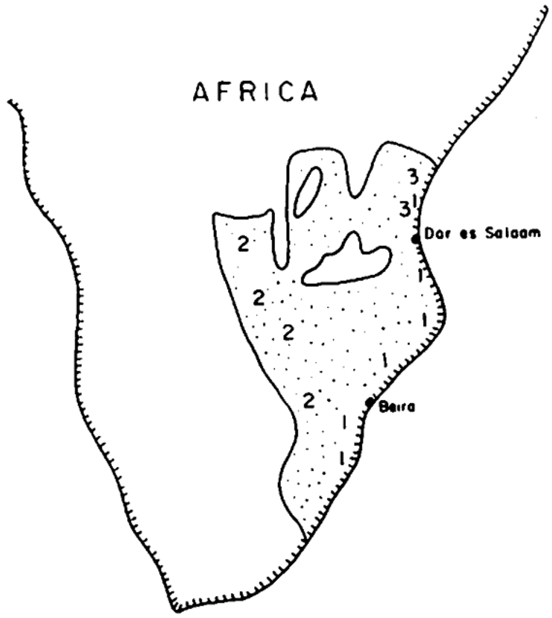
Before leaving the consideration of *orthonotus* forms, mention should be made of a *Nothobranchius* collected from Natal. In 1934, Henry Fowler described *"Fundulus mkuziensis,"* a fish collected by Mr. Bell-Marley from the Mkuzi River in Natal. This fish is definitely *a Nothobranchius* and has been occasionally thought to be another synonym for *orthonotus.* At the present, the authors cannot agree with this view. *Nothobranchius mkuziensis,* although agreeing closely in fin counts with *orthonotus* (but so also does *N. guentheri), is* a much smaller fish (i.e., about the same size as *guentheri).* Furthermore, its dorsal, anal, and caudal fin markings are unique among species of *Nothobranchius* known (see figure 4). We feel, therefore, that *mkuziensis* must be separated from *orthonotus,* at least in the light of our present knowledge.

Perhaps the best account of a typical *Nothobranchius orthonotus* environment has been given by E. Roloff of his investigations around the environs of Beira in Mozambique at the end of July 1958. About a mile from Beira, Roloff found his first *Nothobranchius, N. rachovii,* and an unidentified species later proven to be *orthonotus,* in a ditch by the side of a road. This by itself is extremely interesting as the Gause Principle (i.e., the Competitive Exclusion Principle) states that no two species can coexist at the same locality if they have identical ecological requirements.* Therefore, N. *rachovii* and *N. orthonotus* must, according to the principle, differ in behavior or habitat utilization in some hitherto unknown way. We do know, however, that they differ markedly in the time that their eggs take to develop. It would he helpful to be able to relate this fact to their ecological niches.

In any event, the end of July is the high point of the dry season in this area and so the depth of the water ranged from 12 to 20 inches (the length of this ditch at water level was between 7 and 12 feet). At other points in the ditch, the water was only an inch or so deep (almost completely dried). Roloff surmised that, by the middle of August, the ditch would have been completely dried. In the rainy season, the ditch would have filled to its complete height (some 28 inches) and a good portion of the surrounding territory would also be under water. One authority reported to Roloff that in some places, flooding is so severe that salt water gains entrance inland to some extent (Beira lies on the coast of Africa … see map) but it is not clear whether or not nothos are ever found in brackish water.

In general, Roloff found these ditches free of plant life with the exception of the borders that

*** The principle has never been proven although there is strong evidence to support it. In any event, the authors are in substantial agreement with this concept.**



Distribution of
***Nothobranchius orthonotus*.**

were overgrown with rushes and razor-sharp grasses. The roots of the former grew outwards in many places, to hang down into the water. The bottom was partly mud, partly a mixture of decaying plant life. Each attempt to catch specimens brought forth not only fish, but also thick clumps of mud and plant debris. Left over accidentally from the previous flooding were a few species of *Tilapia* and also *Barbus paludinosus.* Roloff made daily trips back to this ditch (from which the water was slowly evaporating) and during the end of his stay he frequently saw the beautifully colored male nothos lying on their sides on the mud.

The rainy season begins in Beira in November and since many water holes are already dry in June, at least some of the eggs of *N. rachovii* and *N. orthonotus* must have lain dormant for from 5 to 6 months in the mud. One must not get the impression that we are talking about a bone-dry environment, however. The area around Beira is marshy and then too, nightly water condensation from the air prevents complete aridity.

Roloff brought water and bottom samples from these ditches back to Germany with him. The bottom samples consisted of 90% of coarse, peat-like plant materials (roots, woody stems, seeds and pods) and the rest, quartz sand. In an aqueous solution, it tested almost neutral. However, the bottom sample was secured with a net of relatively large mesh size; thus, much of the finer material (mud, etc.) present in nature was not included in the sample.

The water analysis was as follows:

pH	**7.1**
Carbonate hardness	**6.1 DH**
permanate hardness	**2.2 DH**
Total hardness	**8.3 DH**
Chloride	**61 ppm**
Nitrate	**27 ppm**
Iron	**11 ppm**
Silicate	**11 ppm**
Potassium permanganate consumption (after filtration)	**58 ppm**
Residue after evaporation	**202 ppm**
General Appearance	**Clear, yellowish. After standing, amorphous brownish flecks settled to the bottom. No odor detected.**

Characteristically then, we have a medium-hard, neutral water. It must be remembered that this sample was taken during the dry season and the concentration of dissolved solids would be expected to be high. In Roloff's opinion, the hardness at the time of the rains would be 1 DH and even less. The high permanganate consumption indicates a considerable organic material content, and the surprisingly high iron content is a reflection of the iron-bearing red loam characteristic of the area. These analyses were performed by Dr. Geisler on the samples collected by Roloff.

Gerry Rowe (Tanganyika) has made numerous observations in the Dar-es-Salaam area (capital and main port of that country … see map) of many *Nothobranchius* species, including *orthonotus.* In this vicinity alone, he recognizes at least 10 differently colored forms (mostly *orthonotus), so* variable are these fishes! Apparently, Rowe found notho waters somewhat more turbid than did Roloff. In this case, the bottoms were covered with clay that also was suspended in the water. At times, it was difficult seeing the fish even in an inch or so of water. Fish life, other than nothos, was almost non-existent but water scorpions, tadpoles, and water boatmen were common. The latter were avidly eaten by the nothos. As far as plant life was concerned, it paralleled the Beira findings closely. Rowe caught large numbers of nothos in 1 or 2 inches of water that measured a temperature of 84° F. On the other hand, temperatures were more normal during the high water periods.

We may, therefore, summarize the N. *orthonotus* biotope as follows. These fishes live in small water holes that dry up periodically. Although the parent fish die, their eggs lay dormant but protected in the mud bottoms of their habitat until the rains come. As a result of living in such an environment, *Nothobranchius orthonotus* experience wide changes in temperature and water quality, brought about by the oncoming of the dry season with its concomitant evaporation processes. In addition, the fry grow rapidly and the adults live a short but merry life. This summary is admittedly superficial because we know that since more than one species of *Nothobranchius* are found together in the same water holes in nature, they must differ in some manner, no matter how minutely, from one another in the way they utilize or adapt to, their environment.

Although aquarists have described techniques for the reproduction of *N. orthonotus* in the aquarium before, it is still considered a “problem fish” by some. Therefore, a somewhat different but successful breeding method is described shortly. This method has been used successfully not only on this and other nothos, but on several species of *Cynolebias* and *Aphyosemion* as well. Before proceeding, however, we would like to express our appreciation to Bernard Halverson of Jackson, Alabama, who gave us our original breeders.

A large mixing bowl makes an ideal spawning tank for then the breeders are confined to a small space, and energy is not wasted in chasing. Also, due to its sloping, rounded sides, the only available spawning site is at the center of the bowl. A small plastic box (about 3 in. x 3 in. x 1. in. deep) containing about 1/4 inch of spawning medium should be placed in the center of the bowl. The best medium we have used is round-grain, quartz sand ordinarily used in fracturing oil wells (the things we aquarists use!). Water softening resins, small beads or a bottom mop may be substituted. Use slightly alkaline water of hardness 3 to 15 DH; the usually recommended “soft, acid, old water” is not necessary or even particularly desirable for this species. Such recommendations are usually made by “armchair authorities” who generally have a very parochial understanding of such fishes, or else none whatsoever. Ill-advised statements of “soft, acid water” fall into the category of “Old Wives Tales” so often encountered in our hobby.

Only one male should be used in each spawning group. With 2 to 5 females in a spawning group, continuous spawning is practical. Males are hard drivers and, if only one female is available, the pair should be separated on alternate days. Eggs should be collected each night in the following manner: the box of sand is removed and stirred with a dowel or glass rod to separate the lighter eggs from the heavier sand.

Water and eggs are then carefully poured off through a net or fine strainer. This process should be repeated several times to collect all of the eggs.

As suggested by Robert O. Criger of the American Killifish Association for *Aphyosemion coeruleum,* the eggs of *orthonotus* should not be placed in peat immediately, but rather should be transferred from the net to a small container of aquarium water. A drop or two of acriflavine solution may be added as a fungus preventative. The eggs are allowed to wet-incubate in water, in darkness, for about 30 days, and then are transferred to peat. The duration of water incubation is not too critical, and 10 or 12 days' collections may be handled as a unit.

As little peat as possible should be used; otherwise, eggs will be hard to find later on. The peat should be about as dry as fresh pipe tobacco. The drier the peat (to a point), the faster the eggs will develop. Dry incubation temperatures should be in the neighborhood of 70° F. Incubation durations of from 35 days to 6 months have been observed. It is misleading to say that annual eggs will hatch after any fixed minimum dry incubation period, as a very slight change in dryness, temperature or other factors can halve or double the necessary incubation time.

The eggs are ready to hatch when the embryo is fully formed. The best sign of this in *N. orthonotus is* a full development of the copper-colored iris of the eye. A hand lens or magnifying glass is an invaluable aid but *N. orthonotus* embryos are large enough that, with the aid of a strong light, this feature may be seen by the naked eye.

The eggs should be hatched in either fresh rainwater or distilled water with a depth of less than 1/2 inch and temperature not above 75° F. Under these conditions, the eggs hatch out rapidly and few belly-sliders occur. Any eggs with well-developed embryos that are slow to hatch may be helped along by the addition of microworms or infusoria. Eggs that are not ready to hatch may be re-dried but should not have been wetted in the first place. This method of handling eggs has several advantages: (1) The eggs are allowed to develop and hatch in a more natural manner, (2) there is little or no contamination of eggs by uneaten food or feces, (3) eggs are easily detected and removed, (4) eggs are easily counted and (5), eggs are not hatched until ready.

As soon as a few of the eggs hatch, brine shrimp nauplii should be introduced as first food. As soon as most of the eggs have hatched, aquarium water may be added a little at a time. When fry are a week old, they should be living in fairly hard aquarium water. This species is particularly greedy and needs to be fed often and well. Live foods are not necessary but are desirable, particularly for fry and spawning fish. Either frozen, scraped liver, or frozen brine shrimp will serve as a staple food.

Growth is very rapid and spawning can actually start at about 3 weeks. Males and females should be separated as soon as possible to permit faster growth. Sixty days is a good age to start spawning as most of the early rapid growth is complete and females are large enough to produce worthwhile numbers of eggs per day.

This completes our long, hard look at *Nothobranchius orthonotus,* a fish that has been with aquarists off and on for 38 years. Most assuredly, these 38 years have taught the aquarium fraternity much about this fish but it should be clear now that there is still very much to be learned.

Notatus-Olivaceus – A Pair of Aquatic Stripes

[The Aquarium, March 1964. Note: This article was co-authored with Dorothy Blackburn, AJK being the Senior Author.]

In studying members of the genus *Fundulus*, one frequently encounters species pairs, e.g., *confluentus-pulvereus*, *catenatus-stellifer*, *zebrinus-kansae*, *heteroclitus-grandis,* and *similis-majalis*. Species pairs are pairs that are very close or similar. If the pairs are good species but difficult to tell apart, then ichthyologists term them "sibling species." Often it happens that species pairs turn out to be of the same species and consequently, nothing but subspecies to one another. The two fishes we shall describe in this article are also species pairs, i. e., notatus-olivaceus. Whether they are sibling species or merely subspecies, however, is subject to a great deal of debate at the moment. Not being ichthyologists, the authors will take the position that they are separate and distinct, but will caution that future additions to our knowledge may necessitate an entirely different view. As a matter of fact, our good friend James Thomerson of Tulane University is currently investigating the *notatus-olivaceus* problem as a part of his doctoral dissertation in ichthyology. His findings will no doubt aid considerably in settling the matter once and for all, but we will not he surprised should they indicate that these two "species" are one and the same.

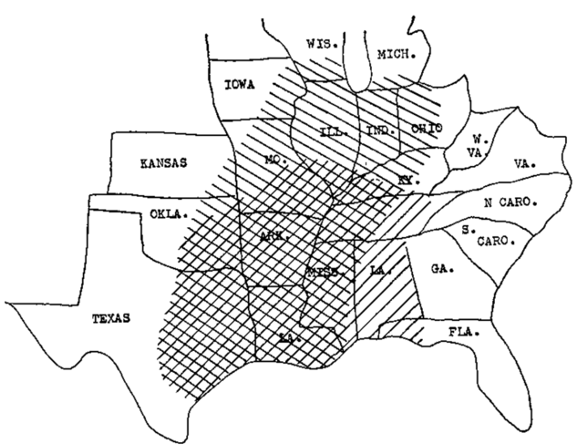


FIGURE 1:
DISTRIBUTION OF *FUNDULUS NOTATUS* AND *FUNDULUS OLIVACEUS*
Code: Diagonal to the right - *Fundulus olivaceus*. Diagonal to the left – *Fundulus notatus*. Cross hatched area - Region of overlay of both species.

Both fishes are fairly old acquaintances to the world of science for Rafinesque described *"Semotilus notatus"* in 1820, and Storer described *"Poecilia olivacea"* in 1845. For a time, these species were placed in the now-abandoned genus, *Zygonectes,* a genus that was then differentiated from *Fundulus* by the more backward position and smaller size of its dorsal fin, smaller than the anal fin. However, this was insufficient justification for a separate genus and *Zygonectes* joins the ranks of dead and forgotten fish genera. Fortunately for aquarists, the scientific names of both species are easily pronounced:

notatus (NO-**TAY'**-TUS)
olivaceus (OL-LA-**VAY'**-SEE-US)

The names mean "marked" and "olive colored," respectively. *Fundulus* means "bottom fish" and was originally applied to certain species of cyprinids, the habits of which kept them near the bottom and made the name more appropriate than it is today. The earliest mention of this name is by Albertus Magnus in 1478 who applied *"Fundulus"* to a minnow. Figulus, in 1540, attached the name *"Fundulus"* to a weatherfish or loach! It was Lacepede in 1803 who first made it the name of a genus and who transferred it from the minnows to the killifishes to include killies of the surface as well as of the bottom. The popular names of *olivaceus* and *notatus* are "black spotted topminnow" and "black stripe topminnow" respectively, which kind of solves the nomenclatural problem very nicely indeed! One of these fishes has been known to German

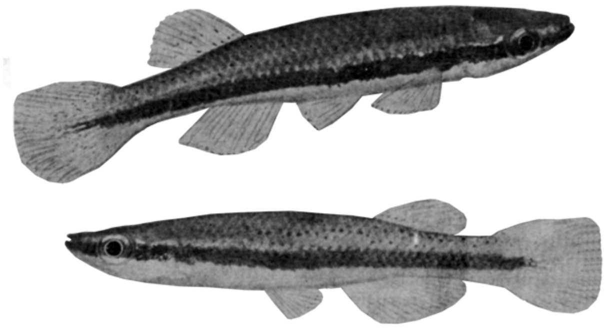


FIGURE 2: *Fundulus olivaceus*, male above, female below. Photograph by Albert J. Klee

aquarists since 1911, although due to the confusion between them, it is really not possible to state with any reliability which one it is. German aquarists have always considered both names as synonymous anyway (preferring *notatus).*

The range of *Fundulus olivaceus* extends from the Chattahoochee and Choctawatchee River systems of Alabama and Florida, and the Clinch River system of Tennessee, to Texas and the Arkansas and Red River systems of eastern Oklahoma, and north to Morgan County, Missouri, Union County, Illinois, and western Kentucky and Tennessee. As for *Fundulus notatus,* its range extends from Mitchell and Grundy Counties of northeastern Iowa, southeastern Wisconsin, southern Michigan, and the prairie regions of western and central Ohio, south to Kentucky, the Duck River of Tennessee, the Gulf drainages from Tombigbee River drainage of Alabama to the Guadalupe River drainage of Texas, and west to Kay, Creek and Johnston Counties of eastern Oklahoma. We supply these locations here in order that aquarists living in these areas might be encouraged to catch their own killies. Figure 1, however, provides a general, overall picture of the distributions of both species. It should be noticed that there is considerable overlap (southwest especially) and since we are dealing with sibling species, aquarists may experience difficulty in identifying their specimens if caught in an overlap area. This problem will be dealt with shortly.

In general, *F. notatus is* known only from fresh waters where it characteristically lives at the surface along lake and stream margins. *F. olivaceus* typically is a surface-inhabiting fresh water fish also but it is known to penetrate brackish water and salt water. The authors have personally caught this species in waters of 288 to 320 ppm salt content (along with *F. pulvereus).*

Both fishes are slender, elongated animals with long, pointed heads. Their distinguishing feature is a broad, dark band running from the tip of the snout into the base of the caudal fin. There are, at times, faint and narrow crossbars on the body, also. About the head there are suggestions of green and in the tail, hints of blue. On the head itself there is a spot which shines in reflected light. The belly area is whitish, the dorsal area olive-brown. There are many fine spots not only on the head, but on the vertical fins as well. Females are similar to males except that they have, in general, a narrower caudal peduncle, fewer spots, shorter fins and (in *notatus),* a less intense lateral band. Although it is difficult to describe sexual differences (and they vary depending upon the region of origin), sexing poses few problems to those aquarists who have dealt with the sex-

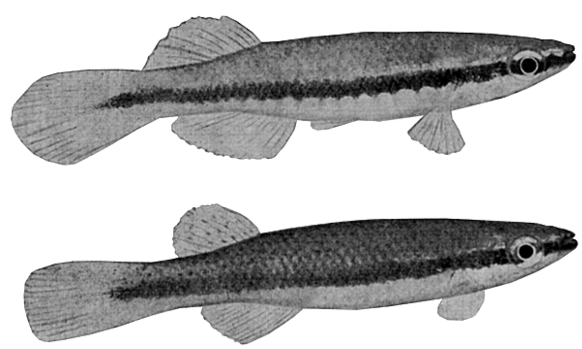


FIGURE 3: Above: *Fundulus notatus*. Below: *Fundulus olivaceus*. Photographs by Albert J. Klee

ing of barbs, rasboras, characins, and other fishes in which sexual dimorphism is not particularly obvious. The males have more elongate anal and dorsal fins and in general possess a more brilliant pigmentation as we have already mentioned. In size, males and females are about the same size except that when filled with eggs, females are more rotund. To the uninitiated, however, it is admitted that sexing is not overly easy.

Although the photographs tell more than the proverbial "1000 words" about pattern, shape, and sexual differences (see figures 2 and 3), there still remains the fundamental problem of distinguishing between the two species. Obviously, if one knows the origin of his fishes and if the area in question is one in which these species do not occur together, then there is no problem. However, should the case be otherwise, then the aquarist must resort of Table I. If the aquarist examines all of the characters in Table I, he should be able to come to a correct conclusion. Furthermore, where the range of *F. notatus* overlaps with *F. olivaceus,* the two are ecologically separated, *Fundulus olivaceus* typically being a quiet water form. However, as we approach the coastal plain, this species inhabits swifter waters.

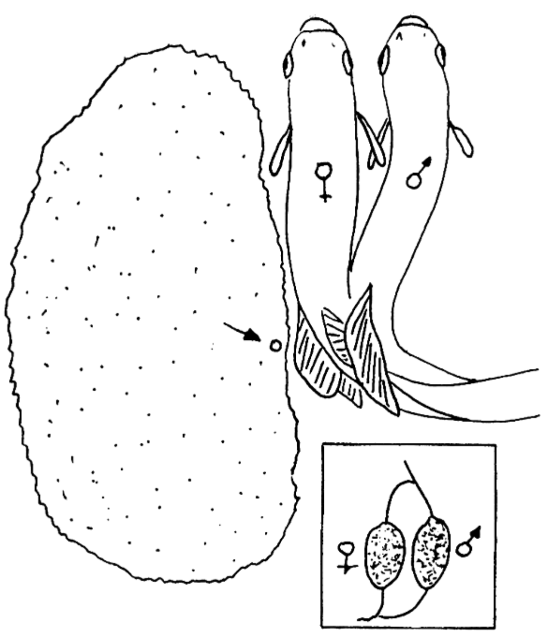


FIGURE 4:
Spawning act of *Fundulus notatus*. The arrow indicates an egg expelled against the spawning substrate. Diagrammatic inset is a cross section to show the position of the dorsal and anal fins. **(After Carranza and Winn)**

This brings us to a more detailed description of selected localities. Although the authors have studied other localities, two will be described only. The first locality is a fresh water irrigation canal off Hildebrant Bayou in southeastern Texas. This canal is surrounded by rice acreage and oil fields (sort of like having money and being able to eat it too!). The terrain here is flat with trees edging the main body of water, mostly willow with a sprinkling of hackberry, holly, oak, gum, fir, cypress, hickory, black walnut, cottonwood and sycamore. Of course, various vines and assorted undergrowth is much in evidence also. The *Fundulus olivaceus* living here were not easily captured, the best procedure being to seine or else to collect fry from a waterhole cut off from the main stream. Although one may become adept with the hand net, this killie doesn't wait around for a second chance if missed on the first try. It promptly makes a long ripple in the water and off it goes. The waters it inhabits (lateral canals having their origin at Hildebrandt Bayou) is rather slow moving, with a mud bottom. Also found in this same locality are perch, *Fundulus chrysotus,* mosquito fish, *Notropis lutrensis,* and small, green grass-pike. There are streamers of vegetation upon which the *olivaceus* lay their eggs and this is where the fry are to be found. They dart out from the vegetation a distance of several feet, stop, and curl their tails. The last-named is a particularly distinguishing feature.

The second location investigated by the authors is one for *Fundulus notatus, viz.,* Tiger

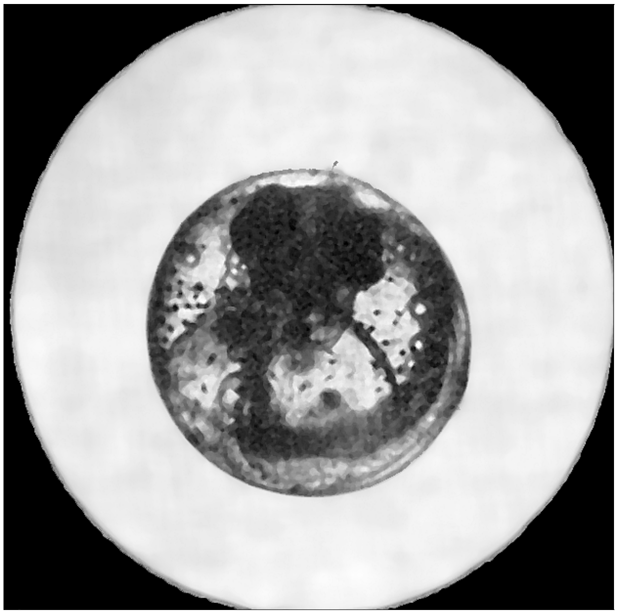


FIGURE 5:
Egg of *Fundulus olivaceus*.
Photograph by Albert J. Klee

Creek, off the Angelina River in northeastern Texas. The country here consists of rolling, sandy hills covered with longleaf pine and offering many clear, fast-moving streams. These creeks have sand or gravel bottoms and feature, in addition to *Fundulus notatus,* darters, pirate perch, catfish, shiners, and bass.

In the aquarium, both species are peaceful and although slightly shy when newly captured, they soon overcome this. The usual "pecking order" exists but territoriality is not particularly strong in these fishes. A tank full of them is a very pleasant sight indeed. They are not only hardy, but take all sorts of foods both dry and frozen (and, of course, live as well). A little vegetable matter is thought by the authors to keep them in the best of health. Although they are most often to be found at the surface of the tank, they can be found at all levels at one time or another.

Both species have been spawned by us in aquaria of from 3 to 15 gallons. As a matter of fact, several spawning pairs can be maintained in 10 to 15 gallon tanks with no hint of ripped fins or other mayhem. Under such conditions, territoriality is asserted, the dominant male selecting the mate of his choice. The smaller male merely swims away without offering any fight but perhaps to spawn at the other end of the aquarium with another female. It sometimes occurs that two males may attempt to spawn with a single female, with one male on each side of her, or even with both males on the same side!

What little courtship there is commences with the male following below and behind the female although he may move ahead at times or even a distance away to return a moment or two later. When the female slows down or stops, the male moves beneath her, his head moving up and down slowly. There is no head butting by the male whatsoever. The male is stimulated to spawn with the female when the latter moves against some object.

The spawning substrate used was the ordinary nylon mop, the eggs being deposited from top to bottom. When the pair is in spawning position, the dorsal and anal fins of the male are bent over the corresponding fins of the female (see figure 4). The dorsal fin of the female may be folded towards or away from her partner. In addition, both fishes assume the familiar S-shape. The fin folding procedure produces a "spawning chamber," insuring fertilization of the eggs. A flip and the egg (the eggs are laid singly) is thrown deep into the nylon.

The eggs average 1.8 mm in diameter and sport a few sticky threads. One peculiar characteristic of the egg is the presence of tiny black spots all over the egg membrane (see figure 5). The eggs, by the way, are often eaten by the parents. The fry hatch in from 10 to 14 days and are able to take newly hatched brine shrimp after the yolk sac is absorbed. No difficulty is experienced in raising the fry and we conclude that, from the start to finish, both species are beginner's fishes. Most important, there is an excellent opportunity to get out in the fresh air and catch your own specimens. We figure that this counts for a great deal in this age of spectator activities!

TABLE I: A COMPARISON OF BOTH SPECIES		
CHARACTERISTIC	**OLIVACEUS**	**NOTATUS**
1. Spots on sides of back	Conspicuous, discrete, blacker on a darker background.	Inconspicuous, diffuse, lighter and browner on a darker background.
2. Crossbars on males	Less prominent, fewer.	More prominent, more numerous.
3. Lateral band on females	More intensely black, more even-edged.	Less intense, less even-edged (serrated)
4. Dorsal and anal fins in adult males	Shorter, more rounded; usually not reaching past origin of caudal; shorter base.	Larger, more pointed; reaching to or past origin of caudal; longer base.
5. Dorsal and anal fins in adult females	Longer when depressed, longer base.	Shorter when depressed, shorter base.
6. Predorsal stripe (i.e., a stripe on the back just before the dorsal fin)	Weak and diffuse in young; absent in adults.	Rather strong, though often broken in young; remnants usually retained in adults.
7. Black pigment above base of anal fin of young	Well, developed; area broad, more solidly black.	Less developed; area narrower, less solidly Black.
8. Caudal peduncle depth in males	Slimmer.	Deeper.
9. General body form	Averages less deep; head and body less wide.	Averages deeper; head and body wider.
10. Snout, side view	More pointed.	More rounded.

Genetics of The Guppy

[The Aquarium, April 1964]

INTRODUCTION

It is surprising, perhaps, to learn that the genetics of the guppy are quite different from those of other aquarium fishes. Primarily, the guppy is unique in the degree of the frequency of sex-linked and sex-limited genes associated with its genetic history and in view of the vast amount of interest nowadays in breeding fancy guppies, it is of interest to review the genetic mechanisms that may be encountered in such programs. It is also apparent that few guppy breeders fully understand these mechanisms or appreciate how they may be applied to their final objectives. Since such objectives are set on a personal basis, this article will summarize in the shortest space possible, the mechanisms only, leaving the reader to tailor his breeding programs in the light of these mechanisms as they may be applicable. As for the reader, it should be emphasized once again that the hobby can advance only if proper records are kept, for it is a hard fact that the results of selective breeding are of value to other aquarists only when sufficient documentation is available to permit independent duplication of individual successes. It might also be suggested that readers review the excellent series of articles on fish genetics written by Dr. Myron Gordon for aquarists, as an introduction to the following summary. Otherwise, it is assumed that the reader can recall some of the basic principles of high school biology. The writer is in considerable sympathy with those aquarists who wish that the subject were simpler but in the final analysis, we must yield to the innate complexity of Nature herself.

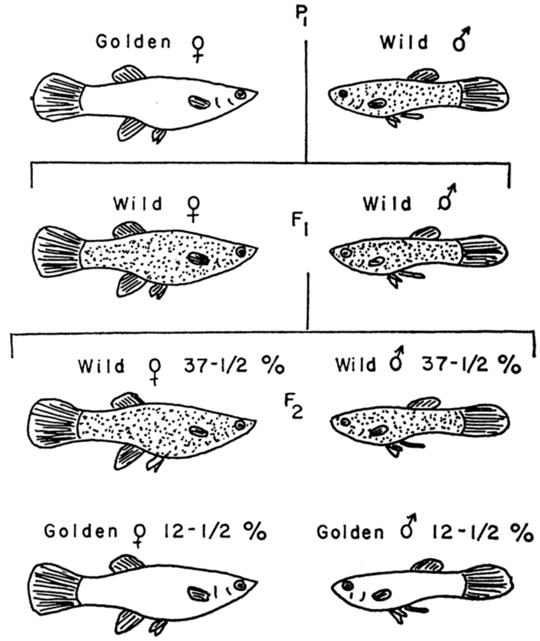


FIGURE 1:
SIMPLE MENDELIAN INHERITANCE

SIMPLE MENDELIAN INHERITANCE

Simple Mendelian inheritance is, in its turn, a reflection of simple probability laws. By such inheritance we mean that the parent transmits to the offspring a random one of its two genes. This is nicely demonstrated by a consideration of a recessive mutant trait of the guppy known as golden. Such a condition is one in which there is approximately a 50% reduction of the melanophores characteristic of wild popula-

TABLE I

	Females	Males	Females	Males
Generation	Genetic makeup	Appearance	Genetic Makeup	Appearance
P_1	GG	Golden	WW	Gray
F_1	GW	Gray	GW	Gray
F_2	GG GW GW WW	Golden Gray Gray gray	GG GW GW WW	Golden Gray Gray Gray

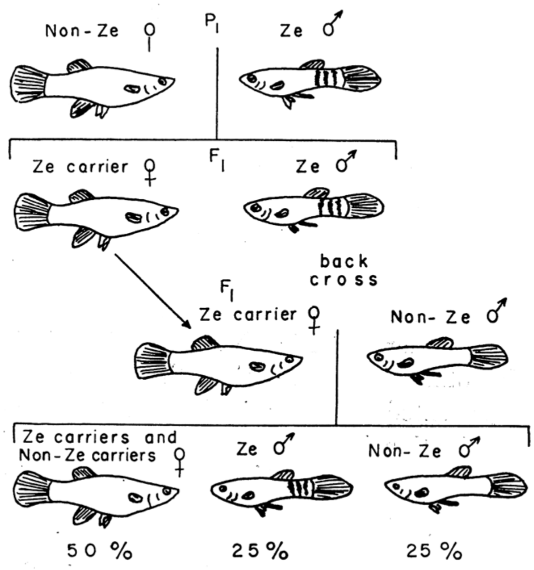


FIGURE 2:
SEX-LIMITED INHERITANCE

tions. In short, this loss of black pigment cells (i.e., melanophores) makes visible the underlying yellow pigment cells (i.e. xanthophores) present in the skin of all guppies, resulting in the production of a distinctively bronze general body coloration with conspicuous black reticulation (further reduction of black pigment results in blond and cream guppies, characterized by a light, unmarked yellow-silver to yellow coloration ... these also, are recessive to the natural wild or gray state). The application of Mendelian theory is shown in Figure 1. The expected 3:1 wild to golden ratio is observed in the F_2 generation, the mechanism being summarized in Table I (G=golden, W=wild or gray). Golden, blond and cream (and also albino) are what scientists call autosomally-linked recessive mutations. An autosome is any chromosome other than a sex chromosome Therefore, inheritance of these factors is not linked to sex and the mutations affect the body color of both sexes equally. We shall refer frequently to the term, "auto some."

SEMI-LETHAL GENES

If we now consider a seemingly almost identical case, however, the results are quite different. Suppose we mate an albino guppy with a wild one. Albinoism in the guppy is, like golden, a recessive mutant trait. Surely the F_2 results must be identical, i.e., a 3:1, wild to albino ratio? We find, however, a 53:1, wild to albino ratio! The explanation is simple. Albinoism is a semi lethal mutation that has associated with it, a high mortality of the fry prior to birth. Actually, golden is also a semi-lethal gene and the actual F_2 ratio is mud greater than the 3:1 given in the previous section.

SEX-LIMITED INHERITANCE

Another interesting type of inheritance it the guppy is the simple Mendelian sex-limited type. The pattern of 2 to 5 bars on the rear portion of the body of males is known as the *zebrinus* (Ze) pattern. This pattern (a dominant one, carried or an autosome) is only visible on males al though females may carry the gene for it; therefore, only males show the pattern although both sexes may be *zebrinus* carriers. Now let us attempt a "back cross,' i.e., we mate a P_1 non-zebrinus male with an F_1 zebrinus carrier female (figure 2) The mechanism of this back cross is shown in Table II (Ze = *zebrinus*, + =non-*zebrinus*, recessive gene).

Thus, the *zebrinus* pattern may seem to appear from "out of nowhere" because of this sex-limited inheritance.

TABLE II				
	Females	Males		
Generation	Genetic makeup	Appearance	Genetic makeup	Appearance
P_1 vs. F_1 back cross	Ze +	Non-*zebrinus*	++	Non-*zebrinus*
Offspring	Ze + ++	Non-*zebrinus* Non-*zebrinus*	Ze + ++	Non-*zebrinus*

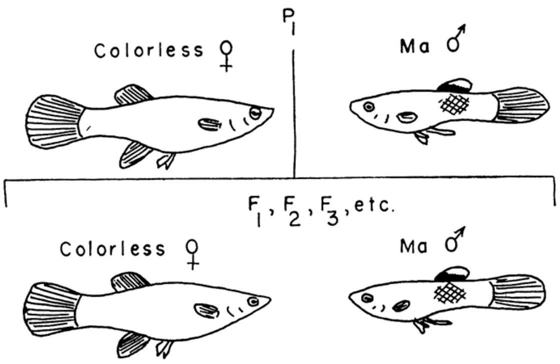


**FIGURE 3:
SEX-LINKED INHERITANCE**

SEX-LINKED INHERITANCE

We arrive now at a consideration of sex chromosomes in the guppy. In mammals, the female is homogametic (XX) and the male, heterogametic (XY). In birds it is the other way around! Both systems are represented, however, in fishes but sex determination in the guppy appears to be of the XX female, XY male type (as in mammals).

It has long been known that a dominant color trait in guppies, a black spot in the dorsal fin plus a red body spot (known as *maculatus* and represented by Ma), is inherited only from father to son. As it turns out, the maculatus gene is ordinarily carried only on the Y chromosome and thus we have sex-linked inheritance (see figure 3). The mechanism is summarized in Table III (Ma = *maculatus*, + = a non-*maculatus*, recessive gene). Therefore, such a gene, if present, can never be "hidden" as in the case of merely sex-limited genes.

CRISS-CROSS INHERITANCE

"Criss-cross" inheritance occurs when a gene is transmitted from a father exclusively to his daughters, or from a mother to her sons. However, in the guppy, criss-cross inheritance may appear to be non-existent because females are not capable of expressing the color or pattern characteristic of its genetical makeup. In the lutius (Lu) form (a yellow form ... note that scientists have given names to a number of color and pattern forms among which are armatus, pauper and coccineus-vitellinus, but there are many others) of the guppy the father transmits this gene only to his daughters (and the mother, only to her sons) and thus represents true criss-cross inheritance (see figure 4). Such daughters do not show the lutius pattern, however, unless they are masculinized by hormones (this is why figure 4 does not show females in the Fl generation to be lutius). The mechanism is as follows (+ = a non-lutius, recessive gene):

The use of methyl testosterone, a standard technique among fancy guppy breeders, brings out the color in lutius females.

CROSSOVER

Crossing over of the sex chromosomes has been observed in the guppy. For example, although the maculatus gene is ordinarily linked only to the Y chromosome, it may on rare occasion, cross over to the X chromosome (actually, only a portion of the maculatus pattern is subject to cross-over ... that part involving the dorsal pigmentation only and not the

TABLE III

	Females	Males	Females	Males
Generation	**Genetic makeup**	**Appearance**	**Genetic makeup**	**Appearance**
P_1	**(X) + (X) +**	**colorless**	**(X) + (Y) Ma**	***maculatus***
F_1	**(X) + (X) +**	**colorless**	**(X) + (Y) Ma**	***maculatus***
F_2, F_2, F_2, etc.	**(X) + (X) +**	**colorless**	**(X) + (Y) Ma**	***maculatus***

TABLE IV				
	Females	Males		
Generation	Genetic makeup	Appearance	Genetic makeup	Appearance
P_1	(X) + (X) +	colorless	(X) Lu (Y) +	Non-*lutius*
F_1	(X) + (X) Lu	colorless	(X) + (Y) +	*lutius*
F_2	(X) + (X) + (X) + (X) Lu	Colorless colorless	(X) Lu (Y) + (X) + (Y) +	*lutius* Non-*lutius*

red body spot). Again, because this is sex-limited, the pattern will not be evident in such females unless they are masculinized. The mechanism is summarized in Table IV.

ALLELISM

An allele represents one of several alternate phases of a gene. Furthermore, instead of one gene having just two phases, one dominant and one recessive, the gene may have two or more expressions in its dominant phase. There is some evidence that patterns such as maculatus, pauper, and armatus are alleles. For example, when a female guppy carrying the coccineus-vitellinus (CoVi) pattern (linked to the X chromosome) is mated to a male carrying both the CoVi and Ma patterns, the expected CoVi and non-CoVi females plus CoVi-Ma and Ma males were obtained. However, an unexpected male Ar-CoVi was also obtained, unexpected because armatus was nowhere in the cross. The mechanism is shown in Table V (and see figure 5).

SEX REVERSAL

There is evidence for a dual sex-determining mechanism in guppies that, in brief, may be summarized as follows:

(a) Female and male sex-determining genes are probably distributed over many autosomes being concentrated, however, in the sex chromosomes.

(b) These superior sex genes in the sex chromosomes may, upon rare occasion, be overridden by those in the autosomes.

Thus, one may have XX male guppies and XY female ones. In other words, their genetic sex is opposite to their real sex. For example, when a male XX guppy carrying the Yt pattern (a bright yellow caudal fin) on both chromosomes was mated with a normal XX female, the progeny were (as to be expected) all females. They all, however, carried the Yt pattern (brought out after masculinization).

Such situations represent a precarious genetic balance, however, and the genetic pressure is such as to restore the normal state of affairs. The mechanism of a cross between two sex-reversed guppies is illustrated in Table VI (also see figure 6).

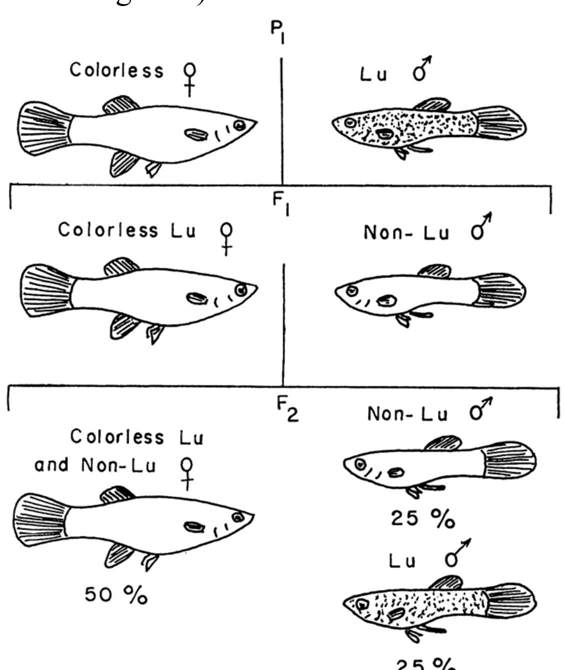


**FIGURE 4:
CRISSCROSS INHERITANCE**

TABLE V				
	Females	Males		
Generation	Genetic makeup	Appearance	Genetic makeup	Appearance
P_1	(X) + (X) +	colorless	(X) + (Y) Ma	maculatus
F_1 (expected)	(X) + (X) +	colorless	(X) + (Y) Ma	maculatus
But F_1 (crossover, rare)	(X) + (X) Ma	colorless	(X) + (Y) +	Non-maculatus

There is, therefore, a canceling-out of the influencing autosomal sex genes in both sexes, and the sex-determining mechanism is restored once again to the sex chromosomes.

CONCLUSION

Without a doubt, the fact that a large number of polymorphic color patterns normally behave genetically as though linked to the Y-chromosomes, is an unusual situation among vertebrates. One experiment involving 44 wild males and the subsequent analysis of 1,286 of their progeny indicated that linkage tends to predominate in the Y chromosome (see Table VIII).

Under normal circumstances, therefore, there may be good reason to concentrate on the males rather than on the females during a breeding program. To a considerable extent, perhaps, the importance of the female in line breeding programs (genetically speaking, that is) may have been overemphasized. This is not

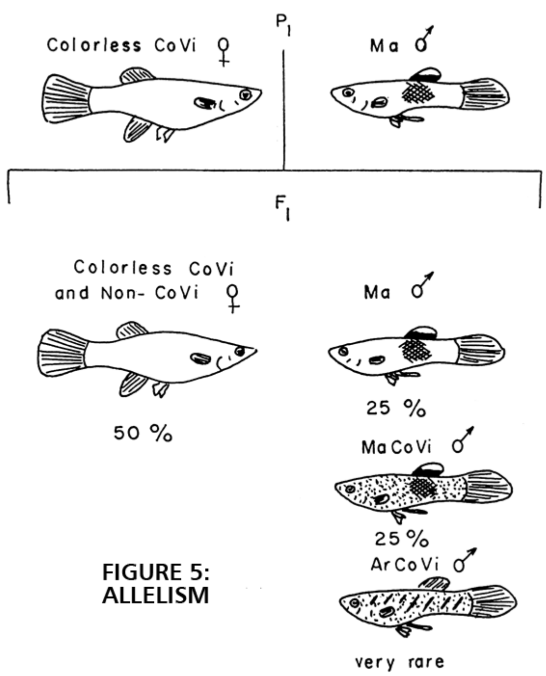


FIGURE 5:
ALLELISM

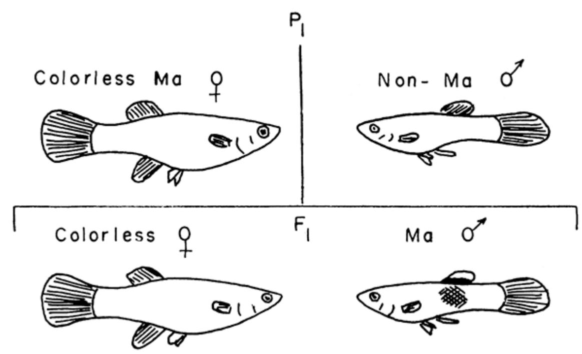


FIGURE 6:
SEX-REVERSAL INHERITANCE

TABLE VII				
	Females	Males		
Generation	Genetic makeup	Appearance	Genetic makeup	Appearance
P_1 (sex-reversed parents)	(X) + (X) Ma	colorless	(X) + (Y) +	*maculatus*
F_1 (reconstituted)	(X) + (X) +	colorless	(X) + (Y) Ma	Non-*maculatus*

TABLE VI				
	Females	Males	Females	Males
Generation	Genetic makeup	Appearance	Genetic makeup	Appearance
P_1	(X) + (X) CoVi	colorless	(X) + (Y) Ma	*maculatus*
F_1 (expected)	(X) + (X) CoVi (X) + (X) +	colorless colorless	(X) CoVi (Y) Ma (X) + (Y) Ma	*maculatus-coccineus* *vitellinus-maculatus*
But F_1 (crossover, rare)	Same as F_1 expected	same	(X) CoVi (Y) Ar	*armatus-coccineus-vitellinus*

to suggest, however, that the female be ignored entirely. As has been pointed out, certain colors and patterns are either autosomally (e.g., golden, albino, etc.), X-linked (coccineus-vitellinus) or both X and Y-linked (e.g., Sb, a blue saddle-like patch near the dorsal fin). Furthermore, it has also been demonstrated that the inheritance of spinal deformities is simple Mendelian in nature. The serious guppy specialist cannot afford to disregard those aspects of guppy genetics which are unusual because it is precisely the unusual that he forever seeks.

What's In A Name?

[The Aquarium, June 1964]

Nomenclature provides a vocabulary for writing and talking about fishes . . . per se, it has no other purpose although as a bonus, a good nomenclatural system sheds considerable light on the interrelationships among the animals involved. Without these "labels," however, the science of ichthyology and of zoology in general would become chaotic, and communication among scientists would grind to a halt. As aquarists, we are exposed both to scientific nomenclature and to popular names but it is only when we have become experienced in the hobby that we begin to appreciate the former. To the beginner, nomenclature is a bugaboo, something to be avoided at all costs and, if the opportunity presents itself, an object of ridicule ("Why the name is longer than the fish!"). Perhaps the strangeness of nomenclatural systems incubates a sort of mistrust ... whatever the reason, it is important that serious aquarists have a good general background in the subject.

TABLE VIII	
LINKAGE OF PATTERNS OBSERVED IN WILD MALES	
Exclusively Y-linked	233
Exclusively X-linked	29
In both X and Y	20
Autosomally-linked	30
Note: The majority of autosomally-linked patterns were simple spots or stripes involving only melanin.	

Perhaps the best starting point for a discussion of ichthyological nomenclature is the hierarchy. A hierarchy is a systematic framework for classification involving a sequence of classes. Every class except the lowest includes one or more subordinate classes. For example, the original Linnaean hierarchy looked like Series I of the following:

SERIES I	SERIES II
Empire	Kingdom
Kingdom	Phylum
Class	Class
Order	Order
Genus	Family
Species	Genus
	Species

Series II is the present-day hierarchy considered to contain the least number of elements that can be used to classify any animal. The "Empire" of Linnaeus' has been abandoned and two new levels, Phylum and Family, have been added. The names, Kingdom, Phylum, Class, etc., are categories in this hierarchy but the names of specific elements in any category are called "taxa" (singular is "taxon"). Thus, for example, Polypteriformes an order), Cyprinodontidae (a family), *Aplocheilus* (a genus) and *Poecilia reticulata* (a species), are all taxa.

The ichthyologist is not limited to these seven levels, however. Additional levels may be obtained by using the prefix, super, ad, sub, e.g., superfamily and subfamily. Proposals have been made to add to these seven basic levels but nothing has been agreed upon officially. In ichthyology, however, the category of "Tribe" is frequently used between Family and Genus. To see how a particular fish fits into the hierarchy, consider the following relationships involving the common aquarium fish, the guppy:

ORDER Cyprinodontiformes
FAMILY Poeciliidae
SUBFAMILY Poeciliinae
TRIBE Poeciliini
GENUS Poecilia
SUBGENUS *Lebistes*
SPECIES *Poecilia reticulata*

It should be noted that by convention or by decree of the International Code of Zoological Nomenclature, some of the names of taxa have standardized endings:

Superfamilies: -oidea
Families: -idae
Subfamilies: -inae
Tribes: -ini

Aristotle appears to have been the first one to use category or rank names o discuss all natural groups of about the same status. Linnaeus (1707-1778), however, was the first one to consistently use a binomial system of nomenclature and our modern system of animal nomenclature begins with the publication of his 10th edition of *Systema Naturae* (1758). In this system, every animal species is designated by two words. As we have seen in our example, the first word is the genus in which the animal is placed while the second, called the "trivial" or "specific" name, is a particular name applied to that species. The generic term is always capitalized but the trivial term is not. Also, it is customary to italicize (or put into bold type) the complete species name in print.

The name of the person who first described the species follows the specific name immediately, although this is omitted in discussion. If the species has been transferred to another genus (or if the genus has been altered for any reason), this name appears in parenthesis. Thus, for example, we have *Betta splendens* Regan, and *Colisa lalia* (Hamilton), the last name being in parenthesis because Hamilton had originally placed the fish in the genus *Trichogaster*.

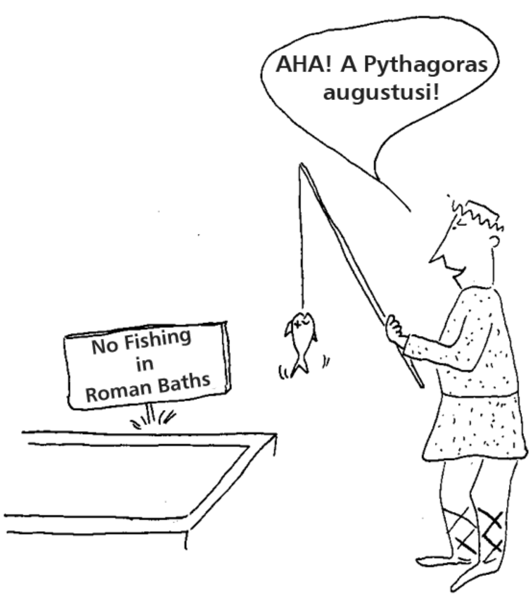
In general, aquarists are not concerned with ranks higher than that of Order. Aside from such unusual fishes such as the lungfish and a few others, all of our aquarium fishes are in the same Class anyway. Although knowing the Order in which a fish belongs tells the aquarist something, it is only when we reach the level of Family that such names take on much significance.

The family, Poeciliidae, for example, tells the aquarist that the fishes in question are expected to be livebearers. The further down we go, the more specific our information becomes. To know that a fish is in he genus *Nothobranchius*, for instance, tells us that the fish is an "annual" with egg-hatching times of some several months. How much the aquarist will be able to guess about some new or unknown fish will depend upon his broad knowl-

"The family, Poeciliidae, for example, tells us to expect livebearers…"

edge of the characteristics of the various groups of fishes and his ability to place fishes into these groupings.

The scientific names of fishes are derived, in the main, from Latin or Greek words. It has been my experience that a scientific name is a limp, lifeless thing if no interest is taken in the meaning of the name itself. I have always considered handbooks dealing with aquarium fishes to be deficient and incomplete when either the meanings of the scientific names used or their pronunciations have been omitted. Do we gain anything by ascertaining the meanings of scientific names? On the whole, this question can safely be answered, "Yes!" It is of



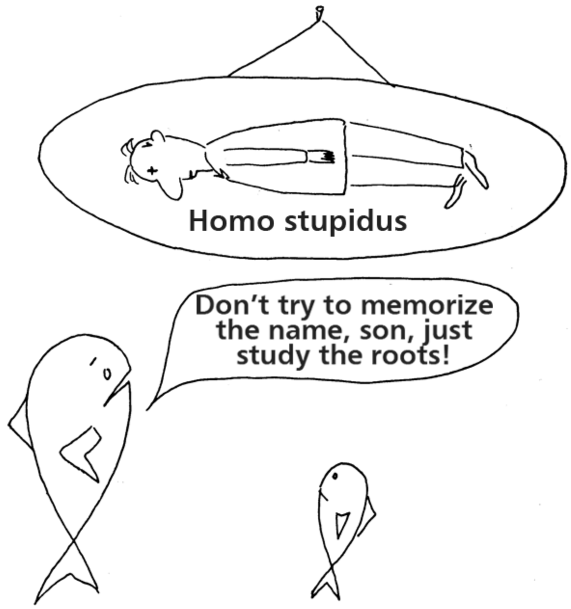
"The scientific names of fishes are derived, in the main, from Latin or Greek words…"

some value to an aquarist to know, for example, that "*atracaudatus*" means "blackish tail," or that "*longiventralis*" means "elongated ventral fins." Aquarists are frequently concerned with identification and it is comforting to know that if a fish is named "punctatus," one should expect spots and not stripes, and if a fish is named "fasciata," one should expect stripes and not spots. However, occasionally we are fooled; *Barbus viviparous*, for example, is not a livebearer!

A better question would be, "Do we gain anything by memorizing the meaning of scientific names?" This question can be answered firmly in the negative. If we rely on rote memory for our insights into these names, for instance, we learn nothing about "*microlepis*" if we only know that "*oligolepis*" means "with large scales." On the other hand, if we know that "*lepis*" means "scale," then a logical extension will automatically give us the meaning of "*microlepis*." Many Greek and Latin roots are used over and over again in ichthyology.

Here are some common examples:

cauda—tail
cephalo—head
cincta—to gird
fascia—band
macula—spot
melano—black
ocellatus—little eye or ocellus
ophthalmus—eye
pinna—feather
pulchra—beautiful
punctata—dotted
reticulata—network s
oma—body
stigma—mark
stoma—mouth
taenia—band
undulata—wavy
vittata—striped
xena—strange



"Many Greek and Latin roots are used over and over again..."

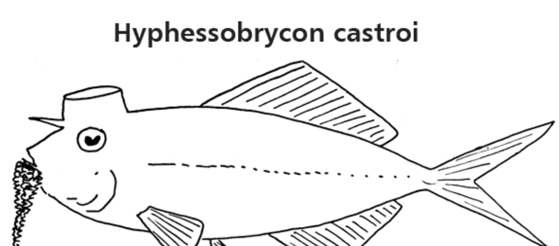
Thus, by knowing that "fascia" means "band," we have an excellent insight into the following fish names: *fasciatus, nigrofasciatus, octofasciatum, fasciolatum, sexfasciatus, multifasciatus, bifasciatus, caudofasciatus, unifasciata, trifasciatus*, and *semifasciolatus*. The aquarist can and should expand upon the list of terms given previously, as he is exposed more and more to the scientific names of fishes.

It frequently occurs that a fish is named after a person, living or dead. Most often, these proper names are used in the specific or trivial name although they are sometimes used as the basis for a generic name. For example, the pearl gourami is scientifically known as *Trichogaster leeri*, being named after J.M. van Leer, a Dutch doctor. As an example of the second type, the glass knifefish (one of them, that is!) is known as *Eigenmannia virescens*, the genus being named after Dr. Carl Eigenmann, the famous American ichthyologist.

You perhaps will have noted that most often the trivial part of fish names based upon a proper name ends in -i. In general, one merely adds -i to the person's name. A common exception, however, occurs when the name ends in -a (feminine). In these cases, -e is added to the name, e.g., as in the cichlid, *Aequidens mariae*. These two endings cover 99% of the cases involving proper trivial names. There is another point about proper names used in the trivial part of a fish's name that deserves comment. It used to be the custom that, if the name ended in a consonant with the exception of -r, a double -i (-ii) was used as an ending, e.g., *smithii, decorsii, antonii*, etc. In recent years there has been a growing tendency to ignore the distinction between -i and -ii endings and to use the former as a matter of course. This is truer in zoology than in botany. It must be remembered, however, that if a name originally ended in double -i, this ending must be retained for all time.

As a side comment, it is interesting to note that capitalization of the trivial name based upon a proper name is still common in botany (e.g., *Cryptocoryne Beckettii*) although the trend is strongly against it. Zoologists have abandoned the practice altogether. Note also that botanists cling to the double -i ending. Finally, it should be noted that Christian and surnames are sometimes run together into a single word, e. g., *Hyphessobrycon haraldschultzi* (after Harald Schultz, the South American explorer.)

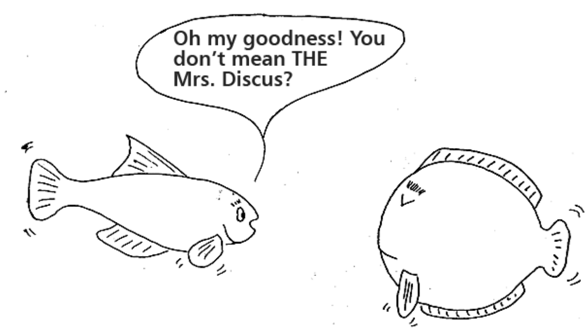
As a matter of grammar the names of genera are treated as singular, all other taxa being treated as plural. Thus we say,



"It frequently occurs that a fish is named after a person..."

"*Hyphessobrycon* is a genus of …" not "*Hyphessobrycon* are a genus of …" On the other hand we say, "The Characidae are related to…" but not, "The Characidae is related to ..." for we are talking, about many fishes using a plural designation. Of course, if we are talking about the category of a taxon, the sentence should go, "The family, Characidae, is related to ...". Here, the noun is "family" and is, of course, singular. The following error is frequently heard; "The *Nothobranchius rachovii* is pretty fish," or, "The *Scatophagus argus* is a brackish water inhabitant." The name of a fish is a collective noun; aquarists should drop the definite article "the," e.g., "*Nothobranchius rachovii* is a pretty fish," etc. Incidentally, note that we must retain the double -i ending on this fish name as it was originally described with that ending.

Occasionally one will find a name in parenthesis after the generic term, e.g., *Xiphophorus (Platypoecilus) maculatus*, or *Xiphophorus* (= *Platypoecilus*) *maculatus*. These two examples are not equivalent, however. The first conveys the information that the fish is a member of the subgenus, *Platypoecilus*, while the second tells that the fish at one time was placed incorrectly into the genus *Platypoecilus*. The equals sign makes the difference. Recently, the subgenus has taken on an increased significance in the case of certain fishes, livebearers, and killies in particular. The subgenus may impart certain information concerning the behavior or breeding of a fish, e.g., in *Aphyosemion (Aphyosemion) australe*, the subgenus tells us to expect fishes that lay their eggs on plants rather than in the bottom layer of the aquarium. If a genus contains subgenera, the name of one of the subgenera must be the same as the genus itself, as it was in our example.

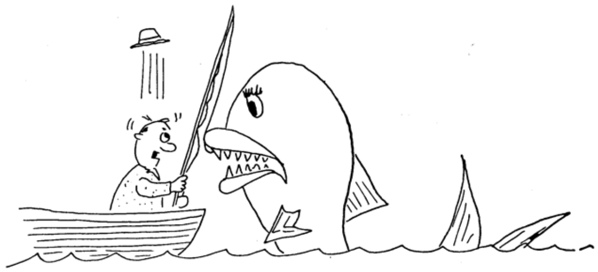


"The following error is frequently heard…"

Some ichthyologists do not like to use the subgeneric classification, preferring instead to arrange fishes within a genus informally, i.e., in complexes or in groups. These have no official nomenclatural status but are useful in discussion or for other special purposes.

From time to time, aquarists may notice that slight changes have been made in the endings of fish names, e.g., *Aphyosemion calabaricus* to *Aphyosemion calabaricum*. This is in accordance with a rule that requires the specific name to be in agreement in gender, number, and case with the generic term. Greek names ending in -on and -oma are usually neuter and take the neuter ending -um (-us usually, but not always, being masculine). There is also the matter of declension, always a tricky business, which further complicates the endings of scientific names. It is almost impossible for an aquarist to understand the endings of scientific names without a great deal of personal research, much of it being beyond the scope of this article. In any event, there are many errors of this sort still to be corrected in ichthyology.

The only category below the species that is officially provided for in the Rules is the subspecies (and incidentally, the plural and singular of species is still species!). The subspecific term follows the trivial term and the same rules hold for both (capitalization, italization, etc.). Similar to the situation in subgenera, one of the subspecific names must be identical with that of the trivial name (e.g., *Aplocheilus lineatus lineatus*).

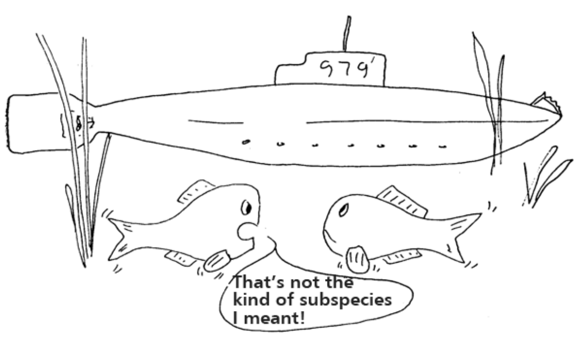


"There are many errors of this sort to be corrected in ichthyology..."

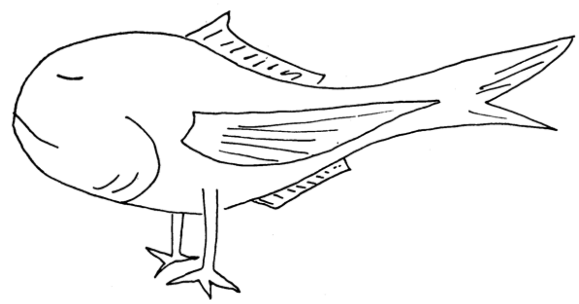
Varieties are not the same things as subspecies. The latter denotes a race that is usually dependent upon geography or ecology. The former are merely specimens that differ from the normal, i.e., aquarists develop varieties while nature develops subspecies. In an old Belgium aquarium magazine I once saw an article dealing with, "*Trichogaster trichopterus cosbyi*, ssp. n." (the "ssp. n." denoting a new subspecies). This was quite erroneous. The opaline gourami (cosby gourami) is an aquarium-bred variant but it definitely has no status as a new subspecies. Another nomenclatural misuse was the Dutch naming of the black discus as *Symphysodon aequifasciata* var. *melanogaster*. The term, variety, has no official standing and indeed, complicates an already complicated species. Ichthyologists would be kept hopping if they were required to name all varieties of a single species developed by aquarists (considered the guppy alone!). The use of subspecific names actually converts the Linnaean system into a trinomial system and if we consider the subgenus, it may even convert it into a quadrinomial system!

A basic rule in zoological nomenclature is that of priority although it is not a hard-and-fast rule by any means. This rule states that the rightful name of a fish is the first name that was published validly in connection with it after January 1, 1758. When the same name has been mistakenly used for two or more forms, it is called a homonyn. For example, at one time it was thought that *Barbus* was used generically for the name of a bird. Since this usage predated its use in ichthyology, the term could not correctly be applied to any fish. Fortunately, it turned out that the name was never used validly as part of the scientific name of any bird (it was used popularly, however) and *Barbus* is still a valid name for a fish.

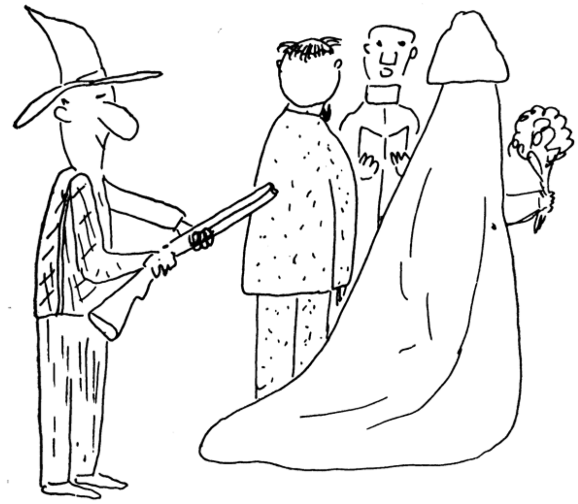
When different names have been published for the same form, they are called synonyms. Thus, *Rivulus poeyi* is a synonym for *Rivulus urophthalmus*. The correct name is the latter as it was first published in 1866 as against 1876 for the former. Although revisions of genera or other groups are responsible for many name changes, the rule of priority takes its share also. Name changes usually are cause for bitter complaint by aquarists. No sooner does he learn the scientific name for a fish, than it is



"The only category below the species ... is the subspecies..."



"At one time, it was thought that *Barbus* was used ... for the name of a bird..."



"Name changes usually are cause for bitter complaints by aquarists..."

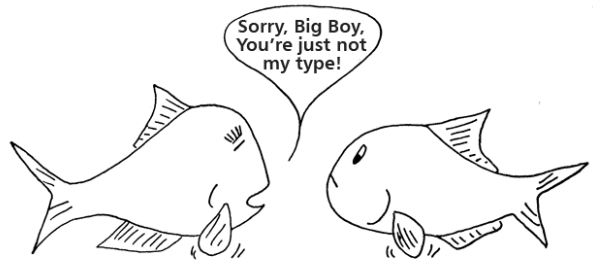
changed (or so it seems!). This was the case with the tiger barb, *Barbus tetrazona*. Formerly it was known as "*Barbus sumatranus*" and frequently, it is still known as "sumatranus" today.

One would think that the law of priority would tend to stabilize fish names but in truth, it has contributed to some instability in its own right. From time to time, some old name is resurrected from the depths to replace a name that has wide acceptance among scientists (and aquarists as well). There is never any real guarantee that any name we use is correct since who can say that some older name will not be discovered in the future? A further complication is that many years ago, descriptions of fishes were not as precise as they are now. It is sometimes difficult to recognize exactly what fishes were being described in old texts. In order to get around this, the International Commission on Zoological Nomenclature is empowered to suspend the rules and designate so-called *nomina conservanda*, names in current use and selected as official regardless of priority. The procedure is slow, however, and many zoologists still take violent exception to violating the principle of priority.

The zoological contents of taxa are not fixed for all time and consequently, may be changed upon occasion. As a result, it is sometimes difficult to determine whether a taxon now in use is really the same one to which a name originally applied. Zoologists have partially met this problem by the designation of types. The type for a species, for example, is an individual fish and the rule is that the name goes along with the species in which the type is placed.

The trouble occurs when the types for two different names are placed in the same species. Priority (or lists of *nomina conservanda*) then enters the picture. The type for a genus is a species; other than Family, higher classifications have no types and the names of these classifications are decided by consensus. As far as aquarists are concerned, two types are of interest; the type (known as the "holotype") as discussed here and the "paratype." Paratypes are merely additional specimens used to define a species.

Since the Rules are relatively new, it sometimes is discovered that an ichthyologist had neglected to name a type species for the genus. There are a number of rules to cover this situation, one of them being that if a genus contains among its original species one possessing the generic name as its trivial name also, then it automatically becomes the type for the genus.



"The type for a species, for example, is an individual fish..."

This discussion does not cover all elements of nomenclature by any means. Furthermore, I have simplified many of the ideas already presented, and have omitted many numerous details. Nor does this article explore the philosophy and techniques of the classification of fishes. What defines a species is not a topic of nomenclature, but rather of taxonomy. All three terms ... nomenclature, classification, and taxonomy ... are related, however, and a discussion of nomenclature provides the vocabulary for the intelligent discussion of the others.

A Rebuttal To "Let's Illuminate With Gro-Lux"

[The Aquarium, September 1964]

Mr. Thomas E. Brown, in his article "Let's illuminate with Gro-Lux" in the July 1964 issue of THE AQUARIUM, states: "There is a great deal of confusion and controversy over the use of Sylvania's Gro-Lux lamps for the illumination of aquaria." In this I heartily concur but submit that Mr. Brown's article serves only to further this confusion. Quoting Mr. Brown again we read: "It is claimed that Gro-Lux is high in "harmful" and "lethal" ultraviolet radiation." He then proceeds to refer to my article "The lethal light" which appeared in the November 1963 ALL-PETS MAGAZINE (which article was reprinted in the January 1964 issue of the FISH CULTURIST and which also served as the basis for my friend Don Cook's article in the March-April 1964 issue of TROPICALS MAGAZINE, "A short history of aquarium lighting"). It hardly seems possible, but I can come to no other conclusion than Mr. Brown never read my article, for I challenge him to show where the words "infrared" or "ultraviolet" ever appeared in it.

What Mr. Brown apparently refers to as "ultraviolet" in my article was carefully defined as wavelengths between 4000 and 5000 angstroms, and as "infrared" was defined as wavelengths between 6000 and 7000 angstroms. Although I could refer to my own article for the pertinent ratios of effective energy, one can refer to Mr. Brown's Table I to see that Gro-Lux differs from warm-white significantly in the production of energy in both of these ranges (as it differs from other forms of fluorescent light, also). My own data show that in these ranges, Gro-Lux emits about 130% more effective energy than does warm-white (these are the main wave-lengths of consequence to the aquarist in the growth of plants and in the lethality of light to fish eggs).

Mr. Brown "pooh poohs" the "lethality" of Gro-Lux. In this, I again submit that this is an egregious error. My article dealt in detail with the effects of the 4000-5000 angstrom range on its lethality to fish eggs and lethal it most assuredly is. I cited not only the Cold Spring Harbour fish hatchery data but pointed out that the yellow coloration and/or melanic pigmentation of many fish eggs is a protective device of Nature's to filter out or to block this harmful "blue" 4000-5000 angstrom radiation. My experiences in the incubation of killifish eggs (all data from which undergoes rigorous statistical analysis), is by no means without value in this regard.

Several other remarks also lead me to believe that is was unfortunate that Mr. Frown's article was not documented by additional, adequate personal research. His remarks re: light penetration vis-à-vis suspended matter in the aquarium is ill advised. For some time now I have been conducting investigations into the use of ultraviolet radiation (defined broadly as radiation between 40 and 4000 angstroms, with maximum lethality towards bacteria in the vicinity of 2500 angstroms … radiations below 2000 angstroms tend to produce ozone in the water) for the sterilization of aquarium water and find that the percentage transmission of such light varies greatly in aquaria even under apparent "good filtration." I do not wish to be-labor this point now since an article is in press describing these experiments, the equipment used, and the data obtained.

The pertinent conclusions (for the complete discussion I refer the reader to my article on this subject) re: Gro-Lux are as follows:

1. For optimum plant growth, plants require radiation in both the 4000-5000 (blue) angstrom and 6000-7000 (red) angstrom ranges. At the present state of our knowledge, the red/blue ratio of effective energy should be approximately 1.8 to 1.9.

2. The ratio for warm-white is 1.85 and for Gro-Lux is 1.88; however, Gro-Lux emits 130% more effective energy in these bands than does warm-white. Thus, as far as radiation needed by plants is concerned, Gro-Lux is more "powerful" than warm-white.

3. The violet-to-blue bands are most destructive to fish eggs. Gro-Lux emits roughly 128% more effective energy in the 4000-5000 angstrom range than does warm-white, 60% more than white, 25% more than cool-white, and 3% more than daylight lamps (daylight lamps are also quite lethal to fish eggs).

This is not to be misconstrued as any personal difference of opinion between Mr. Brown and myself as I hold the highest regard for him. It reflects merely an honest difference of opinion that other aquarists may judge one way or the other.

REFERENCE

Klee, Albert J., "The lethal light," ALL PETS MAGAZINE, Nov. 1963 (also reprinted in the Fish Culturist, January 1964, pgs. 33-35).

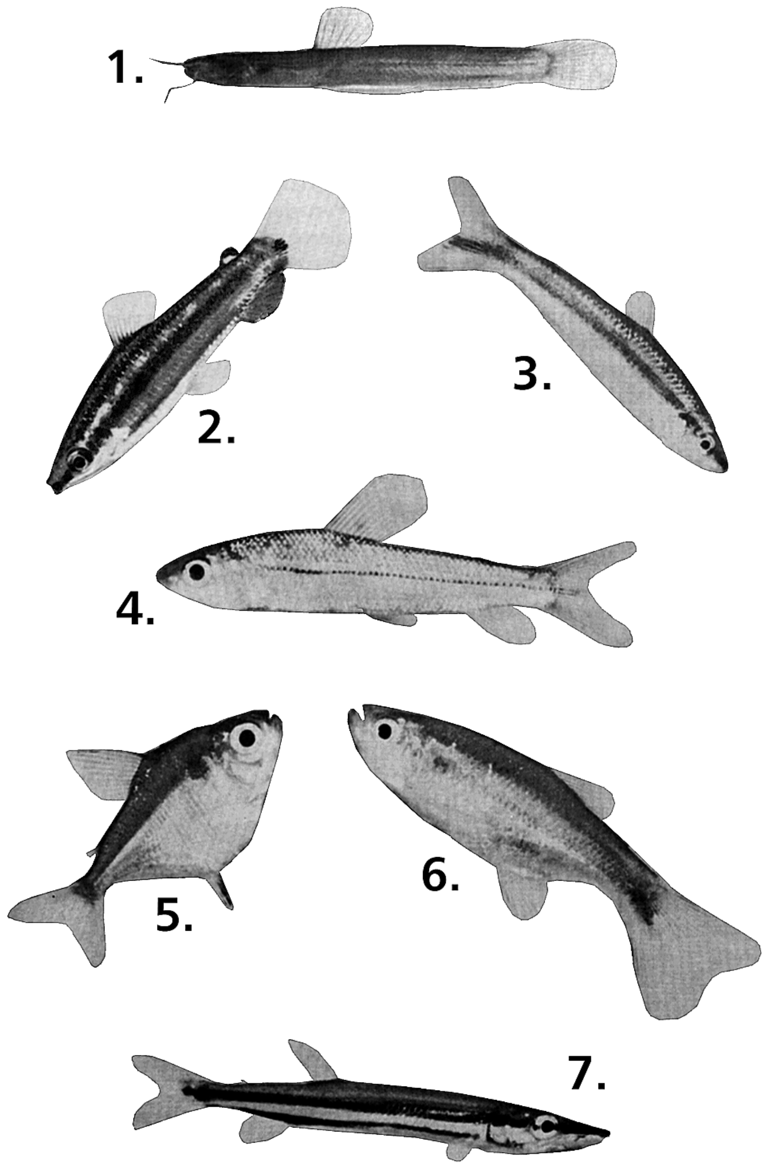
Some New Fishes From Central Peru

[The Aquarium, September 1964]

In May of 1964, Jon Krause of Columbus, Ohio (owner of Verco Tropical Fisheries in that city), brought back a planeload of aquarium fishes from the little-explored regions of central Peru. Jon is a pioneer in the collection of fishes from this area and the story of how it all came about is a fascinating one (but one which we shall defer to another time). It takes quite a bit of courage and skill to land a heavy, military-type aircraft needing at least 4,600 feet of runway, on a strip in the jungle measuring but 4,900 feet!

The catfishes brought back from this trip proved to be extremely interesting. As might be expected, a majority were loricariids of every size, shape, and form. The identification problems here are quite formidable, to say the least, and certainly, new species are represented. Perhaps the most intriguing was a member of the subfamily Tridentinae, one of the parasitic catfishes so characteristic of South America. Prior to this, I had seen a few specimens but this was the first time I had an opportunity to study one in an aquarium. I actually saw it making "attack-like" approaches to other aquarium fishes and it was interesting to see how fast other fishes would attempt to move away from this catfish. The potential victims would try to "shake" it off. Since this catfish is undergoing scientific examination by Dr. Stanley Weitzman of the Smithsonian Institution presently, no more will be said about it at this time. One catfish that should be mentioned, however, is a *Rhamdia* species (see figure 1). This very tiny, brownish catfish has a short but perky dorsal fin and an extremely long adipose fin. It is very active in the aquarium at times, moving incessantly from one end of the tank to the other. *Rhamdia* species are many but are seldom imported. They are related to the more familiar *Pimelodella* catfishes.

The number of characins in South America is impressive indeed. The following characins to be described have not yet been identified and indeed, even some of the generic designations



1. *Rhamdia* species
2. *Anostomus* species
3. *Apareidon* species
4. *Curimatopsis* species
5. *Hyphessobrycon* species
6. *Prionobrama* species
7. *Acestrorhynchus* species

Photographs by the author.

are doubtful. Perhaps the prettiest of all the fishes that Jon brought back is an unidentified *Anostomus* (see figure 2). This fish alternates black longitudinal lines with solid gold ones … the gold is deep and brilliant. In addition, both adipose and anal fins are deeply pigmented. The fish maintains a head-down position when at rest, typical of its close relatives. This fish should prove to be one of our more popular aquarium fishes in the single-specimen, show fish category.

A related fish is *Apareidon* (see figure 3 . . . we are not sure of this generic designation but the fish in question resembles the genus closely) but this is a bottom species. The dorsal surface is gold, followed by a thin black line. Below the latter is a broad gold band followed by a broad black band. The space between this last black band and the belly area is gold. As might be imagined, this is another striking fish.

The next characin, a *Curimatopsis* species (see figure 4), is a large-scaled fish. The dorsal surface and top of the sides gleam in a rich bronze-green, turning into a light gold area immediately above the thin, black longitudinal line. The belly area is a light gold. It is interesting to note the occurrence of gold in the three characins described. In all instances, it is not merely dulled bronze, but the pure color of the polished virgin metal itself. One of the fishes to whom I took an immediate liking is what appears to be a *Hyphessobrycon* species (see figure 5). The dorsum and upper sides are bronze-green, the lower sides being rose-colored. There are two faint vertical bars behind the head but the most striking characteristics are its blood red anal and ventral fins, plus a violet eye. Another striking characin appears to be a *Prionobrama* species (see figure 6) although here again, identification is doubtful (this is only a preliminary report). This is a large, handsome characin, basically colored a beautiful mother-of-pearl. There is a blue sheen on the middle of the body and a green spot behind the gill plate. The middle of the caudal fin is black but the outstanding thing is that both lobes of this fin are grayish-white. One ordinarily doesn't find this sort of pigmentation on characins … this is usually reserved for fishes such as killies.

Fortunately, there is no doubt as to the generic placement of our last characin. It is a member of a pike like group of characins known as *Acestrorhynchus* (see figure 7). This is really a sort of miniature barracuda with a mouth full of needle-like teeth. There are two black longitudinal lines, the space between them colored gold. The dorsum is brownish, the ventrum light brown. A black spot decorates the tail root and extends into the tail itself. A red spot is present in the upper lobe of this fin (as a matter of fact, the whole tail is suffused with pink). This fish is extremely predatory and will take only live foods. Old "needle beak" is an odd one though, and a diversion from the run of the mill characin.

In 1954, Henry W. Fowler of the Philadelphia Academy of Natural Sciences, estimated the number of species of fishes in South America as follows:

Brazil	1334
Peru	503
Paraguay	447
Columbia	397
Guianas	364
Venezuela	325
Bolivia	248
Ecuador	118
Argentina	110
Uruguay	105
Chile	23

These figures of course, need updating but the point is that next to Brazil, even this list shows Peru to be extremely promising as a source of fishes for aquarists. On the basis of drainage systems, the comparison is even better for while the Amazon system has 608 species (Mr. Fowler's 1954 figures) to its credit, the Peruvian Amazon has a close 505. We can, therefore, look forward to many new and interesting fishes for our tanks.

Non Sex-Linked Factors In The Body Coloration of The Guppy

[The Aquarium, October 1964]

The skin of an ordinary guppy (*Poecilia reticulata*) contains a number of different pigment cells, foremost among these in both sexes being melanophores (i.e., black pigment carriers) and xanthophores (i.e., yellow pigment carriers). For the breeding of specialized strains of guppies, it is desirable to learn something about the genetic characteristics of these pigment cells and the "how" and "why" that provides a better understanding of guppy line breeding in general. We will be concerned only with non sex-linked heredity pertaining to body color (thus we exclude "black" which is sex-linked).

There are a number of descriptive terms used by aquarists with regard to guppies, among them being "gold," "blond," "cream" and "albino." Basically, these terms are intimately linked to the number and form of melanin-containing pigment cells (melanophores). The scales of an ordinary guppy contain what are known as "dendritic" melanophores (see figure 1). These are branching, tree-like structures. The body of the guppy contains melanophores also but these are shaped far differently. Two kinds can be observed, viz., "corolla" melanophores, so named because of their flower-like structure, and "punctate" melanophores, named for their dot-like appearance. The former are large, the latter very much smaller (see figure 1).

Gold, blond, and cream guppies do not differ much in the nature of their dendritic melano-

TABLE I

		Hybrid male, Gg	
		G	g
Hybrid female, Gg	G	GG (gray)	Gg (gray)
	g	Gg (gray)	Gg (gold)

phores except that these melanophores are somewhat large in gold guppies.

The fundamental difference between a "wild" type guppy and a gold guppy is that in the latter, the number of melanophores near the surface of the skin is reduced approximately by one-half (with an attendant enlargement to some extent). There is some evidence also that leads us to believe that the gold guppy has a greater number of xanthophores than does the wild type. However, xanthophores are hard to count so that the quantitative data upon which this surmise is based is in some doubt. There is a gene for gold and it is autosomal (i.e., it is not on a sex chromosome). Furthermore, it is recessive to gray (the "wild" or ordinary color). We speak of alternate phases of a gene as `"alleles." Thus, if gray is allelic to gold and vice versa, what we mean is that there is a gene called "gold" and it exists in two phases; one, a dominant phase reflected by the fact that then the guppy is colored gray, and the other, a recessive phase reflected by the fact that then the guppy is gold-colored. Since the gold gene is autosomal, both males and females may carry it. The gold gene follows the very simple Mendelian laws that we have mentioned in the past, i.e., if we cross a pure gold strain with a pure gray strain, the offspring (F_1 generation) would all appear gray. Then, if we interbred the F_1 generation, the F_2 generation would be gray to gold in the ratio 3:1. This is illustrated by the device of the square shown in Table I (g=recessive gold phase G=dominant gray phase).

The gene for blond is very similar in that it is recessive to gray and is also carried on an autosome. Furthermore, it is carried on a different autosome than that of the gold guppy. The fundamental difference between gray and blond guppies is not in the number of melanophores but in their form. The body melanophores of both gray and gold guppies are corolla type while those of the blond guppy are punctate. Thus, the gold gene is a melanic suppressor while the blond gene is one that basically alters the form of the body melanophores. Blond, therefore, is not allelic to gold.

Since the genes for gold and blond are carried on different autosomes, both may occur simultaneously. If this occurs, then we obtain a cream guppy. Not only do cream guppies have a reduced number of melanophores, but also their body melanophores are of the punctate type. Thus, there is no such thing as a gene for cream; it is the result of the simultaneous occurrence of gold and blond. Cream guppies are very nonviable, the combination of gold and blond genes proving lethal to some degree. Blond and cream guppies are very similar in outward appearance, the former being more yellowish in general, however.

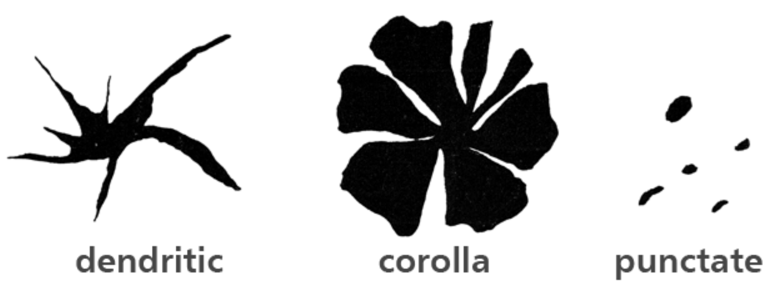


FIGURE 1: Melanophores of the Guppy

Another gene that suppresses melanin (and not only in the chromatophores but elsewhere as well) in the guppy is the gene for albino. Like blond and gold, this is recessive to gray and is carried on an autosome. Also, it is carried on an autosome different from that of either blond or gold. Consequently, a guppy may carry genes for all three, viz. gold, blond and albino. Albino is a highly lethal gene (regardless of statements I have seen recently in the aquarium literature). Among other things, the effect of the albino gene is to eliminate dendritic, corolla and punctate melanophores from the guppy. Consequently, although it has no genetic linkage with blond or gold (i.e., it is not allelic to them), it "overrides" both of these genes in effect except that the gold gene may provide a greater number of xanthophores than an albino guppy might ordinarily have.

Double genetic systems are very interesting. Suppose one mated a hybrid albino and hybrid gold guppy as shown in Table II (g = recessive gold phase, A = dominant gray phase). The following offspring would appear albino: Ggaa, GGaa, Ggaa; the following would appear golden: ggAA, ggAa and ggAa. This leaves ggaa and nine others, resulting in the familiar 9:3:3:1 ratio for simple Mendelian double systems. Actually, the ggaa would also appear albino since the gene for gold could not express itself except for an increased number of xanthophores. Very few, if any, would survive because of its inherent non-viability. To a lesser extent, this holds true for the other albino offspring also.

The gene for blue is likewise carried on a separate autosome but is not allelic to gray but rather to genes for yellow and red. We are talking now about the general blue body coloration, and not isolated areas of brilliant blue in various forms. The blue gene is a suppressor of yellow pigments (red also but these are generally carried on sex chromosomes and are outside the scope of this article). Thus, gray guppies appear blue and blond guppies appear white if the gene for blue is present. Suppose, for example, that we cross a blond guppy with a blue guppy. The F_1 generation would then all appear gray. If we inbreed this F_1 generation, the F_2 generation would appear gray-to-blue-to-blond-to-white in the ratio 9:3:3:1, in accordance with simple Mendelian laws of a double system (see Table III: r = recessive blue phase, R = dominant gray phase, b = recessive blond phase and B = dominant gray phase).

We may therefore summarize what we have learned as follows:

1. Ordinarily, both sexes of the guppy carry melanophores and xanthophores.
2. The common guppy has body melanophores of the corolla type.
3. The gene for gold is a recessive allele to gray, carried on an autosome. It manifests itself by an approximately 50% reduction in body (corolla) melanophores.

TABLE II

			Hybrid gold male (appears gray), GgAa			
			G		g	
			A	a	A	a
Hybrid albino female (appears gray), GgAa	G	A	GgAA	GgAa	ggAA	ggAa
		a	(gray)	(gray)	(gold)	(gold) g
	g	A	GgAa	Ggaa	ggAA	ggaa
		a	(gray)	(albino)	(gold)	(gold-albino)

TABLE III						
			Hybrid blond male (appears gray), BbRr			
			B		b	
			R	r	R	r
Hybrid blue female (appears gray), BbRr	B	R	BBRR (gray)	BBRr (gray)	BbRR (gray)	BbRr (gray)
		r	BBRr (gray)	BBrr (blue)	BbRr (gray)	Bbrr (blue)
	b	R	BbRR (gray	BbRr (gray)	BbRR (blond)	BbRr (blond)
		r	BbRr (gray)	Bbrr (blue)	BbRr (blond))	Bbrr (white)

4. The gene for blond is a recessive allele to gray, carried on an autosome. It manifests itself by a transformation of body melanophores from the corolla type to the punctate type.
5. There is no gene for cream; rather, it is the simultaneous occurrence of genes for gold and blond. The condition is somewhat lethal.
6. The gene for albino is a recessive allele to gray, carried on an autosome. It manifests itself by a complete suppression of melanophores (both skin and scales). It is decidedly lethal.
7. The gene for blue is a recessive allele to genes for yellow and red, carried on an autosome. It manifests itself by suppressing yellow and red pigments.

The Genetics of the Deltatail Guppy

[The Aquarium, November 1964]

One of the most popular tail shapes in the guppy (*Poecilia reticulata*) today is the triangle or delta type (referred to from now on simply as the "deltatail"). In combination with many beautiful colors, this form has been the major reason for the current popularity of the fancy guppy. Consequently, it is of interest to explore the factors that produce such tails and their interrelationships. In this article, the following codes are used for a number of genes:

(a) Co - The coccineus gene. This gene is normally attached to the X chromosome. Females with this gene have transparent tails (unpigmented); males have only the rear-most portion of their tails transparent with the base yellowish, and speckled with very fine black dots.

(b) Cp - This is an unnamed gene, the letters standing for "caudal pigment." In the female, it produces pigmented tail fins (also dorsal but we are concerned in this article only with the caudal fin of the guppy), resulting in grayish-to-blackish shades. In the male, it produces a tail that is colored dark-blue to black. It is normally attached to the X chromosome.

(c) Ch - A recessive gene which does not manifest itself directly, but which influences other genes for tail color in the male guppy. Female guppies carrying this gene are grayish in body coloration but have uncolored tails.

(d) Ds - The doublesword gene. This gene is attached to the Y chromosome. It manifests

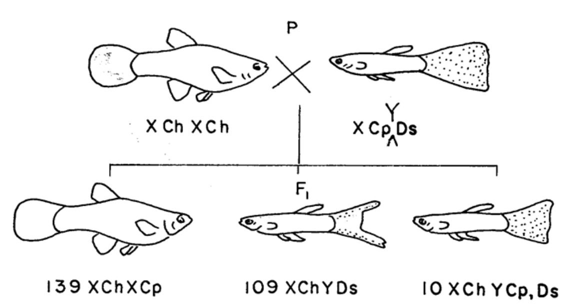


FIGURE 1: Experiment 1 schematic.

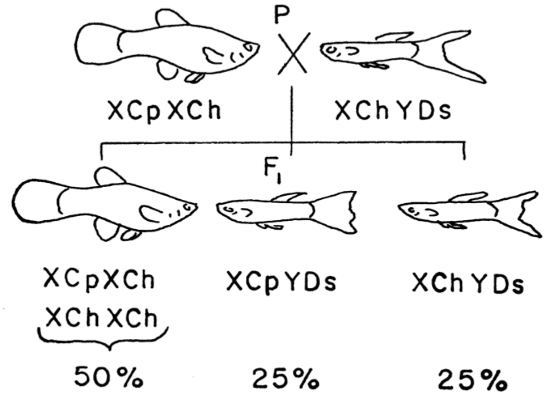


FIGURE 2: Experiment 4 schematic.

itself in an elongation of the upper and lower lobes of the caudal fin of the male.

As it will shortly be demonstrated, there is no such thing as a gene for a deltatail in the guppy. A deltatail is produced when the male carries the gene for doublesword in combination with a number of other genes, the most important being Cp. To simplify things, we postulate the deltatail male guppy as consisting genetically of XCp YDs.

The male guppy used in the following experiments was from a Paul Hahnel strain and, under our postulate, of the genetic makeup, XCp YDs. The female used was of the genetic makeup XCh XCh. Experiment No. 1 was to mate these two fishes. Since the Cp gene is displaced by Ch in males in this crossing, it would be expected that all males would be of the doublesword type (XCh YDs). Table I (also see Figure 1) shows the results obtained. An unexpected 8.4% (3.9% of the total males and females) of the males were deltatails. It was apparent that what had happened was that the Cp gene of the male had "crossed over" (see my article in the April 1964 issue of this magazine) to the Y chromosome, forming males of the genetic makeup. XCk YCp, Ds. Furthermore, the influence of Cp on the Ds gene was still effective even when on the Y chromosome.

In order to pursue this matter of cross-over further, two additional experiments were made, one involving the Fl generation and another involving a backcross (see Table II). The first cross was a hybrid female (Fl) of genetic makeup XCh XCp with a crossed-over male (genetic makeup XCh YCp, Ds). No doubleswords were obtained, proving that the Cp gene was effective on the Y chromosome as well as on the X chromosome. The second was a backcross using an XCh XCh female and the crossed-over male. From this backcross, mostly doublesword males were obtained. This may be explained by the hypothesis that since the pressure is for the Cp gene to link to an X chromosome, and in view of the fact that the female could contribute no Cp genes to prevent its migration, the Cp gene linked to the Y chromosome in the male crossed back over to the X chromosome (of the female) where it "belonged."

Ignoring crossover (which is relatively infrequent), the postulated model of deltatail inheritance in the guppy is shown in Figure 2. Thus, the F2 generation should be 50% females, 25% doublesword males, and 25% deltatail males. Experiment No. 4 was set up to do just this (see Table III). The results were very close to expected and the actual differences from expected values were nowhere near significant (a statistical calculation of binomial confidence

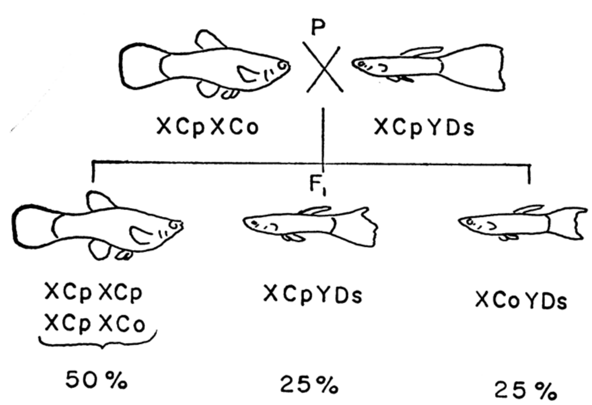


FIGURE 3: Experiment 5 schematic.

TABLE I			
Experiment No. 1. XCh XCh female vs. XCp YDs male.			
	Females	**Doublesword Males**	**Deltatail Males**
Number	**139**	**109**	**10**
Percentage Observed	**53.9%**	**42.3%**	**3.9%**
Expected Percentage	**50%**	**50%**	**0%**

limits was made to determine what constituted a significant difference but these calculations are beyond the scope of this paper … for those who are interested and who know something about statistics, however, the confidence level used was 99%).

Because a female of genetic makeup XCp XCo was on hand, it was decided to cross it with a deltatail in order to see what effect the Co gene had on the Ds gene. One would expect that 50% of the males would be deltatails (25% of the total) and 50% would be of the XCo YDs form (see Figure 3). The results of experiment No. 5 are shown in Table IV. They do not differ significantly from that expected. One thing was of interest, however. The swords on the doublesword males were quite shortened. We must conclude, therefore, that the Co gene inhibits the Ds gene. Thus, the Co gene is not only bad for color (the XCo YDs males also had yellowish tails), but bad for tail shape as well. Unfortunately, it is almost universally carried by common guppies.

Also unfortunately, during these experiments the quality of the deltatails produced began to deteriorate in that the tails were becoming more and more uneven (as we show in all of our figures). This was due to the fact that although the Cp gene was most important in controlling the deltatail, other genes influenced also. These were not taken into consideration. Therefore, an XCp XCo female from Experiment No. 5 (F_1) generation was backcrossed to the original male (P or parent generation) to produce an F_2 delta male (the shortened doubleswords were discarded). Then, an F_1 female of genetic makeup XCII XCp from Experiment No. 1 was selected. Crossing the F_2 male with the F_1 female mentioned produced the usual 25% deltatail males and 25% doublesword males (actual percentages were 23.4 and 25.0% respectively), but the deltatails were now quite good. The inbreeding quite evidently retained those genes other than Cp that are essential for producing quality deltatails.

In conclusion, we may make the following statements:

1. There is no gene for deltatail in the guppy. Rather it is caused by a combination of doublesword gene (Ds) and a number of other genes, notably Cp.

2. The coccineus gene is bad from both a color standpoint, and from the standpoint that it suppresses the doublesword gene.

3. Crossover of the Cp gene from the X chromosome to the Y chromosome takes place in-

TABLE II				
Experiment No.	**Cross**	**Number females obtained**	**Number deltatails obtained**	**Number swordtails obtained**
2	**XCh XCp x XCh YCp, Ds**	**37**	**29**	**0**
3	**XCh XCh x XCh YCp, Ds**	**19**	**2**	**21**

TABLE III			
Experiment No. 4. XCh XCp female vs. XCh YDs male.			
	Females	Doublesword males	Deltatail males
Number	42	20	20
Percentage Observed	51.2%	24.4%	24.4%
Expected Percentage	50%	25%	25%
Difference	+1.2%	-0.6%	-0.6%
Significant	+17%	-14%	- 14%

frequently, resulting in a small number of deltatails where none are expected. Most likely, this was one of the major factors in the original introduction of the deltatail.

4. Only in the infrequent case of a male cross-over may one ignore the female in the production and maintenance of deltatails. At all other times, the female carries the all-important gene, Cp, which is the major influence (other than Ds which is carried by the male only) in producing deltatails.

5. Although the Cp gene is most important in influencing deltatail strains, such strains will deteriorate unless some inbreeding is practiced. This preserves other Ds-influencing genes in the strain.

REFERENCES

Dzwillo, M., "Genetische Untersuchungen an domestizierten Stammen von Lebistes reticulata," MITT. HAMB. ZOOL. MUS. U. INST., Band 57, pgs. 143-186, 1959.

Klee, Albert J., "Genetics of the Guppy," THE AQUARIUM, Vol. 33, No. 4, pgs. 26. 31, April 1964.

Light In The Aquarium - Part I

[The Aquarium, January 1965]

INTRODUCTION

There exists in this universe a tremendous range of radiant energy that travels through space in the form of what scientists term "electromagnetic waves." Like all waves, one could draw a pictorial representation of them and if this were done, one could also measure the distance between crests of successive waves and call this simply, "wavelength". The discerning reader might, in addition, note two other measurements that could be made, viz., the height of such waves and the speed at which they travel. All electromagnetic waves, however, travel at the same speed (186,300 miles per second) and for aquarium purposes, a direct measurement of the heights of these waves is of no interest. Wavelength, on the other hand, is of utmost importance to the aquarist. Now some electromagnetic energy has very long wavelength. An example would

TABLE IV			
Experiment 5. XCp XCo female vs. XCp YDs male.			
	Females	Doublesword Males	Deltatail Males
Number	37	21	21
Percentage Observed	46.8%	26.6%	26.6%
Expected Percentage	50%	25%	25%

be the energy of ordinary 60-cycle alternating electric current for its waves are 3100 miles long! On the other end of things, cosmic rays are almost infinitesimally small.

Wavelength is of consequence to aquarists for a number of reasons, one of which being that the color of light is determined by its wavelength. Visible light, i.e., that form of radiant energy capable of producing the sensation of sight, is of very short wavelength. Thus, it is inappropriate to measure it in feet, inches or even millimeters. The useful measure of visible light wavelength is the angstrom (abbreviated simply as Å) that is equal roughly to four-billionths of an inch. The wavelengths of visible light may be associated with given colors as follows:

Red:	6400-7600 Å
Orange:	5900-6400 Å
Yellow:	5600-5900 Å
Green:	4900-5600 Å
Blue:	4500-4900 Å
Violet:	3800-4500 Å

Later in this article we shall term that 6000-7000 Å end of the spectrum simply as "red," and the 4000-5000 Å end as "blue."

The human eye is not equally sensitive to energy of all wavelengths (i.e., to all colors). The maximum sensitivity is in the yellow-green range at about 5500 Å. Accordingly, the lowest sensitivity is at the violet and the red ends of the spectrum. This results, for example, in the fact that roughly 9 units of red energy at a wavelength of 6500 Å are needed to produce the same visual effect, or brightness, as one unit of yellow-green.

SOURCES OF AQUARIUM LIGHTING AND THEIR CHARACTERISTICS

There are three major sources of light for the aquarium: natural daylight, incandescent bulbs, and fluorescent lamps. The first is, as its name suggests, a natural source; the other two are artificial sources. If we define the wattage, brand and type of either our incandescent bulb or fluorescent lamp, we generally fix rather exactly the kind of light we are producing. I say "generally" because as an artificial light source ages, certain physical characteristics of the source change (an example would be the darkening of a bulb or the ends of a lamp with use) and consequently, so does the kind and quantity of light it emits. Natural daylight, on the other hand, changes drastically with time of day, season of year, geographical location, and climatic conditions. It is, therefore, not a very well defined source of light. It is totally inadequate to state one's source of light as "natural daylight." Be that as it may, this article will primarily be concerned with the two major sources of artificial light mentioned.

From a construction standpoint, every aquarist recognizes certain fundamental differences between incandescent bulbs A source of white light at maximum efficiency would produce about 200 lumens per watt. Accordingly, we can take the actual number of lumens per watt emitted and divide by the theoretical number of lumens per watt (and multiply by 100) to obtain the efficiency of a given light source. If this is done, an ordinary 100-watt incandescent bulb is 10.0% efficient, while a 40-watt white fluorescent lamp system is about 20.5% efficient.

INCANDESCENT VERSUS FLUORESCENT LIGHTING

Let us defer consideration of the quality of light emitted by these two fundamentally different sources for the moment, and learn why the aquarist has attempted to replace the incandescent bulb with the fluorescent lamp. The answer lies in four facts already mentioned, viz.:

(1) Incandescent bulbs do not distribute their light as evenly as do fluorescents (hot spots intensify algae problems and illumination problems).

(2) Incandescent bulbs create more heat than do fluorescents (excess heat is dangerous to fish).
(3) Incandescent bulbs need more frequent replacing than do fluorescents (frequent replacing is a nuisance and also expensive).
(4) Incandescent bulbs consume more electricity than do comparable fluorescent types.

Granted that items (3) and (4) are modified by the higher initial cost of a fluorescent unit, why haven't aquarists stampeded into total replacement of incandescent with fluorescent? The answer lies in the quality of the light emitted by the two types.

Early fluorescent lamps were either of the "Daylight" or "White" types. These two lamps emitted relatively low ratios of "red" to "blue" light. It was found that fish did not look as colorful under these fluorescent lamps as they did under incandescent bulbs. Furthermore, plant growth was not as good either. Both objections were removed in part, however, upon the introduction of fluorescent lamps with a higher red to blue ratio, notably "Warm White" (Westinghouse) and "Warm Tint" (General Electric).

Actually, many fluorescent lamps of varying light characteristics have been made available since that time, and we have previously listed a good number of them.
With the advent of Sylvania's "Gro-Lux" fluorescent lamps, however, a considerable controversy has hit the aquarium hobby. Although fish of colors blue and red are dramatically illuminated by Gro-Lux light, and many aquarists claim spectacular increased plant growth, opponents of the light claim increased fish and egg mortality, and decreased plant growth as a consequence of using this light. Which side is right? My

Light in the Aquarium – Part II

[The Aquarium, February 1965]

When an aquarist switches from incandescent bulbs to fluorescent lamps, he is making a host of changes as a consequence of all of those factors already discussed in Part I of this article. When an aquarist switches from one type of fluorescent lamp to another type of fluorescent lamp, he also incurs a number of changes. To be sure, perhaps no change is made in wattage, diameter of lamp, distance of lamp to water, or length of time per day the lamp is used, but changes occur nevertheless. These changes manifest themselves ultimately in either one or all of six areas, viz., fish, fry, plants, eggs, sexual products (eggs and milt) or the aquarist himself. For a simple comparison, let us examine what these effects might be as a consequence of a basic switch from a Warm White Deluxe lamp to a Gro-Lux lamp, all other factors remaining the same.

(a) THE AQUARIST. Figure 1 shows the spectral difference between the two lamps. Gro-Lux is high in wavelengths between 4000 and 5000 Å ("blue") and also 6000 to 7000 Å ("red"), while Warm White Deluxe is high in wavelengths between 5500 and 6800 Å ("yellow-orange"). Table I shows the effect of colored light on colored subjects.

Now under Gro-Lux, because of its high red and blue emission, red becomes brilliant red, light blue becomes bright blue, and dark blue becomes brilliant blue. White, black, green, yellow, and brown, although affected, are not intensified in their original hues. Aquarists are certain to notice this change in fishes exhibiting reds and blues, and in plants exhibiting reds.

On the other hand, under Warm White Deluxe, red becomes very bright red, yellow becomes a brilliant light orange, and orange becomes a bright orange. Again, the other colors would be altered but not intensified in their original

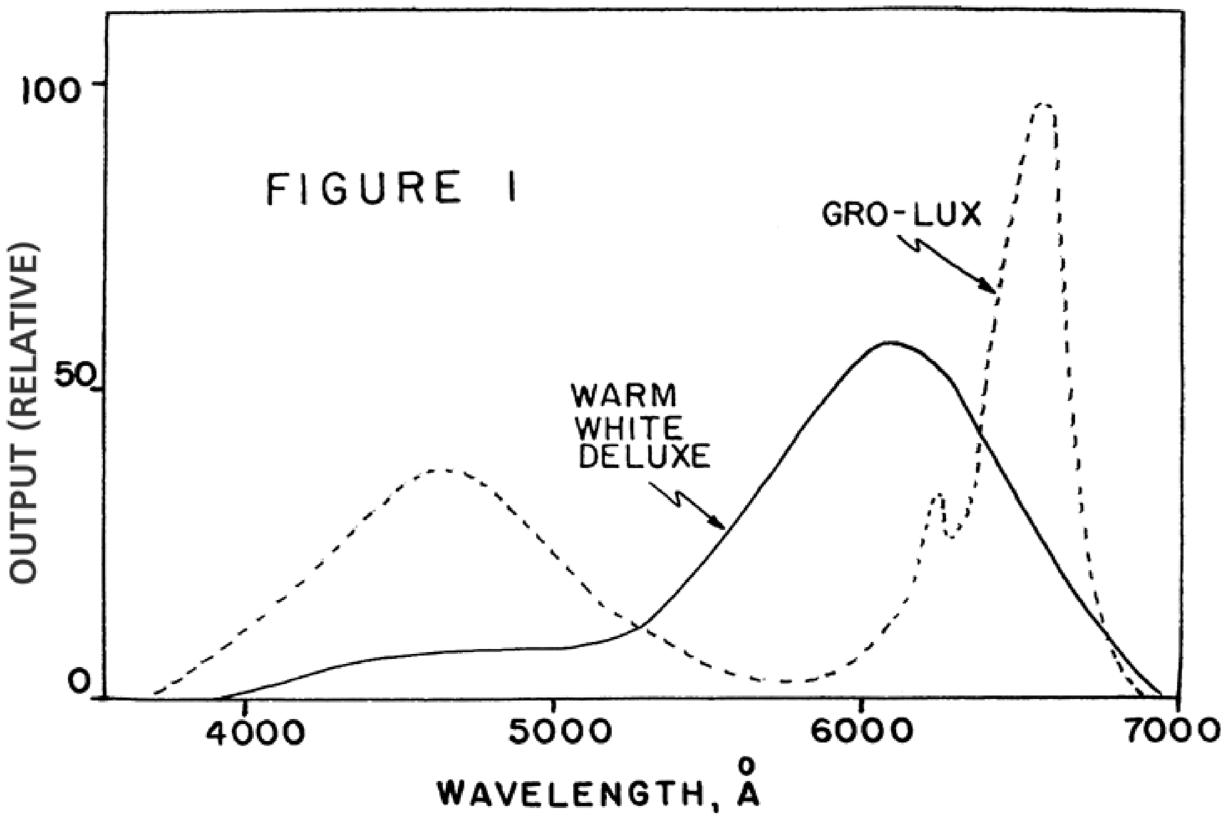


TABLE I			
OBJECT VS. LIGHT QUALITY			
OBJECT COLOR	RED LIGHT	BLUE LIGHT	YELLOW-ORANGE LIGHT
white	light pink	very light blue	very light yellow-orange
black	reddish-black	blue-black	yellow-orange black
red	brilliant red	dark bluish-red	very bright red
light blue	reddish blue	bright blue	moderately red-dish-blue
(lark blue	dark reddish-purple	brilliant blue	medium reddish purple
green	olive green	greenish-blue	yellow-orange green
orange	red	light bluish-red	bright orange
yellow	red-orange	light reddish-brown	brilliant light or-ange
brown	brown-red	bluish-brown	brownish yellow-orange

hue. Thus, an aquarist would notice that fishes and plants with reds, yellows, and oranges would look well under Warm White Deluxe lamps. As a matter of fact, one could devise a preference table (see Table II) showing what fluorescent lamp shows up a particular color best. From the aquarist's point of view, Table II indicates that there is no need for any hobbyist ever to use Soft White, Cool White Deluxe or Warm White Deluxe lamps since other lamps perform better for a given color preference. Although we have given Warm White Deluxe lamps kudos for intensifying yellows and oranges, Warm White and White both are more effective. Table II continues to be a thought-provoker. If one had a well-planted tank (where the plants were "green" green plants) containing blue moons, the most dramatic lighting would be Daylight fluorescent, with perhaps Cool White as a runner-up. This, it is important to state, is only in relation to how the aquarist sees the tank, not to how well the plants grow over a period of time. If I were entering an "aquarium beautiful" contest, I would study Table II and choose fish, plants, and lamp accordingly.

Table II also demonstrates why Gro-Lux is so spectacular. It intensifies two ends of the spectrum, colors that are common among aquarium fishes. For dramatic effect, add blue moons, red moons, reddish cryptocorynes and reddish *Ludwigia*, and who could ask for more beauty?

TABLE II

LAMP PREFERENCE FOR INTENSIFICATION OF COLORS

Color	Lamp (in order of preference)
blue	Daylight, Gro-Lux, Cool White
green	Daylight, Cool White, White
yellow	Warm White, White
orange	Warm White, White
red	Gro-Lux, Natural White

(b) THE PLANTS. Unfortunately for the hobbyist, what might be best for visual effect may not be optimum for plants. It has been relatively recently learned that plants need both red and blue light for maximum activity. Roughly speaking, this means wavelengths in the two bands, 4000-5000 Å and 6000-7000 Å. The effective outputs (i.e., the product of energy outputs in watts and percent utilization by plants … this product is normally measured in watts but all figures have been multiplied by a suitable constant to produce a relative total output for Warm White of 100 units) of various fluorescent lamps are shown in Table III.
The important columns in Table III are "Total" and "Red/Blue Ratio." Gro-Lux is designed to produce a near optimum ratio of red to blue light and as can be seen, this ratio is 1.88 (really an abbreviation of 1.88 to 1). It should be noted that Warm White with its ratio of 1.85 is almost identical. Therefore, insofar as plants are concerned, the only difference between Gro-Lux and Warm White is that the former is 2.3 times as "powerful" (this figure is obtained from the "Total" column). Thus, if an aquarium under a Warm White lamp is receiving an insufficient amount of light, a change to Gro-Lux will likely increase plant growth. However, if an aquarium under a Warm White lamp is receiving enough light for the conditions, a change to Gro-Lux might actually adversely affect plant growth. This accounts for the seeming contradictory reports by aquarists. Note that the increased "power" of Gro-Lux lamps vis-à-vis plant growth, is not perceived by the aquarist visually since the two spectral bands of interest here are not readily perceived by the human eye.

It should also be noted that although White, Cool White, and Daylight produce more useful energy (to plants) than does Warm White, they do not have the optimum "mix" of red to blue. These three types, although they have high outputs in the blue regions (Daylight even approaching Gro-Lux in this regard), are much lower in the all-important red regions than is Warm White.

(c) FISH EGGS. Light varies in its lethality to fish eggs of a given species according to its quantity, intensity, and quality. Simply stated, with regard to light quality the violet to blue bands are highly lethal, with lethality diminishing as progression is made towards the red band. Nature has devised several protective mechanisms against these violet to blue rays, viz.:

1. Many fish spawn during cloudy, windy, or rainy weather during which less of this harmful light is present.
2. Many fishes conceal their eggs (under rocks, below plants, etc.) for protection against this harmful light.
3. Many fish eggs are colored yellow, thus "filtering out" harmful violet-blue rays.
4. Some fish eggs have melanophores (large black pigment carriers) over sensitive areas of the embryo such as the spinal column, brain, and abdominal cavity, to block out violet-blue rays. Large xanthophores (yellow pigment carriers) are often present with the melanophores and these also, filter out violet-blue rays.

Table III also indicates why Gro-Lux and Daylight fluorescent lamps are more lethal to fish eggs than any other type… they simply emit more light in this lethal band than do others. The 90% mortality rate in 1959 at the Cold Spring Harbor fish hatchery of New York State (normal mortality was 10%) was traced to the installation of Cool White fluorescent bulbs. It is because of this proven egg and embryo mortality that I termed Gro-Lux, "The Lethal Light." It is, however, no more lethal than Daylight lamps in this regard.

(d) FRY. We have already discussed some of the protective mechanisms that Nature has devised to protect fish eggs and embryos from the destructive power of violet-blue wavelengths. There is some evidence that fish fry may also be harmed by too much light in the violet to blue range. Many fry also exhibit a melanophore-xanthophore protective system that they lose as they mature (e.g., some native killifishes such as *Fundulus olivaceus* and also many dwarf cichlids). In such cases, the previous remarks concerning Warm White Deluxe and Gro-Lux still hold. We can in general, remind readers that it is to wards the violet-blue end of the spectrum where most physiological damage lies to bacteria, mold, yeast and virus.

(e) SEXUAL PRODUCTS. Some claims have been made that the wavelength of light affects the sex ratio of spawns of fishes. Whether this is due to the effect of light on sexual products (milt and unfertilized ova), fertilized eggs or fry has never been stated. If wavelength does affect sexual products, then the meager evidence available indicates that the red wavelengths are somewhat lethal to the Y-chromosome of zebra danios and guppies. This

TABLE III

EFFECTIVE OUTPUTS IN ARBITRARY UNITS, OF SELECTED BANDS

Red/Blue Lamp	4000-5000 Å Band	6000-7000 Å Band	Total	Ratio
Warm White	35	65	100	1.85
White	50	58	108	1.16
Cool White	64	50	114	0.78
Daylight	78	56	134	0.72
Gro-Lux	80	150	230	1.88

results in reducing the number of males in a given spawn. Other evidence has indicated that temperature may be a major influence upon sex ratio and since the red end of the spectrum is closer to heat energy than is the blue end, these two concepts are not contradictory. Fascinating as these surmises may be, our lack of substantial data, statistically evaluated, prevents drawing any conclusions at this time.

(f) THE FISH. Certain fishes react to light most assuredly. Indirectly, angels (as only one example) alter their coloration with respect to the brightness of their surroundings (by changing the shape of their melanophores). Directly, blind cave fish react differently to different conditions of lighting. In addition, it is known that the spawning of certain fishes is highly influenced by the nature and quantity of light provided. We have already mentioned that many fishes spawn in nature during climatic conditions where violet to blue radiation is diminished. Experiments have shown that there are conditions of too much light under which zebra danios will not spawn; halve this amount of light and spawning commences. But with regard to wavelength (and we are still comparing Warm White Deluxe to Gro-Lux), any indictment against Gro-Lux lighting vis-à-vis the fishes themselves, must be returned as a Scot's verdict, i.e. "Not proven."

CONCLUSIONS

It is obvious that neither the nature of light nor the lighting requirements of the aquarium are fully understood generally by hobbyists. One author even claimed that he had solved the Gro-Lux mystery by pinpointing its alleged harmful "infrared" and "ultraviolet" emission. The fact of the matter is that no ordinary fluorescent lamp, Gro-Lux included, emits radiation in these bands (which are outside of the 4000-7000 Å band we have been discussing all along) to amount to a "hill of beans." A quick glance at the spectral composition graphs of various fluorescent lamps (we have shown two of them in Figure 1) proves this. There is no room for "pseudoscience" in our hobby.

Time and time again I have read "Letters to the Editor" in our aquarium magazines in which was stated that "natural daylight" was used, without any additional cogent comment. The term "natural daylight" defines nothing of real significance; neither does the term "fluorescent lighting." Plant growth, like diseases of fishes, is a complicated and involved subject. No wonder these two subjects form the bases for the most frequently cited problems in such "Letters." No one should expect miracles of aquarists willing to try to provide solutions to these problems. We have no aquarium "Gods" in our hobby, equipped with omniscience.

We can, however, make some feeble forays into the forest of complexity but the reader will forgive me if I mistrust extreme answers. The Gro-Lux controversy is a case in point. Those who would have us consign Gro-Lux lamps to the nearest trashcan are as wrong, in my opinion, as those who feel that the lamp is safe under every and all circumstances. Gro-Lux lighting is a significant event in our hobby, to be sure. Like all significant events, it deserves a proper evaluation and a fair attempt to place it in its correct hobby niche.

Sex Hormones and the Guppy

[The Aquarium, March 1965]

A. INTRODUCTION

There has been a recent surge of interest among guppy breeders in the application of sex hormones in the development of their fishes. Unfortunately, very little information on this subject has appeared in the aquarium literature and what has been published has often been burdened with inaccuracies and misinterpretations. We read, for example, that sex hormones "upset the whole genetic scheme of things." This is hogwash, pure and simple, as we propose to demonstrate.

Guppy fanciers are quite conversant with what are known as the "secondary sex characters" of their fish. In the male these are primarily the gonopodium and male coloration and in the female, gravid spot, general body shape and large size. The hereditary aspects of these secondary sex characters have been studied in the past and discussed in the aquarium literature. What has not been emphasized, however, is that the potentialities for most secondary sex characters of the guppy are present in both sexes. We cannot stress enough the fact that genes merely give the potentiality to produce or to contribute to the production of a physical character, all other things being equal. That the potentiality for most secondary sex characters exists in both sexes of the guppy can be proven by treatment with the appropriate sex hormone.

One might well ask, however, what the worth is of treatment with sex hormones over and above the proof mentioned above. The answer lies in three areas:

1. Temporary Changes - Historically, guppy breeders used sex hormones to bring out physically, evidence of the color and pattern genes carried by female guppies which normally did not manifest themselves because the inheritance was sex-limited, i.e., the genes although present on the X-chromosome were only physically manifested in the male guppy. Thus, temporary treatment of female guppies with male hormones would bring out body and tail color so that the fancier could select his female breeders visually. It was important that such treatment did not damage the reproductive ability of the fish. This is still the most important area in the use of hormones.

2. Permanent Changes - Here the breeder is trying to associate selected male characteristics with females or vice versa. Examples are large males, and increased tail color in females.

3. Disease - Sex hormones have been used in humans in the treatment of certain diseases. Some work has been done in this regard with guppies also. However, there are other treatments that are either just as effective or more effective, which do not involve the risk in their use that do hormones.

Are such goals realizable? A limited "Yes" can be given at this point with one qualified exception. Those characters influenced by strictly Y-linked genes cannot be transferred to female fish via sex hormones. Thus, for example, one cannot produce a female guppy with a double swordtail by the use of such hormones since the gene for double sword is located on the Y-chromosome (a rare exception is in the case of cross-over ... see my article in THE AQUARIUM, November 1964, "The Genetics of the Deltatail Guppy", pgs. 11-14). Remember, the genes supply the potential . . . without the genes there cannot be any physical manifestation of the character. Without the Y-chromosome to which the double sword gene is normally attached, we cannot have a doublesword fish. Fortunately for us, the potentiality for secondary sex characters in the guppy is, contrary to what is ordinarily believed, not controlled by genes linked to the Y-chromosome.

B. SEX HORMONES AND THEIR APPLICATION

In general there are three major categories of sex gland products, viz., estrogenic, androgenic and progestational. All are found in both males and females but estrogens are found in greater concentration in females, and androgens in greater concentrations in males. Thus, estrogens are loosely referred to as "female hormones" and androgens as "male hormones." The basic estrogens are estrone, estriol, and estradiol. Synthetic estrogens are also available under the names diethylstilbestrol (or simply as "stilbestrol"), Hexestrol, and dienestrol. The basic androgen is testosterone with methyl testosterone an important derivative. An important synthetic is testosterone propionate. I have not yet experimented with progestational hormones so no more will be said about them at this time.

There are numerous manufacturers of these substances, among them Ayerst, Barry, Breon, Lincoln, Reed & Carnick, Schering and Sherman. Most of these hormones are generally available in three basic forms: oil solution, aqueous suspension and crystalline. I am particularly familiar with the following specific products:

1. Oreton Methyl (Oreton M). This is a Schering Co. preparation and is simply methyl testosterone. It is available in 10 and 25 mg. tablets.

2. Oreton. Another Schering product consisting of testosterone. It is available in 75 mg. tablets and in 10 cc vials of aqueous suspension containing 25 or 50 mg/cc of hormone.

3. Oreton propionate. The propionate form of testosterone (Schering product again). It is available in 1 cc ampoules of oil containing 25 mg. of hormone, and in 10 cc vials of oil containing 25, 50, and 100 mg/cc of hormone.

4. Progynon. This is a Schering product consisting of estradiol. It is available in 0.2, 0.25, 0.5 and 25 mg. tablets; and 10 cc vials of 0.25 and 1 mg/cc of hormone in aqueous suspension.

5. Estrone. This is a Lilly Company product. It is available in aqueous suspension in 1 cc ampoules of 2 mg/cc of hormone, in 5 cc ampoules of 5 mg/cc of hormone, and in 10 cc ampoules of 2 mg/cc of hormone.

These are but a few examples and do not represent all that is available, by any means.
Application of sex hormones can be made in four different ways, viz., injection, immersion, feeding, and solution in aquarium water.

(a) Injection—There are three areas into which injections with a syringe (typical instrument is a 1 ml syringe with a 27-gauge needle) can be made: body cavity, mouth, and anus. In general, I do not recommend any of them. All are tricky and the fish must be anesthetized as well (either in ice water or in a solution of sodium Nembutal at a concentration of 1 to 2 mg/cc). The first (body cavity) is more often than not, fatal. The second is also frequently fatal and although anal injections are least injurious, they are not safe either.

(b) Immersion—The guppy is caught in a net, which is then shaken to remove excess water. An oil solution is then applied via an eyedropper over the body of the fish excluding the head area. In a minute, the fish is returned to the aquarium. This is not as effective as the following two methods; however, it is safe.

(c) Feeding—This is the most effective method of all. Some sex hormone preparations in crystalline form will readily be gobbled up by the fish (crush the tablets first!) but a better technique is to mix the granular hormone with dry food, equal parts hormone and food. This may also be done with oil solutions and aqueous suspensions if the mixtures are allowed to dry before they are used.

(d) Solution—Stock solutions may be made from either aqueous suspensions or crystalline forms. The crystalline form is not easily soluble in water and must first be dissolved in grain alcohol. Dosages are discussed in the following sections.

It must be cautioned that sex hormones are dangerous to man if misused. Do not place your hands in tank water containing hormones (use rubber gloves if necessary). Furthermore, isolate all equipment such as nets, filters, etc., used in hormone experiments. Do not reuse either filter floss or charcoal in other tanks. Do not unnecessarily mix tanks or equipment used in estrogen experiments with those used in androgen experiments. Label all tanks containing hormones with a large sticker with the legend, "HOT!" and keep children away from all hormone materials as well as the experimental area.

C. THE EFFECTS OF ANDROGENS ON FEMALE GUPPIES

In feeding methyl testosterone to mature females via dry food as described, a typical timetable is as follows:

DAYS AFTER CONTINUAL FEEDING	DEVELOPMENTS
7 - 9	Anal fin diminishes in size and assumes shape of gonopodium.
10 - 13	Male colors start to appear.
24 - 32	Attain full coloration; dorsal and anal fins prolonged.
32 plus	Often hollow-belly, wasting disease, listlessness, death.

Continual feeding, of course, means a heavy dosage of hormone so the reactions described above are extreme. Aquarists are urged to use much smaller dosages (i.e., feeding other than on a continual basis).

A number of observations concerning these extreme dosages are necessary. First of all, there is a decided tendency for the water to foul when using sex hormones. The aquarist must guard against this. Similar results are obtained using aqueous suspensions of methyl testosterone (using 0.2 mg/gal every other day or 0.8 mg/gal every 7 to 10 days) but the tendency to foul the water is even greater. This is why I prefer the dry feeding method when the goal is to bring about extreme changes in a fish.

Secondly, although the timetable given is typical, there is a significant difference among guppy strains in their response. Although the time to anal fin modification is fairly constant, the development of male coloration in some strains may be delayed up to about 20 days after start of hormone treatment. On the other hand, dorsal and caudal fin elongation may be speeded up so that it is complete in from 2 to 2½ weeks after the beginning of treatment. This is why the timetable given can only be used as a rough guide. Sexual maturity in fancy guppies can be delayed or accelerated according to the strain. The timetable for hormone-fed females very closely approximates the timetable for non-hormone-fed males and so we must be prepared to observe strain differences.

Thirdly, some male guppies have non-elongated tails and/or many Y-chromosome linked genes. Feeding sex hormones to females of these strains will not produce elongated tails nor will it produce these Y-linked male colors.

Fourthly, it is interesting to note that cessation of hormone feeding does not always bring about a quick reversal to typical female form. In some instances females will retain these male characteristics for as long as three months. Evidently some hormone is retained in the body tissues and metabolized very slowly.

If the purpose of feeding androgens to female guppies is to bring out their latent, sex-limited coloration or pattern for breeding purposes, then not only are milder doses needed but more precise ones as well. Therefore, I cannot recommend anything other than the addition of hormone (methyl testosterone) directly to the water. The target dosage should be between 0.005 and 0.01 mg/ gal of aquarium water, repeated every other day. Methyl testosterone is not easily soluble in water as we have mentioned, and if the crystalline form is used, it should first be dissolved in grain alcohol. This is advisable even with the aqueous suspension if such is used. I prefer stock solutions of about 0.1 mg/ cc concentration since roughly 1 drop added per gallon of aquarium water will then be the correct dosage. However, calibrate your eyedropper, for the capacities of individual droppers varies considerably. Treatment should be maintained for at least 5 weeks and for aquarists doing very serious study with a desire not to "miss anything"; up to 3 months may be necessary. Roughly 2 to 4 weeks should elapse after cessation of hormone treatment before breeding is resumed. Since the amount of hormone used for this purpose is relatively small, the danger of fouling the water is not as great but the aquarist should remain watchful.

We have talked of mild doses of androgen on half-adult and adult females, and of strong doses on adult females. When androgens are fed to very young guppies, say 14 days old, the secondary sex characters are altered as described but the effect upon the ovaries is even more marked than in older fish. Consequently, the probability of permanent sterility is greater.

We may summarize the use of androgens on female guppies as follows:

1. The use of methyl testosterone on half-grown or full-grown female guppies for the purpose of determining what sex-limited genes they may carry (other than those linked to the Y-chromosome) is of great value in breeding guppies. The technique is fairly safe with regard to possible damage to the reproductive organs if the dosages recommended are used.
2. Overuse of methyl testosterone definitely injures female fishes, causing sterility and even death. The dangerous dosages have been indicated. The probability of causing sterility in very young guppies is great, indeed.
3. There seems to be no real point in using androgens on female guppies for the purpose of making them more colorful or increasing fin development. It is true that females can be made more colorful, especially in the tail fin, through the use of hormones and that this effect may be of some semi permanence. Such females might be used for show purposes but the accompanying fin alteration might disqualify the fish, and the ethics of exhibiting such females is doubtful in the first place.

D. THE EFFECTS OF ESTROGENS ON MALE GUPPIES

(1) Adult Fish

One might expect that the action of estrogens on male guppies is perfectly analogous to the action of androgens on female guppies. This is not exactly the case, however. We must recognize one basic fact and that is that feeding estrogens to adult male guppies produces much less marked effects than feeding comparable quantities of androgens to adult female guppies! For example, we can change the anal fin of a female guppy into a gonopodium by feeding androgens, but it is not possible to change the gonopodium of an adult male into a female-type anal fin by feeding estrogens.

Some aquarists have reported little or no change in adult, mature male guppies after use of estrogens. Generally, this is clue to application of the estrogen via the feeding method or the solution method since insufficient estrogen is supplied this way. Injection of estrogens, on the other hand, produces a very marked effect particularly in loss of male coloration. Injections do not affect the gonopodium, however.

Finally, there is an interesting effect of estrogens upon the sex organs of adult male guppies. If the amount of estrogen used is of the order 0.2 mg/gal every other day or 0.8 mg/gal every 7 to 10 days, or if the estrogen is applied via the feeding method, the maturing of sperm in the testes is speeded up! As a result of this hurried process, there is frequently a premature release of free sperms into the testicular ducts without the customary encapsulation (guppy fanciers are aware of the fact that normal sperm is delivered to the female via agglutinated capsules called "spermatophores"). The effect of this on fertility is not yet known. Overfeeding of estrogen, of course, will deplete the testes, inhibit them, and cause sterility.

(2) Immature Fish

Before an age of 30-35 days, guppies are essentially sexually undifferentiated fish. If we add controlled amounts of hormone via solution in the aquarium water, the amount of harm to the reproductive capacities of the fish is also controlled. I suggest an aquarium concentration of not greater than 0.1 mg/gal with re-addition every other day or 0.4 mg/gal with re-addition every 7 to 10 days. Guppies in such solution, depending upon the strain of fish involved, develop female characteristics including increased size. When the use of the hormone is stopped, the males will develop their secondary sex characters but will retain the increased size that may have been brought about by use of the hormone. The feeding technique may also be used.

One may ask about the advisability of using estrogens on guppies less than 14-19 days old . . . from birth, for example. This can be done with satisfactory results. What is important is the length of the treatment and the dosage concentration, not at what age under 30 days the treatment was started. The longer the treatment or the higher the concentration, the greater will be the damage to the sex organs. Using the dosages recommended, the treatment length effects upon the testes are as follows:

LENGTH OF TREATMENT	EFFECT
Up to 20 days	Relatively mild.
40 - 80 days	Considerable number of males will have their testes changed into ovaries.
100 days	The percentage of males having their testes changed is very great, up to 90%.
150-190 days	Sex glands atrophy to about 15% of their former size.

Of course, the longer one uses the hormone, the longer it will take for males to show their own male coloration after use of the hormone is stopped. Injections of estrogen, because of their effectiveness, produces atrophied sex glands. These sex glands can be examined under an inexpensive microscope of relatively low power, by the way.

Finally, if we treat males at the half-grown stage, after sexual differentiation has begun but before it is completed, development of male sex characters will be halted, and development of female characters will be started. A mixture of male and female characters, therefore, can be observed.

We summarize the effects of estrogens on male guppies as follows:

1. It is considerably more difficult to produce changes in adult male guppies with estrogens, than it is to produce changes in adult female guppies with androgens.

2. Other than premature sperm release, there are few significant changes, if any, in adult male guppies when safe dosages (via feeding or solution) of estrogens are given. Injections, which are not safe, do produce significant color and pattern changes.

3. Estrogens can be used on immature fish to ultimately produce male guppies of increased size, but the effect is dependent upon the strain of guppies involved.

4. Over dosage or prolonged treatment of male guppies with estrogens can cause damage to sex organs ranging from reversal of testes to ovaries, to almost complete atrophy of the testes.

E. REVERSE COMBINATIONS

This will be a brief section since the reasonable application of androgens to male guppies, be they immature or adult, has not produced any significant visual effects. Methyl testosterone triggers the inherent developmental sequence of male secondary sex characters in guppies but this, of course, automatically occurs in healthy male guppies anyway. Overdoses of androgen will harm male guppies, even causing their death, so there is no possible benefit from using them here.

In a like manner, light to moderate doses of estrogens on female guppies produces no really significant changes. Heavy doses via injection, however, frequently interferes with egg production, or else interferes with the deposition of yolk in the eggs. Thus, these reverse combinations (androgens on males, estrogens on females) do not appear promising for this type of usage.

However, androgens on males and estrogens on females are of some limited value in accelerating the comeback when the opposite combinations were used on the fish in the first place. Thus, to bring a male to color and other secondary sex development in the shortest possible time after cessation of estrogen application, the use of androgens is helpful to a degree.

F. CONCLUSIONS

Major summaries have been made on the specific effects of sex hormones in sections C and D, so they will not be repeated here. This article was not intended to be the last word on sex hormones vis-à-vis the guppy, of course, but it is a starting point for further developments. As my own interest in sex hormones was stimulated by genetical questions and not by attempts to breed fancy guppies, the serious guppy breeder may very well take some giant steps in the use of hormones to improve his fish.

I do not wish to get into arguments over the pros and cons of using sex hormones. The facts are obvious, however. They have their uses and their limitations. They are not panaceas by any means. Used incorrectly, they are dangerous to fish and aquarist alike. Their use has demonstrated some vital points in genetics, however. The effect of sex hormones is not upon genes but rather upon the potential for physical development that the genes provide. Every guppy, regardless of its sex, has the potentials for many elements of "maleness" and "femaleness." These concepts are a far cry from the simple Mendelian concepts that we hear so much about in the hobby today.

The Genetics Of Inbreeding

[The Aquarium, May 1965]

Inbreeding is a term used to denote mating systems in which fish (as an example) are mated to fish more closely related to themselves than are random members of the whole population of fish. Mating father to daughter is inbreeding, of course, but what about mating first cousins? Where do we "draw the line"? The purpose of this article is to clarify these concepts of inbreeding and to state these various degrees of relationship rather precisely.

Now two genes in a population of fish may be alike for two entirely different reasons, viz.:

1. They may be alike by virtue of simply being gene A, for example, without these two A genes being related by descent from antecedents. You and I may both have genes for brown hair but since we are not related, these genes are not copies of a gene from a common ancestor. This situation is called, "identical by state."

2. They may be alike because they are copies, arising from the reproductive process, of a single gene occurring previously in the ancestry. My brother and I, for example, both have genes for brown hair and these genes are cop-

ies of a gene occurring previously in the ancestry, i.e., from our parents. This situation is called, "identical by descent." Genes identical by descent, of course, are also identical by state but not vice versa necessarily. In inbreeding, we are concerned with the second case only, i.e., genes that are identical by descent.

Let us begin by defining a "coefficient of parentage", or R(X,Y) for short. We define this coefficient as follows. Consider two fish, X and Y, with genotypes ab and cd respectively. In other words, X carries genes a and b, and Y carries genes c and d. Define R(X,Y) to be the probability that a gene selected at random from X is identical by descent with a gene selected at random from Y. We can obtain a gene from X equal to a gene from Y in four ways, viz.:

$a = c$
$a = d$
$b = c$
$b = d$

Let the probability that a = c be P(a = c). Now if all we wanted was the probability that at least one gene from X was identical with one gene from Y, this would simply be the sum of all the probabilities, viz.,

$$P(a = c) + P(a = d) + P(b = c) + P(b=d)$$

However, the coefficient of parentage is not defined in this way. Rather it is this probability after we have selected a random gene from X and a random gene from Y. But we have shown above that there are four ways to select a gene at random from X and one at random from Y. Each possibility has a probability of 1/4. The coefficient of parentage, consequently, is as follows:

$$R(X,Y) = \tfrac{1}{4}\,[P(a = c) + P(a = d) + P(b = c) + P(b = d)]$$

Suppose we mate two unrelated fish and wish to determine the coefficient of parentage of two of the offspring selected at random. Assume that the offspring have genotypes, ab and cd, respectively. Note that the genotype is written in standard form, i.e., the first gene is from the father and the second is from the mother (a and c are from the father, therefore, and b and d are from the mother). Now the father could pass on either of two genes to his offspring, each with equal probability. Therefore, P(a = c) = ½. However, P(a = b) = 0 since this is the probability that gene a (from the father) is identical in descent with gene b (from the mother) and we have already said that the parent fish were not related. By similar reasoning, P(b = c) = ½ and P(b = d) = 0. The coefficient of parentage then is:

$$R(X,Y) = 1/4(1/2+0+1/2+0) = 1/4$$

We are not interested only in the coefficient of

TABLE I

COEFFICIENTS OF PARENTAGE

	A	B	C	D	E	F
A	1/2	0	1/4	1/4	3/8	5/16
B		1/2	1/4	1/4	1/8	5/16
C			1/2	1/4	1/4	1/4
D				1/2	3/8	5/16
E					5/8	3/8
F						9/16

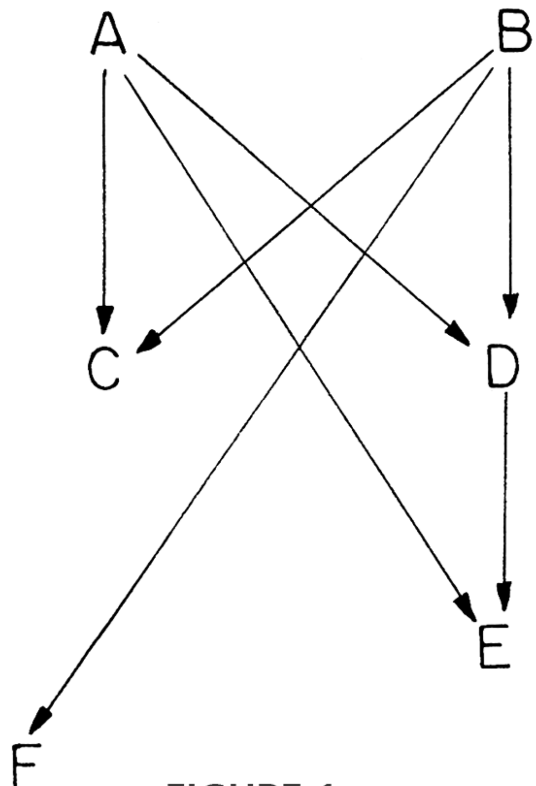


FIGURE 1

parentage, however. We are also interested in how closely related are the genes in a given fish. We now define the coefficient of inbreeding, F(X) for short, of an individual as the probability that the two genes possessed by that individual at one place in the chromosome are identical by descent. In other words, given a fish of genotype ab, F(X) = P(a = b).

Now one may, by applying simple high school algebra to the formulas for R(X,Y) and F(X), arrive at the following additional formulas:

(1) R (X,X) = 1/2 [1 + F (X)]
(2) R(X, YxZ) = ½ [R (X,Y) + R (X,Z)]
(3) F(XxY) = R(X,Y)

where YxZ, for example, is an offspring of the cross between Y and Z.

Now we are prepared to solve a problem in inbreeding and I will guarantee that the results will be fascinating! Referring to Figure 1, let us breed fish A to fish B, which are not related, and obtain fish C and fish D (C and D are full sibs, i.e., brothers and/or sisters). We then do a parent-offspring cross by mating A with D to obtain E. We end up by crossing B with E to obtain F. If anyone were to ask you how closely related F is to A, or how inbred F is, you might throw up your hands and give up! But it is really quite simple and the answers might surprise you. First, we construct Table I.

The table was constructed as follows. A and B are not inbred so, F (A) = F (B) = 0. Consequently, using formula 1, R(A,A) = R(B,B) = ½. Obviously R(A,B) = 0 since A and B are not related. C is an offspring of A and B so that using formula 2,

R(A,C) = ½ [R(A,A) + R(A,B)] = 1/4 and
R(B,C) = ½ [R(B,A) + R(B,B)] = ¼

Since D's ancestry is identical with that of C, R(A,D) = R(B,D) = 1/4 also. E is an offspring of A and D so that again using formula 2,

R(A,E) = ½ [R(A,A) + R(A,D)] = 3/8

C is an offspring of A and B so that using formula 3, F(C) = R(A,B) = 0 and by formula 1, R(C,C) = ½ [1 + F(C)] = ½. The rest of the table is filled in a similar manner.

These coefficients of parentage are interesting in their own right. By looking at the column under F, for example, we see that F is most closely related to E (since it has the highest coefficient of parentage, i.e., 3/8), and that B and D are equally as closely related to F (they both have the same coefficient of parentage with F, i.e., 5/16). I showed Figure 1 to my wife and then asked her questions about the degree of relationship of these fish and she was really surprised when we compared her intuitive answers with the calculation!

The coefficients of inbreeding of individuals may be obtained from the diagonal elements of Table I using the fact that from formula 1, F (X) = 2R(X,X) – 1. Consequently,

F (E) = 2(5/8) - 1 = ¼
F(F) = 2(9/16) - 1 = 1/8

Therefore, the probability that E's two genes are identical by descent is twice that of F's probability. In short, E is twice as much inbred as is F! The aquarist may construct other breeding schemes and analyze them in a similar manner.

Some Aspects Of Dorsal Fin Inheritance In Goldfish

[The Aquarium, September 1965]

As wonderful as they are, the concepts of Mendelian inheritance do not satisfactorily explain many of the individual differences that we observe in our fishes. In Mendel's own work, for example, he stated: "Out of 1,064 plants, in 787 cases the stem was long, and in 277 short." There were no "mediums" and thus he was able to formulate the inheritance of stem length in *Pisum* (the genus of plant with which he worked) in relatively simple terms. The stem lengths to which Mendel was referring were the results of crossing hybrid stock where "tall" dominated "short." According to Mendel's theory, a 3:1 ratio of tall-to-short should have been obtained. The actual results were really in the ratio 2.84:1, but this was close enough considering that the sample was relatively small.

Now suppose we try to apply the same sort of theory to dorsal fin length in the goldfish. Here, "tall" and "short" are better termed "high" and "low." But how high is a "high" dorsal fin; how low is a "low" dorsal fin?

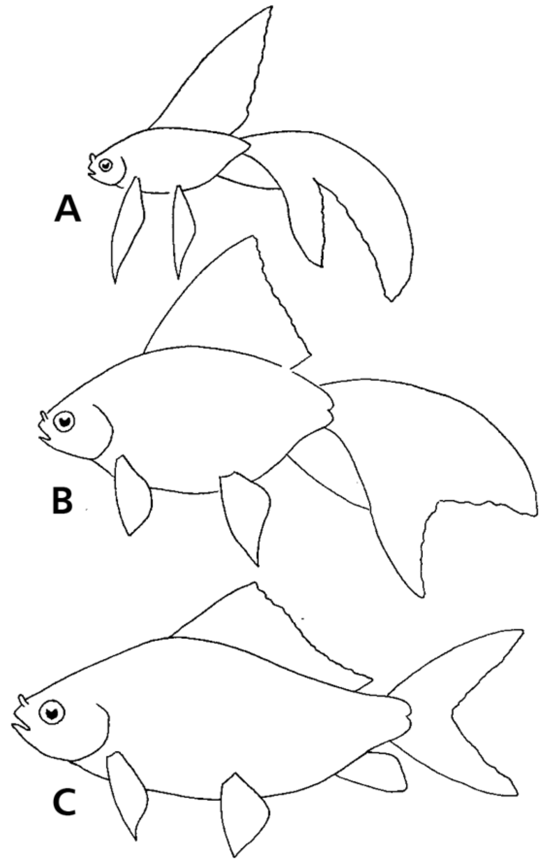


FIGURE 1: REPRESENTATIVE SHAPES OF GOLDFISH STRAIN INVESTIGATED
A: 92.5-107.5% dorsal fin (very rare).
B: 47.5-62.4% dorsal fin (most common)
C: 17.5-32.4% dorsal fin (rare).

Mendel had no problem with Pisum because although his "talls" varied in length, as did his "shorts," the tallest "short" was nowhere near the length of the shortest "tall." As a matter of fact, Mendel's task was even easier because when he crossed "tall" with "short," the hybrids were all tall plants, not medium-length ones, because "tall" was dominant. If we cross a "high" dorsal fin goldfish with a "low" dorsal fin goldfish, we observe all sorts of dorsal fin lengths in the offspring! In a goldfish, "high" does not dominate "low."

Now how is the aquarist going to measure 'dorsal fin length in the goldfish? Although

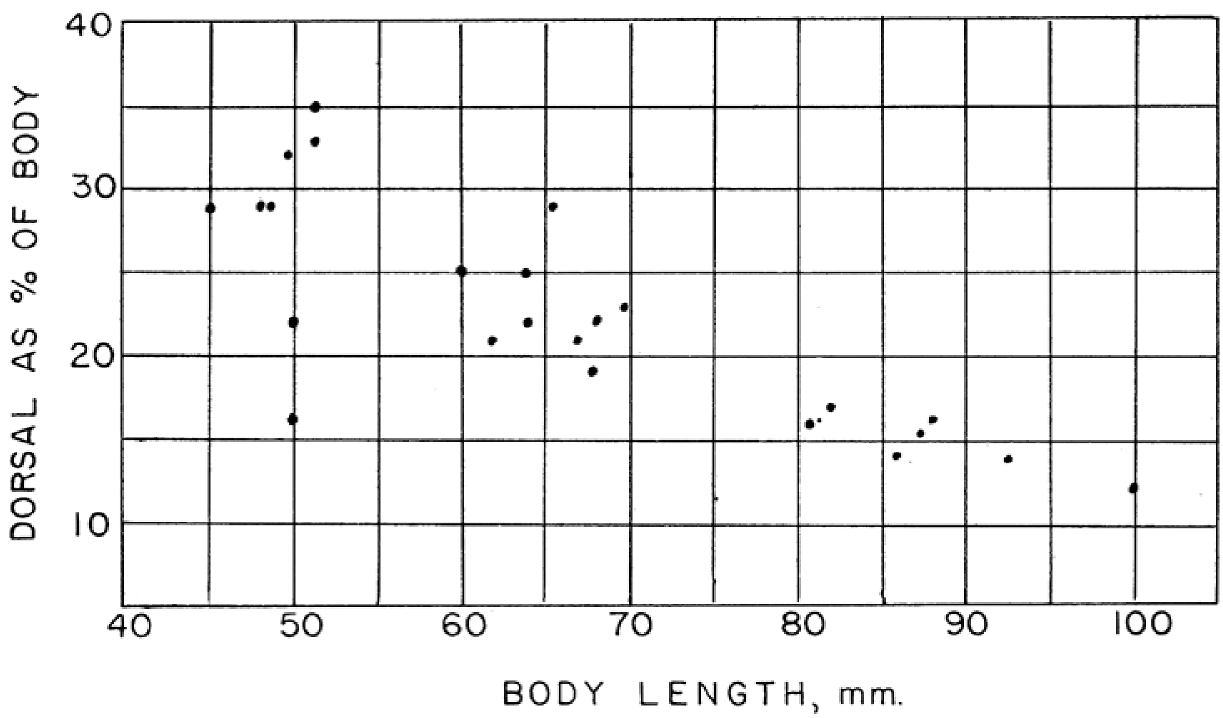


FIGURE 2: RELATIONSHIP OF BODY LENGTH TO LENGTH OF DORSAL FIN.

somewhat a messy (mostly damp!) procedure, a goldfish of reasonable size, say one year old, can be caught in a soft-filament net and while being held firmly in the net by one person, another can measure the longest ray of the dorsal with an accurate ruler (millimeter scale). Not much the worse for the experience, the fish can then be returned to a different tank and the procedure repeated until all of the fish in a given tank have been measured. One could just as easily take some other measurements at the same time, e.g., body length.

But dorsal fin length in a fish is a relative thing. Certainly it is related to the size of the fish. Furthermore, the size of a fish may be dependent upon environmental factors such as temperature, size of tank, competition for food, etc., of no concern to the aquarist studying heredity. One solution is to compute the height of the fin as a percentage of body length. Looking at some high-finned fish (extremes, of course) in one particular strain of veil tailed goldfish, the following such values were found: 94.1%, 107.9%, and 89.3%, for an average of 97%. Therefore, extreme high-finned goldfish of this strain had a dorsal fin roughly 100% of their body length. Looking now at some low-finned goldfish (again, extremes) in the strain, the following values were found: 10.2% and 9.8%, for an average of 10%. Thus, extreme low-finned goldfish of this strain had a dorsal fin roughly 10% of their body length. The midpoint between these two extremes was (100 + 10) /2 = 55%. Figure 1 shows typical representatives of these three categories.

Now let us try to fit one of Mendel's laws to this situation. Suppose we postulated that a goldfish with genetic makeup AA, represented fish with 100% dorsals and makeup as represented 10% dorsals. Then Aa would represent the 55% dorsal fish if A did not dominate a. Then if we crossed a 55% fish with another 55% fish, we would expect 100%, 55% and 10% fish in the familiar 1:2:1 ratios (or 25:50:25, expressed as percentages).

TABLE I			
OFFSPRING OF POSTULATED Aa x Aa CROSS			
Genetic makeup	AA	Aa	aa
Goldfish type	100%	55%	10%
Theoretical %	25	50	25
Observed %	6.1	81.7	12.2

TABLE II					
OFFSPRING OF POSTULATED AaAa x AaAa CROSS ?					
Genetic makeup	AAAA	AAAa	AaAa	Aaaa	aaaa
Goldfish type	100%	77.5%	55%	32.5%	10%
Theoretical %	6.25	25	37.5	25	6.25
Observed %	0	24.2	51.5	21.2	3.1

TABLE III							
OFFSPRING OF POSTULATED AaAaAa x AaAaAa CROSS							
Genetic makeup	AAAAAA	AAAAAa	AAAaAa	AaAaAa	AaAaaa	Aaaaaa	aaaaaa
Goldfish type	100%	85%	70%	55%	40%	25%	10%
Theoretical %	1.56	9.36	23.4	31.2	23.4	9.36	1.56
Observed %	0	6.1	27.2	33.3	21.2	9.1	3.1

TABLE V					
OFFSPRING OF POSTULATED AAAAAa x AaAaAa CROSS					
Genetic makeup	AAAAAA	AAAAAa	AAAaAa	AaAaAa	AaAaaa
Goldfish type	100%	85%	70%	55%	40%
Theoretical %	6.25	25	37.5	25	6.25
Observed %	6.2	21.8	34.3	34.3	3.12

TABLE VI				
OFFSPRING OF POSTULATED AAAAAa x Aaaaaa CROSS				
Genetic makeup	AAAaAa	AaAaAa	AaAaaa	Aaaaaa
Goldfish type	70%	55%	40%	25%
Theoretical %	25	50	25	0
Observed %	22.5	60	15	2.5

TABLE IV									
OFFSPRING of POSTULATED AaAaAaAa x AaAaAaAa CROSS									
Genetic makeup	AAAAAAAA	AAAAAAA a	AAAAAAaAa	AAAaAaAa	AaAaAaAa	AaAaAaaa	AaAaaaaa	Aaaaaaaa	aaaaaaaa
Goldfish type	100%	88.75%	77.5%	66.25%	55%	43.75%	32.5%	21.25%	10%
Theoretical %	0.39	3.1	10.92	21.84	27.3	21.84	10.92	3.1	0.39
Observed %	0	3.03	18.2	18.2	24.2	18.2	15.2	3.03	0

Experiment no. 1 did just this. The male selected was a 53.3% fish, and the female was 54.2% (both as close to 55% as could be found). The fish were bred and a year later, 33 offspring were measured (the results are given in the appendix). It was observed that the offspring measured between 10.9% and 84.0% (dorsal fin length as a percentage of body length). Now if the appropriate Mendelian law held, we should have only obtained three types of fish, viz., 100%, 55%, and 10% fish. Let us place each of our 33 fish into one of these three groups by noting that the midpoint between 100% and 55% is 77.5%, and that the midpoint between 55% and 10% is 32.5%. Thus a "high fin" goldfish will be anything larger than 77.5%, a "medium fin" anything between 32.5% and 77.5%, and a "low fin" anything below 32.5%. If we do this we find 6.1% "high fins," 81.7% "medium fins," and 12.2% "low fins." This does not agree very well with the theoretical 25:50:25 ratios. These computations are summarized in Table I.

Let us alter our hypothesis a bit. Suppose two pairs of genes are involved, each contributing to dorsal fin length equally. In other words, a 100% fish is AAAA, a 10% fish is represented by aaaa, and a 55% fish by AaAa. Now a cross between two AaAa fish results in five types of goldfish as shown in Table II (along with their expected frequency of occurrence). Using the midpoints of each class as we did previously, we again may classify each of the offspring and compare the percentages actually observed with the theoretical values. Unfortunately, it is beyond the scope of this article to show how these theoretical values are obtained but it is basically an extension of the simple case discussed previously. In Table II we see that the agreement, while although better than before, still leaves much to be desired.

Now let us postulate that three pairs of genes control dorsal fin length. Using similar reasoning, and an expansion of genetic theory to three gene pairs, we may concisely summarize everything as shown in Table III. Considering that this is really quite a small sample, the agreement is very good! We are now almost certain that dorsal fin length in the goldfish is controlled not by a single pair of genes, but by at least three pairs. This is a type of inheritance Mendel never heard of. It is called, "polygenic inheritance" and the theory behind it is called the "multiple factor hypothesis."

We might even consider four gene pairs. The analysis is summarized in Table IV. It will be noted that the agreement between theoretical and observed values is not as good as in the three gene pair hypothesis (this has been tested statistically by the author). Further proof that the three gene pair hypothesis is a good one can be obtained by crosses other than with 55% fish. In Experiment no. 2, an 86.3% male (postulated genetic makeup AAAAAa) was crossed with a 55.5% female (postulated genetic makeup AaAaAa). The resultant data for this experiment is given in the Appendix.

The analysis is shown in Table V, using the three gene hypothesis. Again, considering the small size of the sample, the agreement is quite good. At the same time, another experiment was performed, this time crossing an 85.5% male (AAAAAa genetic makeup) with a 19.5% female (Aaaaaa genetic makeup). The resultant data for this experiment (no. 3) is shown in the appendix, and the analysis based upon the three gene pair hypothesis is shown in Table VI. Once again, the agreement is reasonably close, certainly no worse than that obtained by Mendel in his study of Pisum.

In the course of these experiments (made by Dr. Wilhelm Berndt . . . see reference), the observation was made that the relative length of the dorsal fin (as we have defined it) was correlated with the body size of the fish. A plot of relative dorsal fin length versus body size for the data of Experiment no. 1 is shown in Figure 2. These data were evaluated statistically by the author and indeed, a linear relationship between these two factors was found to be significant. About 65% of the variability in fin ratio could be explained by body length alone. Therefore, the same genes that influence dorsal fin length also influence body size. The high-finned goldfish has been observed to be less hardy than its low-finned counterpart but this is partly related to food intake since, being smaller fish generally, they are less able to compete with their tank-mates. But aside from size, high-finned goldfish also have been observed to have a higher frequency of fin defects. If these defects are crippling in nature, then the visibility of high-finned strains is obviously affected.

We have shown a concrete example of non-Mendelian inheritance in which a simplified model of polygenic inheritance was postulated. To its credit, the theory seems to fit the facts, which is a good beginning for any theory! I use the term, “simplified model,” because it was assumed that the (at least) three gene pairs postulated contributed equally to the quantitative inheritance of the continuous character of interest. We might have postulated that these genes do not contribute equally, but until better evidence is produced, we will stand by the Law of Parsimony (“Occam’s Razor) and conclude that three equally weighted genes control dorsal to-fin length ratio in the goldfish. Polygenic inheritance does not mean that continuous characters are always controlled by a large number of genes each with a very small effect. There are almost always a few genes that make the major contribution. The fewer the major genes and the larger their individual contributions, the more “discontinuous” the inheritance will be. For example, in the guppy, deltatail is determined by many genes but only two of them are individually of great consequence, i. e., Cp (linked to the X chromosome) and Ds (linked to the Y chromosome).

The capacity of a gene to affect several different areas in the physical aspects of an animal is called “pleiotropy.” In short, pleiotropy is a synonym for multiple gene effects. Many of the genes for color in fishes, for example, appear to have an effect on body size. More important, however, is the fact that pleiotropy often affects the very characters that are of greatest interest to aquarists, e.g., fertility, sexual vigor, longevity and tolerance of environmental extremes. We can see this being demonstrated in the highly selective breeding of the guppy. Not everyone is satisfied with these aspects of the fancy guppy as we know it today.

The phenomenon of pleiotropy is now so well substantiated that geneticists are beginning to wonder whether any genes exist, in higher organisms, that are not pleiotropic. An example of a pleiotropic gene is one we have just mentioned, e.g., the Cp gene in the guppy. This is a gene linked to the X-chromosome and primarily manifests itself in a form of black pigmentation in the caudal fin. But in addition to caudal pigmentation, it affects the shape of the tail as well. It is a vital ingredient in the formation of the deltatail guppy. However, it is obvious that the genes controlling dorsal fin length in the goldfish are also pleiotropic since they control, to a great extent, body size as we have seen.

Without intending to disparage his great achievements, we conclude that the "beanbag" genetics of Mendel is a vast oversimplification of the real world, and the goldfish example presented illustrates just how complex a supposedly "simple" aquarium genetics problem can be.

REFERENCE

Berndt, Wilhelm, "Vererbungsstudien an Goldfischrassen", ZEITSCHRIFT FUR INDUKTIVE ABSTAMMUNGS AND VERERBUNGSLEHRE, Vol. XXXVI, pgs. 164-349, 1925.

APPENDIX

Dorsal Fin Ratios, Experiment No. I

84.0	72.5	60.6	52.7	44.8	31.1
78.3	69.6	59.4	51.6	42.7	24.2
76.2	65.5	57.4	50.8	40.0	10.9
75.0	64.0	55.1	48.0	36.2	
73.9	63.2	54.3	47.3	34.0	
73.3	61.5	54.1	46.6	32.0	

Dorsal Fin Ratios, Experiment No. 2

100.0	81.3	68.2	64.0	51.4	48.1
92.8	81.3	66.6	63.6	50.0	44.8
87.5	81.3	66.6	61.9	50.0	
86.6	69.6	66.6	60.0	50.0	
85.7	68.4	65.5	51.5	48.4	
82.4	68.2	64.0	51.4	48.4	

Dorsal Fin Ratios, Experiment No. 3

75.0	60.0	54.5	50.0	42.8
71.4	60.0	53.8	50.0	34.5
70.0	60.0	53.8	50.0	33.3
70.0	60.0	53.8	50.0	25.0
66.7	56.2	52.9	50.0	
66.7	56.2	52.9	50.0	
66.7	56.2	52.9	43.4	
66 7	56.2	50.0	42.8	
62.5	55.6	50.0	42.8	

Metals in the Aquarium

[Aquarium Journal, February 1955}

Introduction

This topic is a large one and as little information has appeared in the aquarium literature on the subject, this article represents an attempt to summarize the inter-effects of metals, aquarium fishes, and aquarium water. Corrosion of metals is dependent upon many different factors and it would be beyond the scope of this article to consider more than a few which are important and critical to the aquarist.

Metals, their Uses and Dangers in the Aquarium

The most often encountered metals in the aquarium are iron, stainless steel, aluminum, magnesium, brass, copper, lead, zinc, nickel, and chromium. Aquarium frames are regularly made of stainless steel, iron, copper, brass, or aluminum. Metallic submersible heaters are found constructed of iron or brass with a nickel or chromium plating or else of stainless steel. Straphangers for thermostats and non-submersible heaters are usually made of stainless steel or aluminum. Lead has appeared in the aquarium in ornamental figures and in bands for weighting down plants. Zinc or galvanized iron is sometimes found as a fungus preventive in the form of strips hanging in the aquarium or hatching jar, although this is not a common practice. In addition, metals quite often affect the aquarium indirectly as in the case of plumbing lines and water storage containers.

This list of metals and their uses is by no means complete but it serves to outline their most important applications in the aquarium.

Generally speaking, fish are affected by a specific metal to the extent that the metal dissolves in the water of the aquarium. Almost all metals in solution are necessary to the health of fish but an excess of any one of them can easily cause their deaths.

Some metals are more toxic than ot
hers. Copper is more toxic than zinc, zinc more than iron, and iron more than nickel. However, the effect of a metal on a fish may be affected by the presence of other substances in the water. For instance, if metal A is toxic to fish at a concentration of 1 particle per million and substance B is not toxic to fish at all, when A and B are added together in the aquarium, the combination may not be toxic at a concentration of A of 1 ppm. It might really take 2 ppm of A to kill any fish with B present. This is, in effect, what happens when zinc, lead, aluminum, or copper dissolves in hard water. The calcium present in hard water nullifies, to some extent, the toxicity of zinc, lead, and aluminum while the magnesium present helps nullify the toxic effect of the copper. Thus, hard water is antagonistic to most of the poisonous metals! This fact will be brought out further in the comments on the individual metals.

Lead

Lead is a metal with a Dr. Jekyll - Mr. Hyde personality. In hard water, a thin protective coating forms upon its surface and the metal is perfectly harmless. However, when the water is soft, lead dissolves and is a toxic substance to fish. The dissolved lead combines with the organic material of the fishes' mucous and coagulates, it. When this occurs on the gills, the fish suffocates. pH's between 6 and 9 do not affect the solubility of lead very much. The lesson here is - keep lead out of soft water.

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. In one experiment conducted, a colloidal solution of copper was made up and its effects on certain fish were studied. The addition of hard water prolonged the lives of these fish while those in a control tank which had no addition of hard water, died.

Copper is sometimes used in the form of a sponge or gauze to cure Velvet. At best, this is a dangerous practice. It is impossible to determine just how much copper the water has dissolved. Even though copper is not considered a cumulative poison like lead, the only way it can dissipate and not harm fish is to be absorbed by plants. Copper is best left out of the aquarium altogether.

Very beautiful aquariums have been made of copper and brass (a copper alloy) but unless every precaution is taken to insure that the aquarium water will not come in contact with the metals, the fish may be poisoned.

Zinc

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. The Steinhart Aquarium had difficulty keeping some fish alive in water that came in contact with galvanized cooling coils (containing zinc). When oyster shells were placed in the water from the cooling coils, the zinc precipitated on them and the water was made safe for the fish: These shells served to harden the water. The best solution for the aquarist, however, is not to use oyster shells but to keep all aquarium water from contact with this metal.

Brass

Brass 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.

Iron

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. Filtration will usually remove this suspension but since suspended iron can also clog water-softening materials that may be used in the filter, decreasing their efficiency, it is necessary to place the filtering material in the filter so as to remove the iron before it reaches the water softener. For large homemade tanks, it is a good cheap metal to use for the frames, but in view of its rusting tendencies, the inner surfaces of the frame should be painted with asphaltum and the top of the frame checked from time to time for rust.

Aluminum

Most aluminum is in the form of an alloy and may contain copper, magnesium, or zinc. Aluminum is not affected by soft waters but rots slowly in natural waters containing calcium and magnesium. Normally it is resistant to warm, humid conditions but under the constant drip and condensation in the average aquarium, forms a porous white oxide, which hastens further corrosion. Aluminum salts are poisonous to some extent but they ultimately settle out of hard waters and do not affect the fish very much. On the other hand, soft waters increase its toxicity to fish. Although aluminum has been used quite often for aquarium frames, stainless steel is a better metal for small tanks and for large tanks iron is equally good, cheaper and without risk.

Nickel and Chromium

Nickel is very insoluble in water. In addition, its salts are less toxic than those of iron. Much the same can be said of chromium except that chromium is a little more soluble and toxic. Both metals are to be considered non-toxic in the aquarium. It is because of these properties that they are used as protective coatings for heaters, air stems, and other metal objects that must be immersed in water. However these substances do wear off and dissolve, leaving the metal object unprotected. If the object is made of copper or brass it will then dissolve and poison the water. Careful surveillance of equipment of this nature is necessary.

Stainless Steels

Stainless steels are steels containing large quantities of other metals, mainly nickel and chromium. They are highly resistant to water but they *do rust!* This is especially evident when condensation water from the aquarium cover has lain on the stainless steel frame for a while. Usually the rust can be wiped off and the surface then looks as good as new again. Some method should be provided to prevent water from coming into prolonged contact with the top edge of the aquarium. A good way to do this is to suspend the aquarium cover below the top edge of the aquarium by means of plastic strips or brackets. This metal works well and may be used with iron frames with advantage as well. Stainless steels are harmless to fish.

Summary

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 copper, zinc, and brass, while the metals to be considered "safe" are nickel, chromium, and stainless steel.

In general, stainless steel is the best metal for aquarium frames, but when cost must be considered, iron can be used for large sizes if some provision is made for minimizing its contact with water.

A Novel Approach To Selecting Pairs Of Fishes

[Aquarium Journal, July 1958]

Often an aquarist is faced with the problem of choosing one or more pairs of fish from a tank containing fish that are too young, or for which there are no known methods, to sex. Actually, when we select a "pair" of baby angels or small neons we are, in effect, "taking a chance" or gambling. One thing we like to know when we "take a chance" is the odds involved. Consider an aquarium containing a large number of small black angelfish, too young to be sexed. Let us assume that there are just as many males present as there are females. Upon selecting a single fish from this tank, the probability of picking a male will be one out of two or g presuming there are equal numbers of both sexes present. In another way of putting it, the probability is 50%. Of course the probability of picking a female would also be M. On the second fish withdrawn from the aquarium the probability of it being a male is this time just about % (we have assumed a large enough number of fishes so that, even if a few are withdrawn, the number of males left still closely approximates the number of females left).

Since, in the first draw, the probability of picking a male was 32 and, in the second draw, the probability of picking a male was also about 32, the probability of picking two males in two draws is merely times 32 or g (25%). However, what holds for the probability of picking two males must also hold for picking two females. The probability then of picking two females in succession is also g or 25%. If we pick neither all males nor all' females in two draws, then we must pick a pair. The probability of picking a pair is 100% less the other two probabilities or 100% -25% -25%, or 50%. The following summarizes these simple computations:

Probability of picking two males 25%
Probability of picking two females 25%
Probability of picking a pair 50%
Total probability 100%

Although these calculations are simple, they serve as a basis for understanding the tables we shall now consider. When the computations are carried out further (and using certain rules and laws of probability that are outside the scope of this article), Table I is obtained.
This can be a very useful aid to the aquarist in choosing pairs of fishes. From the table, it can be seen that a selection of 5 or more fish indicates a high probability of getting at least one pair. However, 5 fish will not give us much assurance of getting 2 pairs. The probability of this occurring is very low (63%). To insure receiving 2 pairs, a selection of about 8 fish must be made. The aquarist may, by all means, select fewer but then his chances are decreased by the amount indicated in the table.

It might be well here to clarify the percentage probability terms. A probability of 94% for choosing at least 1 pair with 5 selections (fish) merely means that, by selecting 5 fish, 94 times out of 100 we will get at least 1 pair. On the other hand, 6 times out of 100, the selection of 5 fish will result in either all males or all females. The following will serve as a guide:

0-50% **very little chance**
50-75% **poor**
75-85% **fair**
85-90% **good***
90-95% **excellent****
95% **practically certain.**

***Suggested as a minimum for average cost fishes. **Would use this as a minimum if the fish in question were expensive.**

The question that now arises is, "Is it reasonable to assume that a batch of young fish will contain approximately the same number of males as females?" Unfortunately, there is little published information in aquarium litera-

TABLE I
Probabilities for an Aquarium Containing Fish Equally Distributed Between Males and Females

Number of Fish selected	Probability of obtaining at least 1 pair	Probability of obtaining at least 2 pairs	Probability of obtaining at least 3 pairs	Probability of obtaining at least 4 pairs
2	50%			
3	75%			
4	88%	38%		
5	94%	63%		
6	97%	78%	31%	
7	98%	88%	55%	
8	>99%*	93%	71%	27%
9	>99%	96%	82%	49%
10	>99%	98%	89%	66%
11	>99%	>99%	93%	77%
12	>99%	>99%	96%	85%

* The symbol, >, stands for "greater than."

ture that enables us to answer this question accurately. My own opinion is that, over the long run and for most fishes, the sexes are roughly equally distributed. However, I have found exceptions, particularly among the killifishes. Batches of *Epiplatys chaperi* and *Aplocheilus lineatus* raised by me have shown biases for the presence of one particular sex over the other. Some time ago, a dealer in my area received a shipment of *Aphyosemion gardneri*, some two dozen fish in all. Of this lot, there was present only one female. Since this shipment or lot was small I would have hesitated to include it as an example (especially because of the collectors possible prejudice in collecting only colorful fish) except that there are many references in aquarium literature that reinforce this observation. **[Editor's note: I also can reinforce this observation. I once (about 15 years ago) had a "strain" of pearl danios that always (about 25 broods) produced large broods of about 90% males. I have since had other strains of pearl danios that produced batches of young that were about equal in number of both sexes.]**

To see how different sex ratios in a group of fishes might affect the chances for choosing a pair, Table II shows these probabilities when the sex ratios are altered. The Table shows the diminishing chances for selecting pairs of fishes as the excess of one sex over another increases.

Introduction to the Characin Family

[Aquarium Journal, January 1959]

The characin family (family Characidae) is well represented in the aquarist's tanks and, together with the various livebearing fishes, provides the vast majority of aquarium fishes offered for sale. Although the term "characin" is heard more and more frequently nowadays in aquarium circles, it plays definite second fiddle to the old and popular term, "tetra." This latter term is merely an abbreviation of a scientific name, which has been highly restricted in its use by ichthyologists. For aquarists, however, it is still a short and easily pronounced popular name for most characins.

Practically all of our aquarium characins have come to us from South America. Those that have not mostly fall into the category of "rare" fishes. In the wild, many are found as schooling fishes preferring the middle and upper water levels of flowing streams and open waters. Many do not, 'however, shun planted zones of these waters which, by the way, are often clear and exposed to stray rays of sunlight.
In shape, they remind most persons of the "typical" fish although aquarists familiar with all sorts of odd fish shapes find it hard to characterize any fish shape as "typical."

TABLE II

Probabilities for Obtaining at Least One Pair of Fishes When Selecting Fish from an Aquarium Containing Various Sex Ratios

	Number of Fish Selected				
Sex Ratio	4	6	8	10	12
95:5	19%	27%	34%	40%	46%
90:10	35%	47%	57%	65%	72%
80:20	59%	74%	83%	89%	93%
70:30	75%	88%	94%	97%	99%
60:40	85%	95%	98%	99%	99%
50:50	88%	97%	>99%	>99%	>99%

Narrow, oval, bulky cross sections are very common in these fishes. So are forked tails. The ventral or belly line of the characins is frequently very much curved so that the front part of the body is more massive than the rear. Very few tetras are really intense in color as compared with many killifishes (exceptions include the neon and cardinal tetras) but they frequently are beautiful fishes. Their coloration is mostly due to a brilliant iridescence, which shows up especially well under oblique lighting. Elongated fins are rarely found in characins but *Triportheus elongatus* and *Pseudocorynopoma doriae* are among the exceptions. Most aquarium characins are less than 2 inches in length and so are well suited for the average sized aquarium.

In general, the tetras or characins are well suited to the community tank. Some are, however, vegetarians; some omnivorous, and some are predators. Thus some are fin nippers and plant eaters will be found among them. Usual tetra fare will include a variety of foods, both live and dry. This undemanding nature also extends to temperature requirements but72° to 75° F is probably the optimum out of breeding season, 74° to 78° or sometimes 80° F for breeding.

Breeding characins is both easy and hard, depending upon the species. Almost all lay a large number of semi-adhesive eggs. They do not pair off as in the case of cichlids (such as angelfishes) but breed in groups as small as a pair up to as large as a school. Most of them will eat their eggs if given the opportunity. Since the tetras are a varied lot, exceptions do exist. *Copeina arnoldi* and various species of *Pyrrhulina,* and *Copella* do afford some measures of parental care. Some such as *Pseudocorynopoma doriae* are rumored to be able to store sperm cells for some time, resulting in several spawnings from one fertilization. Breeding conditions are usually best at 2-4 DH (German degrees of hardness) and a pH of from 5.5 to 6.5. Since the fry are very small after hatching, very fine first foods, such as infusoria, must be provided at the start. Once through this stage (about 1 to 2 weeks), rearing the fry is relatively easy, even using dry food.

The following may serve as a guide to spawning several popular characins:

A. Easy to Spawn
1. Bloodfin, *(Aphyocharax rubripinnis)*
2. Black tetra, *(Gymnocorymbus ternetzi)*
3. Buenos Aires tetra, *(Hemigrammus caudovittatus)*
4. Lemon tetra, *Hyphessobrycon pulchripinnis*
5. Head and Tail Light, *Hemmigrammus ocellifer*
6. Flame tetra, *Hyphessobrycon flammeus*
7. Black line tetra, *Hyphessobrycon scholzei*

B. Difficult to Spawn
1. Rosy tetra, *Hyphessobrycon rosaceus*
2. Serpae tetra, *Hyphessobrycon callistus*
3. Neon tetra, *Hyphessobrycon innesi*
4. Ulrey's tetra, *Hemigrammus ulreyi*
5. Rummy nose tetra, *Hemigrammus rhodostomus*

The Bleeding Heart Tetra

[Aquarium Journal, May 1959]

My first inkling that such a fish as the bleeding heart tetra existed came as a result of an article in the German aquarium magazine, DATZ, of December 1956. The description of the fish, which almost made my mouth water, went as follows:

"Characteristic of this fish is a bluish-red spot lying on each side of the body directly underneath the beginning of the dorsal fin and surrounded by a mother-of-pearl halo. Through the eye, a black band is struck, the width of which is equal to the pupil. The dorsal fin is decorated with a red-white-black-red-white stripe. In appearance, the fish is similar to the species, *Hyphessobrycon rosaceus.*" About a year later, I felt that this description was justified when I received several specimens of this magnificent fish for my collection. At first the fish was called the "Perez tetra" and later, the "bleeding heart tetra." The former name was after the Perez Brothers of Florida, then importers and wholesalers of tropical fishes.

The bleeding heart tetra appears to be closely related to the several other species of *Hyphessobrycon.* These are as follows:

1. *H. callistus*
2. *H. serpae*
3. *H. bentosi*
4. *H. copelandi*
5: *H. rosaceus.*

To somewhat confuse things, the first fish, *H. callistus,* was known as *H. serpae* in this country. It is now often called the serpae tetra. The last fish on the list is our common rosy tetra. The others on the list have been imported but usually wind up being called a serpae tetra or more often they are mistaken for *rosaceus.* [Editor's note: I have seen all these species imported alive into the United States. Of them all *callistus, bentosi, rosaceus,* and the author's present subject are the most colorful. Recently Mr. Hoedeman, a Dutch aquarist-ichthyologist, has seen fit to place all other species except his new one *(rubrostigma)* as subspecies of one species, *H. callistus. Sev*eral other ichthyologists who have studied characins believe that they are all distinct species. It is the editor's policy to follow the later view.]

The bleeding heart tetra resembles, to a great extent, the members of the above group. Hoedeman, of the Zoological Museum of Amsterdam, named the fish, *Hyphessobrycon rubrostigma (rubrostigma* means "with red spot") and noted that it is probably related to the five tetras noted above.

Leaving the problem of classification to the ichthyologists, the fish itself and its requirements prove somewhat less complicated. Although the exact location of its original habitat has remained a secret, we do know that the fish comes from Colombia. Full-grown adults sometimes exceed 2-1/2 inches and, at this size, the dorsal fin of the male is truly outstanding.

They are lively, schooling fish and are friendly in a community aquarium. Feeding bleeding hearts proved no problem as they fell all over one another to eat both live and dry foods. Although the water in the Cincinnati area is both hard (200 ppm) and alkaline (7.2-7.6 pH), these fish appeared in bright colors at all times. However, when placed in an aquarium in which the water had been adjusted for delicate killifish (pH 6.0, hardness 80 ppm), their colors became even more intense.

The bleeding heart tetra is not easy to sex since they are relatively deep-bodied fishes and the usual method of choosing the deeper-bodied fish as the female does not strictly hold. When less than full grown, there is no discernible difference in fin sizes either. However, utilizing an old method called, "candling," a decided difference can be seen between the sexes. Candling consists of backlighting the fish with a bright light, at which time the abdominal cavity becomes illuminated. In the females, the swim bladder is slightly curved to hook-shaped. The swim bladder in the males, on the other hand, is straighter with hardly any hook at all. These differences become more noticeable as the female fills with eggs.

Although never having been successful in spawning the bleeding heart tetra myself, a number of my friends have been fortunate in doing so. There is nothing unusual to report about the spawnings as they are similar to regular *serpae* breedings. The following points were noted, however:

1. Most spawnings took place in soft to moderately soft water (60 to 120 ppm).
2. pH appeared to be of less importance with a slight edge given to neutral or acid conditions. In most cases, adjusting the hardness of the water brought the pH down automatically to these conditions.
3. No breeder was able to reproduce the fish with consistency. Also, it was difficult to find pairs that would spawn.

A typical spawning should consist of a pair being placed in a 15-gallon aquarium (temperature 70° F, pH 6.8, hardness 80 ppm) the bottom of which had previously been covered with *Ceratophyllum, Ambulia* or nylon yarn. The breeding play should commence shortly afterward and consist of lively dashes from one end of the tank to another. The lighting should be arranged so that the main body of the water would be illuminated but the bottom remains darkened.

Spawning usually takes place the following morning (or else be completed by then; it is sometimes difficult to state exactly when it takes place). At this time the breeders should be removed. On the second to third day after the breeders are taken away, the fry hatch from the eggs and will be observed to be free-swimming in a matter of hours. The fry start immediately on newly hatched brine shrimp. One breeder even uses microworms. The young grow quite fast and are soon eating dry foods and larger brine shrimp.

I should also mention here that these fishes have the same pleasing habits of display that is so well known in *rosaceus.* They pair off, male to male, male to female or female to female, extend their fins to the fullest, assume their most intense colors and literally strut in front of each other, a gorgeous sight. By the way they are peaceful like *rosaceus,* not nippy like *callistus.*

With its great beauty and easy facility for getting along with its companions, the bleeding heart tetra would disappoint no aquarist who undertakes its care.

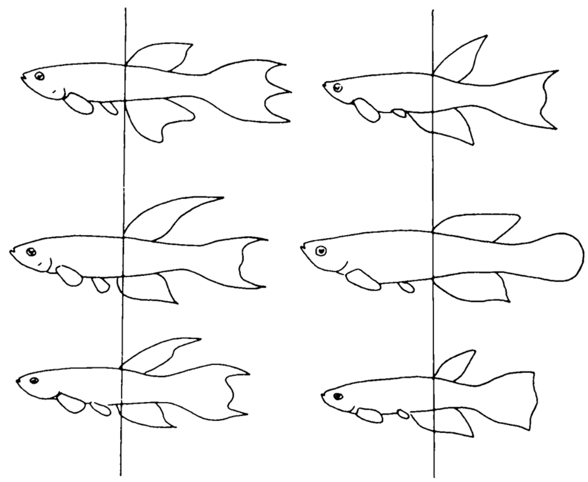
A Fresh Look at the Genus *Aphyosemion* –Part I

[Aquarium Journal, August 1960]

AN AQUARIST'S LOOK AT CLASSIFICATION

The African fishes of the genus *Aphyosemion* include some of the most beautiful fishes that have come into the hands of aquarists. These colorful killifishes have afforded aquarists many hours of pleasure, not only by gracing their tanks with rich colors and delicate forms, but by providing them with living material for tinkering with the magic of nature. Perhaps two of its best-known species are the lyretail and the blue gularis. However, there are so many points of difference between these two fishes that they are usually discussed separately and, indeed, it is often that the aquarist wonders if they are members of the same genus.

It does not take one long to recognize some purely external differences. The blue gularis, for example, is a much larger fish with a more projecting jaw and ponderous throat region. Another difference shows itself in the relative placement of the dorsal and anal fins. In the lyretail, the dorsal fin is shorter and is placed somewhat behind the anal fin. On the other hand, these two fins are directly opposite in the blue gularis. There are behavioral differences also that result in greatly different methods of breeding. Fishes such as the blue gularis are soil-breeders, that is to say, they deposit their eggs in the sand, gravel, mud or other material used as a covering for the bottom of the aquarium. These eggs take an extraordinarily long time to hatch, measured in weeks and even months. Unlike most other fish eggs, higher temperatures prolong the egg development time, this method of breeding being



Position of Dorsal and Anal Fins in Aphyosemions.

evolved through an ecological need of the species. Water in their natural habitat, the small water holes and pools in which these fishes live, periodically dries up. Although the parents may die, the eggs remain in the soil to develop and ultimately hatch under more favorable conditions. The lyretail, on the other hand, is a typical plant-thicket spawner, laying adhesive eggs on plants. It is true that the two weeks necessary before the eggs batch is still a comparatively long development time, but it is nowhere near as great as in the case of the blue gularis.

Therefore, it is not difficult to understand that aquarists have made several differentiations within the genus *Aphyosemion.* On a purely breeding basis, the classifications, "soil-breeder" and "plant-breeder" have evolved. Some years ago, ichthyologists recognized two subgenera of the genus *Aphyosemion* based mainly upon the relative position of the dorsal and anal fins. Included in the group, *Fundulopanchax,* were those fishes whose dorsal fins were directly over, slightly behind or slightly ahead of the anal fin. This measurement, it should be mentioned, was made at the forward base of these fins (see figure). *Fundulopanchax* then included, among others, all of the soil breeders plus *Aphyosemion bivittatum, A. loennbergii, A. multicolor, A. splendopleuris* and *A. bitaeniatum.* After a period of time, aquarists began to use the term *Fundulopanchax* purely in the generic sense such as *Fundulopanchax bivittatum, Fundulopanchax gularis,* etc.

In 1933, Dr. George Myers, an outstanding American ichthyologist, carefully reexamined the genus *Aphyosemion.* Perhaps no better introduction to this work could be made than to quote Dr. Myers: **"This genus is a very large one and contains several diverse elements. It was originally described to include especially those species . . . with low-set pectoral fins, rounded snout and posterior dorsal ... With these I included the more elongate species ... related to *gularis...* since it seems impossible to draw a line, based on dorsal [fin] position, to distinguish the two groups."** He goes on to say, **"Even on the rather incomplete and vague original description of the genus (particularly the rounded snout) it is possible to recognize well-preserved specimens of *Aphyosemion* without microscopic examination. This is well illustrated by the fact that aquarists, who in general know these fishes better than most ichthyologists, immediately accepted the genus and found no difficulty in recognizing its members in their aquaria. It was, in fact, the differences observed in aquaria that led me to describe the genus."**

From there on, Dr. Myers was unable to justify the splitting of the genus into two new ones on anatomical grounds. He did, however, reaffirm the two subgenera and added a third. His classification appeared as follows:

SUBGENUS *APHYOSEMION*

Those fishes with dorsal fin inserted slightly to considerably behind the origin of the anal fin; dorsal fin short with from 8-12 rays; smaller species with more rounded snouts and less projecting jaws. This subgenus included such fishes as *Aphyosemion australe, A. calliurum, A. vexillifer,* and others.

SUBGENUS *FUNDULOPANCHAX*

Those fishes with dorsal fins over or slightly behind the origin of the anal fin; dorsal fin longer with from 10-16 rays; larger species with more projecting jaws and heavier throat region. This subgenus included such fishes as *Aphyosemion gularis, A. arnoldi, A. bivittatum, A. multicolor,* and others.

SUBGENUS *CALLOPANCHAX*

Those fishes with dorsal fins over the origin of the anal fin; both fins relatively far forward on the body; very broad dorsal fin with from 17-19 rays. Only one fish, *Aphyosemion sjoestedti,* was included in this subgenus.

The addition of the last subgenus fell right in with aquarist's thinking, for *A. sjoestedti* resembles no other *Aphyosemion.* In addition to its external physical differences, it is a soil-breeder whose eggs take the longest of all aphyosemions to hatch, 2 to 6 months. Even the eggs of the soil-breeders of the subgenus *Fundulopanchax* do not take much over 8 weeks to hatch. From strictly an aquarist's point of view, however, the grouping was not quite satisfactory.

Within the subgenus *Fundulopanchax,* a clearly defined group could be distinguished. This is the so-called "bivittatum" group and includes *Aphyosemion bivittatum, A. loennbergii, A. multicolor, A. splendopleuris, A. rubrostictum* and *A. bitaeniatum, all fishes* of similar breeding behavior and appearance. The fin ray count in the dorsal fin varies between 10 and 13 and this fin in the males is considerably pointed and elongated. The most striking common feature is the horizontal dotting or striping on the fishes themselves, especially on the females (this will be brought out in sketches in the next part of this series). All of these fishes lay adhesive eggs on plants, which take 12-14 days to hatch under normal conditions. This is very much in contrast with the soil-breeder behavior of other members of the subgenus. From an aquaria's point of view, this certainly is justification for treating this group apart from the other members of the subgenus *Fundulopanchax.*

The well-known Dutch ichthyologist and aquarist, J. J. Hoedeman, in 1956 clearly recognized the existence of the "Bivittatum" group. On the basis of differences just noted, Mr. Hoedeman felt that four groups of *Aphyosemion* should be recognized (Hoedeman makes it clear that this classification is for aquarists only). These are as follows:

I. Small aphyosemions, incubation period of eggs about 12 days, plant spawners.

A. Females without longitudinal stripes, eggs laid on plants near water surface.
"Calliurum" Complex"

B. Females with 2 or more longitudinal stripes, eggs laid on plants near the bottom.
"Bivittatum" Complex"

II. Large aphyosemions, incubation period of eggs more than 2 weeks, soil-breeders.

C. Incubation period 30-40 days.
"Gulare" Complex"

D. Incubation period from 60 to more than 100 days.
"Sjoestedti" Complex"

Mr. Hoedeman had created four groups from Dr. Myers' three by splitting the latter's subgenus *Fundulopanchax.* As far as the aquarist was concerned, this was a decided improvement.

It would be nice if this aquarium classification scheme worked 100% of the time, unfortunately it does not. There are two things wrong with this classification (again may I emphasize that this is a scheme for aquarium purposes and not an ichthyological one):

(1) There are several aphyosemions that breed at times like plant-breeders and at other times like soil-breeders.

(2) Several members of the "bivittatum" complex lay eggs taking 30 or more days to hatch.

The latter statement may surprise some people but it is based upon my own personal experiences and will be amplified later.

In regard to the first statement, at least four species must be considered as "switch-breeders," as I shall call them. These are *Aphyosemion calabaricus, A. roloffi, A. calliurum,* and A. *labarrei.* The literature is filled with references to this breeding inconsistency of the first two and my own experiments have shown this also to be true with the last. Considering Dr. Myers' subgeneric classification, *Aphyosemion roloffi* and *A. labarrei* are related to the subgenus *Fundulopanchax* on the basis of dorsal-fin position and ray count (12-13 rays).

On the other hand, A. *calabaricus* possesses 9-11 rays in this fin and should therefore, be classed with the subgenus *Aphyosemion* (by similar reasoning, *A. calliurum* should also be placed here.)

The genus *Aphyosemion is* one, which certainly needs more study both by aquarists and ichthyologists. The whole question is complicated further by the tendency of this genus to form subspecies and to hybridize (at least 4 species have recognized subspecies). It is known that *Aphyosemion filamentosum* is one of the most variable of all fishes in pattern and color and it is suspected that *A. fallax* may be a natural hybrid of *A. gulare* and *A. spurrelli. The* "bivittatum" group itself may very well be a collection of subspecies. They are strikingly close not only in behavior and appearance but also inhabit the same and fairly restricted, zone in nature.

With this said, we next pass from classification to a more intimate look at the members of each group.

A Fresh Look at the Genus *Aphyosemion* –Part II

[Aquarium Journal, September 1960]

THE MEMBERS OF THE APHYOSEMION GROUPS

Few aquarium handbooks list all of the *Aphyosemion* species imported as aquarium fishes. For this reason, all but the very rarest are sketched for this article.

A. The Calliurum Group (figures 1-10)

This group includes *Aphyosemion australe, A. calliurum, A. cameronense, A. calabaricum, A. cognatum, A. meinkeni, A. oeseri, A petersi, A. schoutedeni* and *A. vexillifer,* at least these are the fishes of this group that have been kept by aquarists. Detailed, individual descriptions would be too space consuming for this article, however, a few remarks about selected members of the group are in order.

At least two members of the group apparently have subspecies. *Aphyosemion australe* is split into *A. australe* and *A. australe hjerresenii* (the latter is the golden or orange lyretail). It is commonly supposed that the orange lyretail is a comparatively recent introduction but German aquarists saw it in 1924 and again in 1930 (the subspecific name was finally added in 1953.) The species itself has been an aquarium fish since 1913!

Aphyosemion calliurum is split into *A. calliurum calliurum* (the yellow calliurum) and *A. calliurum ahli* (the blue calliurum). From the sketches, it can be seen how variable the patterns are in the dorsal, ventral, and anal fins. This variability is characteristic of many aphyosemions.

In some accounts, *Aphyosemion meinkeni* has been confused with *A. labarrei.* They are two distinct species and, indeed, the dorsal/anal fin juxtaposition as well as dorsal fin count, clearly place *labarrei* in the subgenus *Fundulopanchax* of Dr. Myers. It should be noted that *Aphyosemion meinkeni* and *A. calliurum* both are somewhat light shy and prefer the bottom strata of the aquarium for their living space.

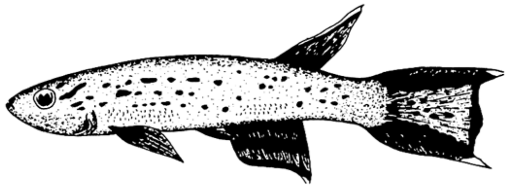


Fig. 1. The Lyretail, Aphyosemion australe

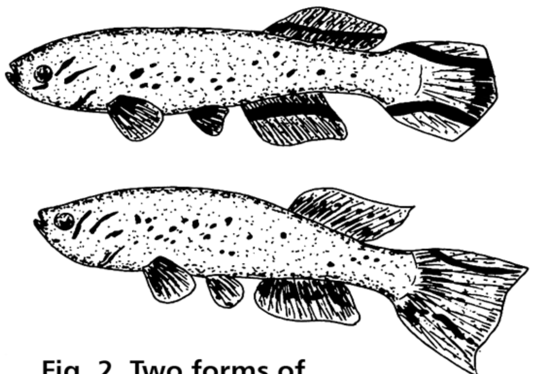


Fig. 2. Two forms of Aphyosemion calliurum

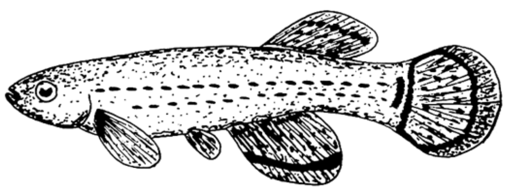


Fig. 3. Aphyosemion cameronense

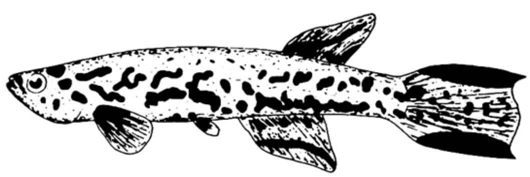


Fig. 4. Aphyosemion calabaricum

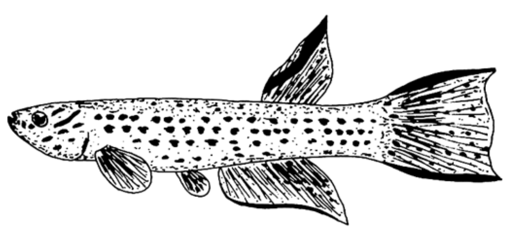


Fig. 5. Aphyosemion cognatum

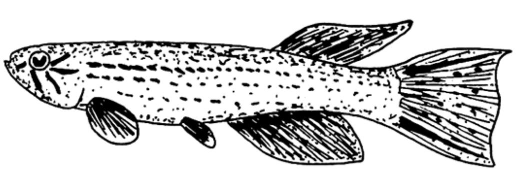


Fig. 6. Aphyosemion oeseri

One species I have never kept (therefore it is not pictured) and for which I can obtain little information is *Aphyosemion liberiense.* From the meager information I do have, however, it should be placed in this group.

B. The Bivittatum Group (Figs. 11-16)

This group includes *Aphyosemion bivittatum, A. bitaeniatum, A. rubrostictum, A. loennbergii, A. multicolor* and *A. splendopleuris.* Again, these are the species kept as aquarium fishes; there may be others in the future. *Aphyosemion bivittatum* has two subspecies, *A. bivittatum bivittatum, and A. bivittatum hollyi.* The species itself is a very old aquarium fish having first been imported into Germany in 1908. This whole group is, as a rule, light shy and prefers to spawn near the bottom of the aquarium on plants.

C. The Gulare Group (Figures 17-23)

This group includes Aphyosemion arnoldi, A. fallax, A. filamentosum, A. roloffi, A. gardneri, A. labarrei, and A. gulare. The last has two subspecies, A. *gulare gulare* (the yellow gularis) and *A. gulare coeruleum* (the blue gularis). *Aphyosemion arnoldi, A. filamentosum,* and *A. gardneri* have become the center of some identification controversy. American aquarists, in general, have gotten all three confused. Foreign aquarists, until relatively recently, confused *A. arnoldi* and *A. filamentosum.* To my knowledge, only *A. filamentosum* and *A. gardneri* have been imported into this country within the past few years in any quantity. The latter is by far the plainer of the two since it lacks the flashing colors of its cousin. Fortunately, *A. gardneri is* a fairly constant fish in pattern and can be recognized by the dark edgings to the dorsal, caudal, anal and ventral fins. In color, it varies from light blue to light violet. The picture in Innes' *Exotic Aquarium Fishes*, is not *A. gardneri* but *A. filamentosum.* Axelrod and Vorderwinkler in their *Encyclopedia of Tropical Fishes* 1st edi-

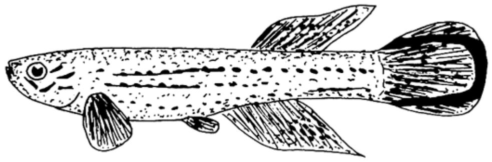


Fig. 7. Aphyosemion meinkeni

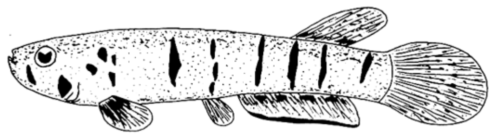


Fig. 8. Aphyosemion petersi

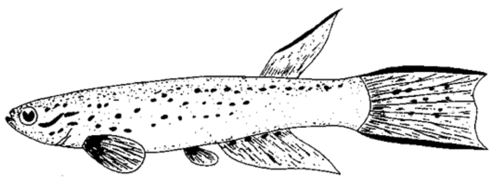


Fig. 9. Aphyosemion schouredeni

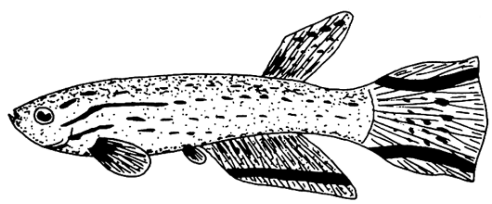


Fig. 10. Aphyosemion vexillifer

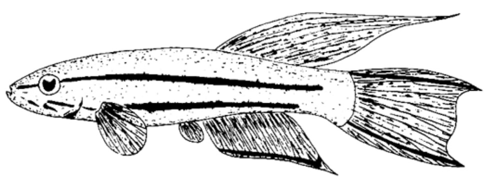


Fig. 11. Aphyosemion bivittatum

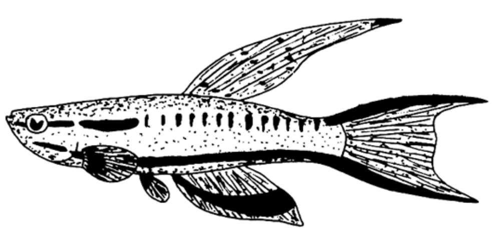


Fig. 12. Aphyosemion bitaeniatum

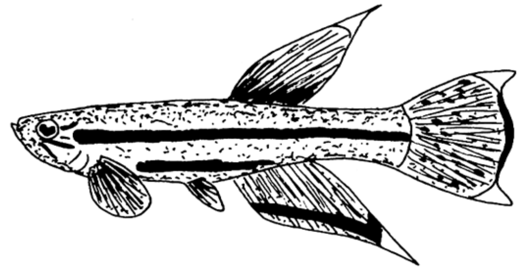


Fig. 13. Aphyosemion loennbergi

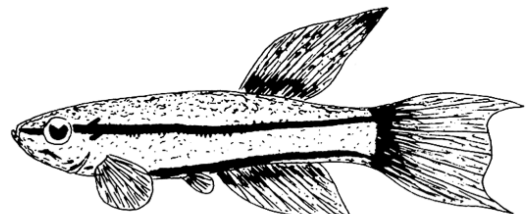


Fig. 14. Aphyosemion splendopleuris

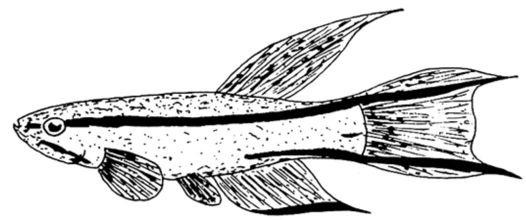


Fig. 15. Aphyosemion multicolor

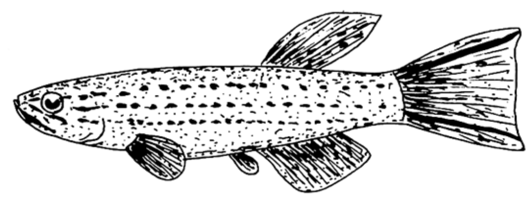


Fig. 16. Aphyosemion rubrostictum

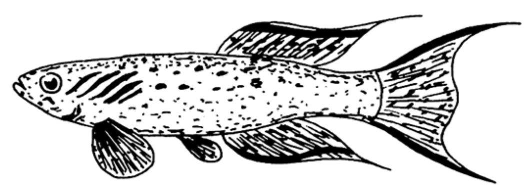


Fig. 17. Aphyosemion arnoldi

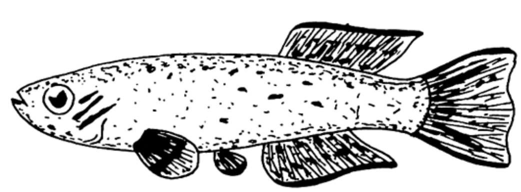


Fig. 18. Aphyosemion gardneri

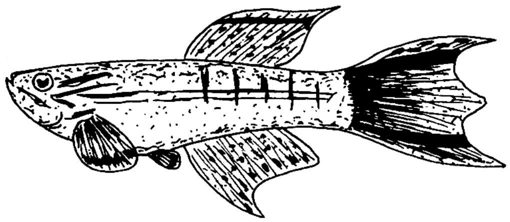


Fig. 19. Aphyosemion fallax

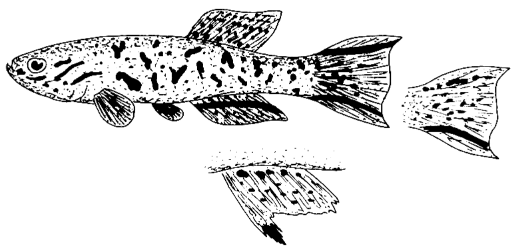


Fig. 20 Aphyosemion filamentosum with variations in pattern and form.

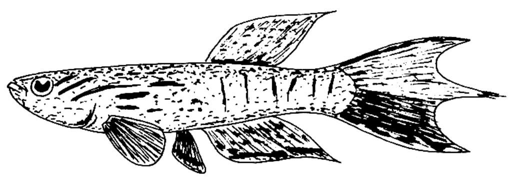


Fig. 21. Aphyosemion gulare

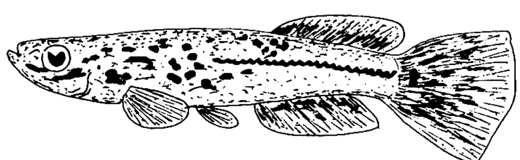


Fig. 22. Aphyosemion labarrei

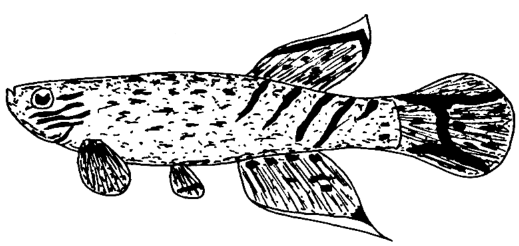


Fig. 23. Aphyosemion roloffi

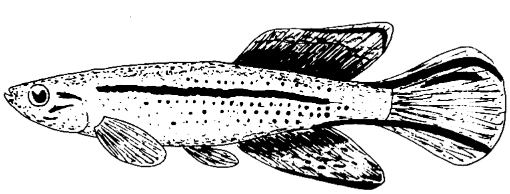


Fig. 24. Aphyosemion sjoestedti

tion, picture *A. gardneri* in color at the top of page 609. Be sure to look at the top picture as the lower is misidentified as another strain of *A. gardneri* while it is actually *A. filamentosum.*

Aphyosemion filamentosum, itself, is another matter. Here is an extremely variable fish in color and pattern. Figure 20 shows some of the alternate designs that it displays. As a matter of fact, subspecies probably could be assigned to this fish, just as in the case of *Aphyosemion calliurum.*

Aphyosemion arnoldi is a rare fish. It does not have the anal and tailfin markings of *A. filamentosum.* The tail, dorsal and anal fins have dark edgings somewhat like *A. gardneri.* However, its caudal peduncle is slimmer (the caudal peduncle is the base of the tail) and the elongations on its fins are longer than found with *A. gardneri.* Axelrod and Schultz, in their book, *Handbook of Tropical Aquarium Fishes*, show a correct drawing of this species. *Aphyosemion arnoldi* has 15 to 16 rays in its dorsal fin while *A. filamentosum* has only 13. I have examined specimens of *Aphyosemion* purporting to be *A. arnoldi* and have found only 13 rays. Aquarists certainly should have an easy time telling the three species apart (even without counting rays!). I have bred 2 forms of *A. filamentosum* and 2 forms of *A. gardneri* but have never kept or seen *A. arnoldi* (other than drawings) and therefore conclude the last-named to be a rare *Aphyosemion* in this country.

D. The Sjoestedti Group (Figure 24)

Its wide dorsal fin and extraordinarily long incubation time mark this as an unusual *Aphyosemion.*

A Fresh Look at the Genus *Aphyosemion* –Part III

[Aquarium Journal, October 1960]

CONCLUSION

A. Remarks on the "Switch Breeders"

It has long been known that *Aphyosemion calabaricum* spawns both on plants and also in the manner of the soil breeders. The usual breeding method is to spawn them on fine-leaved plants or nylon spawning mops. Under these conditions the eggs take from 12 to 20 days to hatch. In the absence of plants, however, the fish will spawn on the bottom and in such instances the eggs will take from 50 to 60 days to hatch. The choice of breeding behavior depends upon the aquarium setup. If there is gravel or sand on the bottom and nylon yarn or plants are present, the fish will most often spawn as a plant breeder. On the other hand, the absence of plants or yarn and the presence of a peat or mud bottom will result in a soil breeding behavior. *Aphyosemion roloffi* is less choosy and will assume either method apparently at whim.

One reliable literature reference states that *Aphyosemion laberri* is bred like *A. australe* but I could only get them to spawn via soil breeder procedure (4-6 weeks hatching time). Therefore, it perhaps must be concluded that *A. laberri is* a "switch breeder." From anatomical considerations, it is in the subgenus *Fundulopanchax* and ordinarily would be expected to breed as a soil breeder. In this respect, it behaves like *A. roloffi.* It must also be concluded, therefore, that the natural waters of these species are occasionally subjected to periods of dryness. Some reports state that *Aphyosemion rubrostictum* also is a "shift breeder." Unfortunately, this is another rare species I have not kept and so cannot confirm this.

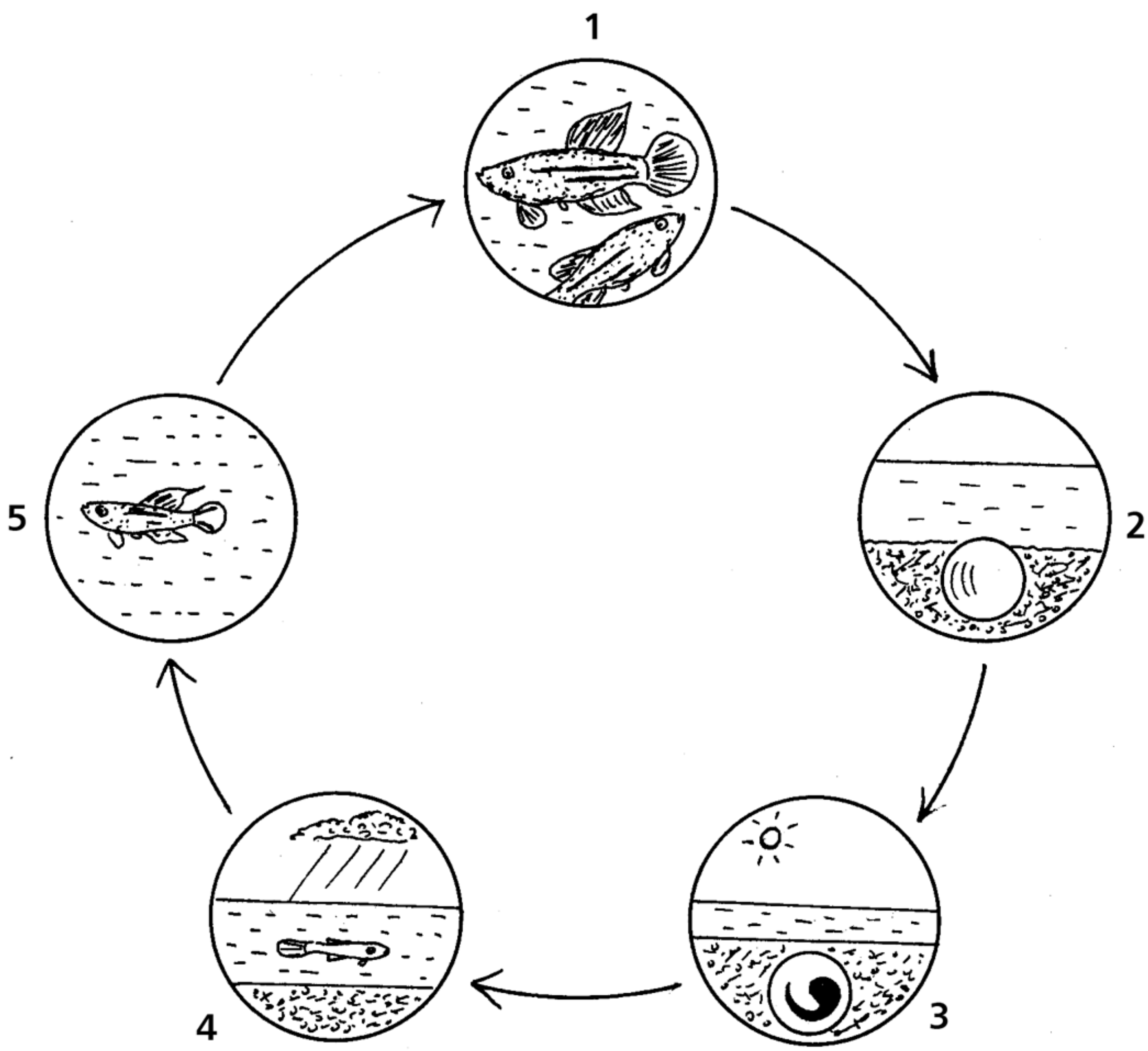
Some aquarists are under the impression that the idea of "shift breeding" is new, apparently neglecting the fact that Mr. Christopher Coates, Curator of the New York Aquarium, clearly stated this as early as 1933 in this country. As a matter of fact, the aquarium literature is full of references to shift breeding. Herman Meinken in his book (he is a coauthor), *Die Aquarienfische in Wort and Bild,* states that blue gularis occasionally lay some eggs on plants. Sterba, Innes, and Wilhelm all have documented the fact that *Aphyosemion filamentosum* has been known to do so, also. In an article last year in DIE AQUARIEN AND TERRARIEN ZEITSCHRIFT*,* Johannes Frank reported that A. *caliurum calliurum* eggs might take 4 to 5 weeks to hatch, depending upon the temperature. Recently, George Maier has reported the results of his experiences with *A. calliurum ahli,* which spawned for him as both a plant and a soil breeder. Usually, the eggs of this fish take about 20 days to hatch but Mr. Maier found this was extended, in some cases, to 31 days.

My own experiences with *Aphyosemion bivittatum* have shown that hatching times could be extended to over 30 *days* — the higher the temperature, the longer the hatching time. Perhaps this fish will also prove to be a shift breeder. As a final point, B. Verbruggen (in the July 1960 issue of the Dutch aquarium magazine, Het Aquarium) has stated that lyretails will sometimes spawn in peat in the manner of the soil breeders if no plants are present!

Thus, we must conclude that definite hatching times cannot be given for a great many aphyosemions nor can their spawning behavior be relegated to a single classification. This, therefore, accounts for discrepancies among published reports and the personal experiences of many aquarists. It is popular nowadays to pan the "experts" (a very unsatisfactory phrase as being all wrong. This is nonsense. The "experts" are not wrong, necessarily; their knowledge is merely incomplete. In this way, they prove to be human like the rest of us.

B. Remarks on the Annual Breeders

The term "annual fish" has been applied to all of the soil breeders, carte blanche, by many



GULARE-GROUP BREEDING CYCLE IN NATURE
1. Spawning in bottom
2. Egg being placed in bottom.
3. Partial drying of habitat.
4. Natural water addition via rain or water course diversion with hatching of fry.
5. Growth of young *Aphyosemion*.

aquarists. This, in my opinion, is a great mistake. “Annual fish” has far greater significance when applied to species of *Cynolebias, Nothobranchius,* and others where these fishes live in a true savanna-like climate characterized by a definite and prolonged dry period. If the term is to be applied merely upon the basis of longevity, then it is logical to include guppies and bettas as “annual fishes.” What aquarists usually mean by the term is related to certain peculiarities of a fish’s natural habitat.

Members of the “gulare” group are found in rainforest regions and their soil-breeding behavior coupled with a long egg incubation time is not a result only of the cyclic “wet-dry” characteristics of these regions, but also as a consequence of sub cycles within the wet periods. The gulare group and the bivittatum group fishes frequently inhabit watercourses so small that they tend to dry even during periods of normal rainfall. As discussed previously, blue gularis occasionally become plant-breeders, laying their eggs above the bottom. It has also been demonstrated, time and time again, that drying is *not* a necessary condition for the development of gulare group eggs. These differences, therefore, should be sufficient to exclude almost all aphyosemions from the "annual fish" class. Hence, the only *Aphyosemion* that can rightly be called "annual," is *Aphyosemion sjoestedti.* This discussion brings us logically into the final phase of this series of the genus *Aphyosemion.*

Aphyosemions are found in what amounts to equatorial West Africa. Dr. Ladiges tells us that *Aphyosemion arnoldi* is found in small, strongly overgrown pools containing almost black water. The water color results from a consequence of organic decay products, for example, humic acid. *Aphyosemion gardneri* is reported to occur in still smaller to the smallest possible muddy pools, even to the extent of footmarks on muddy paths! Thus we see how a habitat can dry even in a relatively wet environment.

In water holes in Ikany (formerly German Togoland) are found great numbers of *Aphyosemion bitaeniatum* and these are easily captured with nets. Aphyosemions are also found in the Sierra Leone River upwards in the direction of Port Lokko above the brackish water zone in side streams.

The land is marshy and thickly overgrown with grass. For one particular instance, a small side stream running through this region terminated as a series of small pools around the border of the area. The width of the pools was about 2 feet and the depth reached about 8-14 inches. There is a dry period here during which the pools dry up, so adaptability of the soil breeders to these adverse conditions is easily appreciated. Aphyosemions can be found, therefore, in small, slowly flowing, very shallow watercourses, pools, and spring marshes. These are mostly in the rainforests of the coastal regions, and occasionally become admixed with salt water containing rich amounts of humus materials.

The effect of the rainy season upon the water characteristics is remarkable. At other times of the year, the pH is reported to measure under 7.0, usually about 6.0 near the coast and even below 5.0 in the Blackwater regions inland. During the rainy period, the pH *rises* close to 6.0 inland. Also during the rainy period, the hardness of the water *drops* to almost 0 DH as opposed to up to 10 DH at other times. The organic content of the water drops to, typically, 30 milligram per liter during the "dry" season up to 50 during the rainy season. Surprisingly, the temperature stays fairly constant, and never rises much above 77° F.

In general, the plant breeders inhabit the so-called rainforest areas of Africa in which, although there is no real dry season, there are periods in which the rainfall doubles or triples. The soil breeders either occupy pools so small that they dry even in a rainforest region or else inhabit a climatic region known as a savanna that does have a decided dry season. The effect of temperature upon the eggs of Aphyosemion species is reversed from the usual state of affairs with aquarium fishes due to this "wet-dry" cycle. For aphyosemions, especially the soil breeders, the higher the temperature, the longer the eggs take to hatch. It would be unfortunate for these fishes were this not so for it would mean that the fry would hatch out in drying pools, to face the prospect of a rather bleak hunt for food. It is reasonable to imagine that, the smaller the pool, the higher the temperature. From what we have seen, the relationship holds for mineral concentration also. Loeb has shown that increasing mineral concentrations in the water of the soil breeders hinders the development of the eggs. As soon as this concentration is reduced, as for example would occur during the diluting effect of the rainy season, the fry hatch out.

The eggs of the soil breeders are somewhat different from those of the plant spawners. The eggs of the latter are adhesive by virtue of a long, sticky thread hanging from the shell. The eggs of the soil breeders, on the other hand, are covered with very tiny, fine hairs. The hairs may function as an anchor in the mud or other material in which they are laid but their function is not totally clear. George Maier has found that the eggs of *Aphyosemion calliurum ahli* are surrounded with a sticky band, the usual sticky thread being absent. A microscopic examination of the eggs of the species of *Aphyosemion* should prove interesting to fanciers of these fishes.

The aquarist's old trick of freeing *Aphyosemion* fry from the egg by transferring them to dirty water is appreciated now in the light of the fish's natural habitat. The purpose of the dirty water (some aquarists go so far as to add drops of microworm culture) is to introduce bacteria that soften the shell of the eggs, thus permitting the fry to hatch out. During the dry period, when the pH is low, the bacterial concentration is low. As the rains come, the pH rises and so does the bacteria population.

Taking all these factors into consideration, we can ascertain the requirements of the genus. We need shade, thick planting, and quiet water. The temperature should remain low, about 72° F, both for fish and eggs. This should increase the longevity of our fishes and decrease the hatching time for the eggs. We can appreciate the wide ranges of pH and hardness that these fishes can withstand, provided that the upper limits are not exceeded and changes are gradual. Indeed, such changes might well be needed by these species for otherwise they will spawn continually and soon wear themselves out.

In this series of articles, I have attempted to summarize those aspects of the genus *Aphyosemion* that have been sketchily treated in the past. For those aquarists interested in this appealing genus of fishes, I hope this material will provide a helpful background for additional study of the group.

The Genus *Botia*

[Aquarium Journal, March 1961]

During the past few years, importations have provided aquarists with an increased number of members of the genus *Botia.* Prior to this, the only *Botia* available to aquarists in any quantity was the beautiful clown loach, *Botia macracantha.* Since information concerning the new botias is practically non-existent in American aquarium literature, the naming of these fishes together with expected behavior patterns poses several problems.

The genus *Botia* belongs to the loach family, known as Cobitidae. They belong to a group of loaches possessing single or double movable spines under the eye. This group also includes members of the genus *Acanthophthalmus,* such as the "kuhlii loach." The spines in this genus are so developed that German aquarists refer to them as "thorneyes" (Dornauge) and indeed these spines do present some difficulties for aquarists when the spines become enmeshed within a net. To prevent damage to the fish, it is best that the net be cut. In the genus *Botia,* the spines are a sort of protective device. Hugh M. Smith reports that snakes, attempting to swallow these fishes, often become victims of their own hunger. The similarity of the spines to the tusks of wild pigs leads to the Siamese name for the botia of "pia hu" or "pigfish."

It is interesting to note accounts of their existence in their natural habitats. According to

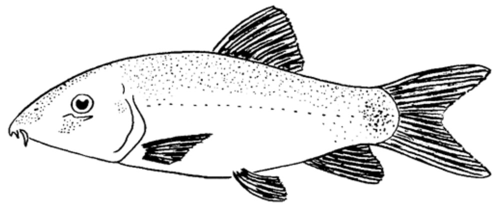
Smith, the genus it characteristically an inhabitant of rock caves, continually rooting in the sand and water debris. A few species, however, are found in large muddy rivers and even lakes. Nazir Ahmad writes in his work on fishes of Lahore (West Pakistan) that the loaches of this region lay in mulm and organic debris of dirty pools. We know at least one Botia from this region. The point is that the botias differ in their environment requirements. Obviously, the still-water forms will prefer different surroundings than the river species. An examination of a fish's body form is often a valuable aid to the aquarist in predicting its requirements. Some of our botias lack the straight ventral or belly lines of the typical bottom fishes. Others do exhibit this characteristic. Of course, actual experience with these fishes indicates marked differences in behavior patterns. It has been observed, for instance, that the clown loach will not be uncomfortable in the absence of rocky hiding places providing the aquarium planting is heavy. The tiger botia *(B. hymenophysa)* on the other hand, is active in the sand and under rocks. It is quite a "foxhole digger" and tends toward being a fin-nipper, something the clown loach is not.

Inevitably, the question of breeding botias arises. There has (to the date of writing) been no published report of successful breedings of these fishes to the author's knowledge. However, in private conversations with at least one reputable source (the breeder himself), we have received information that the clown loath has bred on more than one occasion. The spawnings were more or less in the typical bubble-nesting manner. That this loach breeds in this way is no guarantee that others of the genus will breed in a similar manner. Consider the cichlid genus, *Tilapia,* for example. Although the tilapias are normally considered by aquarists to be mouthbreeders, some species do breed in the normal cichlid way. Even among the *Tilapia* mouthbreeders, in some species it will be the male who incubates the eggs while, in others, this task falls to the female. Certainly each species of *Botia* will have to be studied individually in order to determine

TABLE I

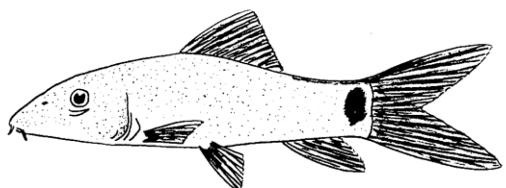
Water Analyses From Southeast Asia

	Medan City (Northeast Sumatra)	Singapore jungle water	Jahore State (Southern Malaysia)
clarity	Turbid	Turbid	clear
Color	Yellowish	Colorless	n.t.*
odor	Extreme decay	None	n.t.
pH	6.1	6.0	5.3-5.9
Ammonia, ppm	2.6	0	n.t
Nitrate, ppm	20	0	n.t.
Dissolved iron, ppm	1	Trace	0.3-2.3
Total hardness, ppm	40	10	n.t.
Dissolved manganese, ppm	3.6	0	n.t.
Sulphate, ppm	3.6	0	n.t.
*n.t. = not tested			

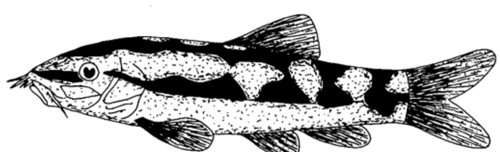


Botia modesta **(Bleeker**

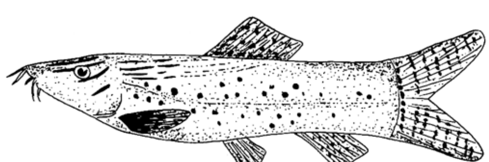
Botia lohachata **Chaudari**



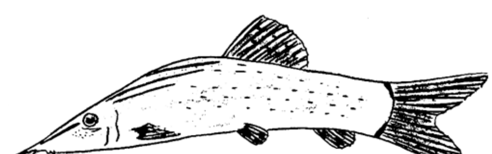
Botia lecontei **Fowler**



Botia sidthimunki **Klausewitz**



Botia beauforti **Smith**



Botia berdmorei **Blyth**

under what conditions and the manner in which they will breed. The botias are "problem" fishes and obviously considerable ingenuity will be needed to induce breeding.

Table I, which contains three water analyses from Southeast Asia, indicates some interesting features of the natural habitat and water in which our aquarium botias are found. The first two analyses are extracted (in a modified form) from Dr. Ladiges' book, *Der Fish in der Landschraft* (The Fish in Its Habitat); the third is from Comdr. Alfred Marsak's articles on his expeditions in Malaya. As can be seen, there are some differences among the analyses. The Medan City analysis (See Figure 1) indicates water with a considerable content of organic matter. The hardness, while not as low as the Singapore water, is low by our standards. Singapore jungle water is, of course, extremely low in dissolved materials. All of the analyses indicate a low pH, and iron dissolved in the water. In one case (Medan City), a high manganese content was found.

Which if any of these factors is important in the breeding of botias is not known. There is much room for experimentation here. If pH is important, it is probably the nature of the pH, rather than its absolute value, that is more critical. This, unfortunately, the analyses do not give us. Although mineral acids like nitric and sulfuric may be present and contributing to the pH, organic acids such as tannic and the so-called "humic" acids may be far more significant. The many experiments with peat filtration have indicated that organic acids are helpful in keeping and breeding many "problem" fishes. Whether success in these cases is due to an indirect effect, such as the reduction of water bacteria* and the reduction of light due to the colored organic acids or whether there is an unknown more direct effect upon fishes again is not known. This is a fertile field for the aquarist with an interest in experimentation.

As an aid in the identification of these fishes, the following is an annotated list of Southeast Asian aquarium botias.

***The bacteria content of the Medan City water, in spite of its turbidity and organic content, was surprisingly low.**

Botia macracantha (Bleeker)

This, of course, is the popular and beautiful clown loath. With two exceptions, the botias to be described by the author will have six barbels, 4 on the nose and the other 2 on the corners of the mouth. One of these exceptions is the clown loath which, in addition to these 6, has another pair located on the tip of the lower jaws. Thus the 8 barbels together with its broad dark vertical bands distinguish this loath. The bands are three in number. The first is through the eye; the second is in front of the dorsal fin; the third is between the tail and the dorsal fin and passes through the anal fin. The base color of the fish is orange and all fins are red. The dorsal fin has, as an upper border, a dark band. It is native to Sumatra and Borneo and reaches a length of 12 inches. Aquarium specimens are very much shorter.

Botia hymenophysa (Bleeker)

This botia is popularly known as the tiger botia. Unfortunately for identification purposes, color and markings in this species vary considerably. The sketch of *B. lucasbahi* without the dorsal stripe may be taken as *B. hymenophysa.* There are from 10-12 slanting bands on the body and the dorsal fin contains 11-13 branched rays. According to Smith, the color of a newly captured specimen is as follows: Back and sides yellow with 11 somewhat slanted blue vertical bands. The distance between the bands is narrower than the bands themselves. The upper part of the rear band is darker and composed of blue spots. The top of the head is blue; ventral surfaces pale yellow. Dorsal fin is yellowish-orange with 4 blue oblique lines. The tail fin is yellowish-orange with 4 narrow blue oblique bands at the base; other fins are bright yellow." Weber and Beaufort, however, describe the species as having brown hands with blue borders and a blue spot on the upper third of the anterior dorsal ray. Aquarium specimens usually do not show any bright colors. Undoubtedly color varies according to the locality of collection. Length to almost 9 inches, aquarium specimens usually reaching no more than 4-6 inches. Habitat: Sumatra, Borneo, Java, Malay Peninsula, and Siam.

Botia lucasbahi Fowler

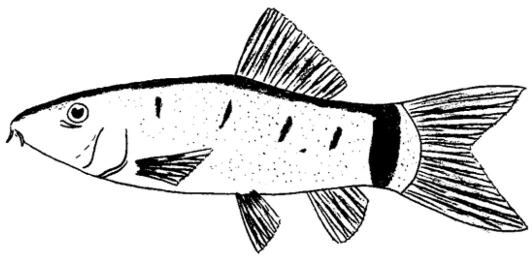
This species is very similar to the preceding one and may not be distinct. There are 10-15 dark slanting bands on the body, as wide or wider than the distance between them. The dorsal fin contains 9-10 branched rays and flaunts a black border. The fish is apparently a form from larger and calmer waters. Habitat: similar as for *B. hymenophysa.*

Botia beauforti Smith

This is a long *Botia* with an exceptionally thick tail base. There are a number of dark spots (bordered by a lighter ring) on the sides. The dorsal fin has numerous dark spots. Several curved bars decorate the head; there are 5 straight lines on the back from the head to the dorsal fin. Basic color is bright grayish-green. Dorsal and tail fins are bright orange with oblique lines of black spots. The anal fin is yellow with slanting brown spots. Other fins are pale orange. The spots on the flanks form a series of long lines. Dorsal contains 9-branched rays. Length to 10 inches. Habitat: Siam.

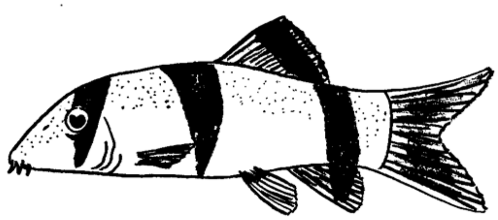
Botia modesta (Bleeker)

This loach possesses a heavy-set body. It has been given the popular name of blue botia (also incorrectly called *B. pulchripinnis).* The blue botia is devoid of markings with the exception of a weak pattern on the tail root, however, this is often totally lacking. The body color is variable but tends mostly to blue-grey or blue-green. The underneath is pale yellow or white. All fins are bright orange, orange-red or yellow: ventral fins are somewhat lighter than the others. Length to 10 inches. It is a food fish in Siam where it is known as "pia mu khav" (white pigfish). Also from the Malay Peninsula.



***Botia horae* Smith**

***Botia lucasbahi* Fowler**



***Botia macracantha* (Bleeker)**

Botia lecontei Fowler

Aquarists have known this Botia as the green botia. It is similar to *B. modesta* and differs mainly in that the green botia is a much slimmer fish and has a strong to oval spot on the tail root (under certain conditions this spot may fade out). *B. lecontei* has a slim body, straight ventral area, and a narrow tail root. *B. modesta,* on the other hand, is a plump form with a broad tail base and a rounded ventral area. The green botia is also variably colored; base color is pale with a hint of green, some specimens are slightly blue-green. The fins are light red to orange. Length uncertain but reaches at least 5 inches. Habitat: Malay, East Siam.

Botia berdmorei Blyth

Botia berdmorei differs from *B. beauforti* in two details:

(1) The tail base of *B. berdmorei is* considerably thinner than that of its cousin.

(2) In *Botia beauforti,* the dorsal fin begins ahead of the ventral fins, while in **B.** *berdmorei,* the dorsal is practically right over the ventral. In addition, the dorsal fin is not quite as brilliantly colored as is the case with *B. beauforti* and presents a more yellowish sheen. Habitat, Burma and Thailand. Length to 10 inches (aquarium specimens much smaller, however).

Botia lohachata Chaudhuri

Here is a very distinctive botia from Pakistan. It is also another exception to the “six barbel rule” as, like the clown loach, it has eight barbels. The body color is silver-gray with a gold-yellow sheen. A distinguishing feature is the black Y-shaped markings on the sides of the body. These markings vary considerably, however, and may at times have grayish centers, giving the effect of gray Ys surrounded by black Ys. Our drawing shows a solid black form of Y-markings. The fish usually attains an aquarium length of about three inches. In deportment, the Lohachata loach is less shy and less aggressive than most other botias. It does not seem to burrow like some other species, either. Altogether, a pretty addition to a community aquarium.

Botia horae Smith

Our last *Botia is* well marked. There are 3 or 4 slanting lines on the body according to the mood of the fish. In most cases these are only faintly suggested. In addition to these there is a large dark band around the tail. From the tip of the nose to the tail band on the back is a dark band. Coloration similar to that of *B. modesta.* Length to 5 inches. Habitat: Siam.

There has been some confusion concerning *B. modesta, lecontei,* and *horae.* The American ichthyologist Fowler and the Indian ichthyologist Hora have described *B. modesta* as having a back band. Smith, on the other hand, described this fish without back band but with a tail band. The original description by Bleeker, however, was that *B. modesta* had neither bands, stripes nor spots. Although most of the descriptions in this article are after those of Dr. von Wahlert (Ichthyologist with Overseas Museum in Bremen, Germany), the author has included the opinions of Dr. Wolfgang Klausewitz (Senckenberg Nature Museum, Frankfurt, Germany), which apply to these three fishes.

Botia sidthimunki Klausewitz

Believe it or not, here is a dwarf Botia that, as an adult, barely reaches over 1% inches in length! Like others of the genus, it is a bottom dweller but less of a "hide-and-seeker." It prefers the security of an overhanging rock or a hollow stone to the customary gravel burrowing of its cousins. The sketch gives the pattern of this dwarf botia fairly well but cannot, of course, show the pleasant yellow-brown body colors. The black pattern varies somewhat from fish to fish but the portrayal is a typical one. As is common in many of our aquarium fishes, the young show more "crisp" designs. This can be compared with the clown loach, for example, where the young are much better patterned than the adults. Dr. Klausewitz supplies us with a short water analysis of its place of capture in Siam: pH — about 8 and hardness, about 4 DH.

Sexing Tropical Fishes

[Aquarium Journal, April 1961]

In a recent issue of the BOSTON AQUARIUM NEWS (a publication of the Boston Aquarium Society, Inc.), Dr. Theodore W. Sprague makes an interesting and sagacious observation concerning probabilities associated with the problem of choosing pairs of fishes from dealers' tanks. The discussion concerns the cichlid, *Cichlasoma severum,* and appears as follows:

"I had six of this species, which grew to a good size. Their most notable accomplishment was a number of spawnings by one or more of the females, who would allow none of the others to approach the spawning site. It is possible that my fish were all females, though on the basis of probabilities this would seem unlikely. Incidentally, this raises the question as to whether the chances of securing at least one of each sex when we buy a batch of young fish may not sometimes be poorer than considerations of simple probabilities alone would suggest. That is, 'the dice may be loaded': for example, if one is the first to draw from a dealer's tank and selects the largest specimens, may one not possibly increase the chances of getting all males? Or all females if other customers have already culled the handsomest?"

Dr. Sprague's point is well taken and opens up a field for discussion, which serves as a sequel to my article in the AQUARIUM JOURNAL treating this concept of "sexing by probability" ("A Novel Approach to Selecting Pairs of Fishes," July 1958). This problem can be stated as follows: "How many fish must I buy to virtually assure myself that I will obtain at least one true pair, when I am unable to determine their sex?" This problem can be extended to include two, three, or more pairs. The question arises whenever aquarium fishes are too small to sex with confidence or whenever sexing criteria for the species in question are not available. Thus, how would one sex baby neon tetras? Or, how does one sex scats? The answers to these questions are simple but unsatisfactory - one just doesn't sex these fishes without some plain or fancy guessing.

Aquarists have approached this problem in the simplest possible way - they merely buy more than two fish, hoping that there will be at least one pair in the purchase. But how many fish? Three? Five? Ten? Since there is a limit to the size of the aquarist's pocketbook, there is a limit to the number of fish he can purchase. For any given number of fish in a purchase, the number of true pairs of fish obtained will depend upon two things:

(1) The number of fish from which the aquarist makes his purchase, and

(2) The sex distribution of this original number.

In regard to the first factor - if the ratio of males to females is 2:1 and there are only three fish from which to choose, then the aquarist is 100% sure of obtaining a pair if he buys all three. On the other hand, if there are 100 fishes from which to choose and he still buys three fishes, his chances of obtaining a pair are considerably less than 100% (actually, about 67%). In regard to the second factor if the ratio of males to females is 1:1 and the aquarist buys three fishes out of a lot of 100, his chances of getting a pair are now increased to 75% (as opposed to 67% with a 2:1 ratio). In the article in the July 1958 issue of the JOURNAL, probabilities for picking one or more pairs of fishes for varying sex ratios were given. Dr. Sprague indicates that the story is not quite told, however, and I quite agree with him.

Although the hobbyist can usually estimate the number of fishes in a dealer's tank, he will usually know nothing about the distribution of sexes and must, therefore, assume some reasonable value, say 50/50 or 60/40. Dr. Sprague points out that (a), the lot of fishes may already have been picked over, resulting in vastly unequal proportions of males to females, and (b), that if the aquarist is first at the dealer's tank, he may consciously choose and make judgments as to sex, resulting again in a sex ratio different from 50/50. In case (a), the Laws of the Calculus of Probability are still quite valid, the only problem being that now the sex ratio is presumably different from 50/50 and unknown to the aquarist. In general, if the sex ratio differs from 50/50, the probability of picking a pair is lessened; if the number of fishes to choose from is smaller, the probability of picking a pair will be greater. Unfortunately, the improvement from the latter factor is tiny as compared to the disadvantage of the former (see table).

To cite a hypothetical example, imagine a tank of 120 fish, 60 males and 60 females. Suppose other aquarists have so chosen their purchases so as to pick two males for every female they buy. After 90 purchases (60 males and 30 females), you now enter the store and pick two fish at random. Your probabilities of getting a pair will be a big goose egg, or zero! There are

TABLE 1

PROBABILITIES (IN PERCENTAGES) FOR PICKING A SINGLE PAIR FROM A POPULATION

	Number of fishes purchased					
Number of fishes in dealer's tank	**2**	**3**	**4**	**5**	**6**	**7**
300	**50.2**	**75.3**	**87.8**	**94.0**	**97.0**	**98.6**
40	**51.3**	**76.9**	**89.4**	**95.3**	**98.0**	**99.2**
8	**57.1**	**85.7**	**97.1**	**100.0**	**100.0**	**100.0**

no males left. It must be remembered, however, that other aquarists in this example *were* able to sex the fish, at least to the tune of two males to every female. This brings us to a basic assumption involved in all of our statements about probability, that of the random sample. In this respect, we now illustrate a reverse example of Dr. Spragues' second point.

The theory behind probability discussions of the sort treated here heavily depends upon the aquarist's choice of fishes being a random sample. This is to say, that it is assumed that the fishes are picked at random, no attempt being made in sexing them. In most cases, if the aquarist does know something about the external characteristics of the fish in question, the probabilities of getting a pair will be increased. However, if the aquarist is only fooling himself and really knows nothing about sexing the fish, any discrimination on his part *could* result in lower probabilities of picking a pair. Consider the following hypothetical situation. Imagine a species of fish in which the females are normally larger than the males but the latter are much more aggressive; in other words, the runts of the litter are most likely to be females since the males are the first ones to reach the food. Thus, the largest fishes in the dealer's tank are females and the smallest (the runts) are, also. Now suppose that an aquarist feels that the small fishes are the males and the largest are the females (a frequent assumption). On this basis, he will always pick, in reality, almost all females, whereas had he picked fishes at random, he would have gotten the probabilities noted in the tables of my previous article.

Thus, to use the probability method, one must play fair with its basic assumptions. The method works best when there are absolutely no indications as to sex. If you really can't sex the fish in question, it is best to play it the probability way. Any judgments of sex that are not valid may hurt your chances of procuring a pair. And in the final analysis, we find we use the probability method when there is nothing else to use. Unfortunately for aquarists wishing to breed fishes, this circumstance is not infrequent.

Conductivity Measurements of Aquarium Water, Part I

[Aquarium Journal, April 1961. Note: This article was co-authored with Donald J. Stoneking, AJK being the Senior Author..]

The number of qualitative measurements made by aquarists is many fold; color, taste, smell, and all the allied measurements suggested by these three senses. On the basis of such qualitative observations, the aquarist makes his many decisions. In an effort to more closely identify those factors pertinent to successful aquarium management, hobbyists have also added a number of quantitative measurements to their list of techniques notably temperature, pH and more recently, hardness. All of these measurements (both qualitative and quantitative), of course, are made on the one commodity basic to all aquarium keeping, the water itself.

None of these measurements by themselves tell the whole story. All must be integrated to implement the solution of our aquarium problems. Occasionally, certain measurements are singled out for attack by some aquarists — pH is a favorite "whipping boy." Such hobbyists incompletely understand that the whole is made up of its parts. What frequently occurs is that, lacking many quantitative measurements from which to choose, hobbyists are forced to talk about the ones they know and can use. Thus, the measurement of pH is stressed frequently. Thoughtful hobbyists, however, go more deeply than just pH. For instance, it appears that the "kind" of pH is more important than the value itself. It makes a difference whether water is acid as a result of humic acid or sulfuric acid content. This, however, is another story.

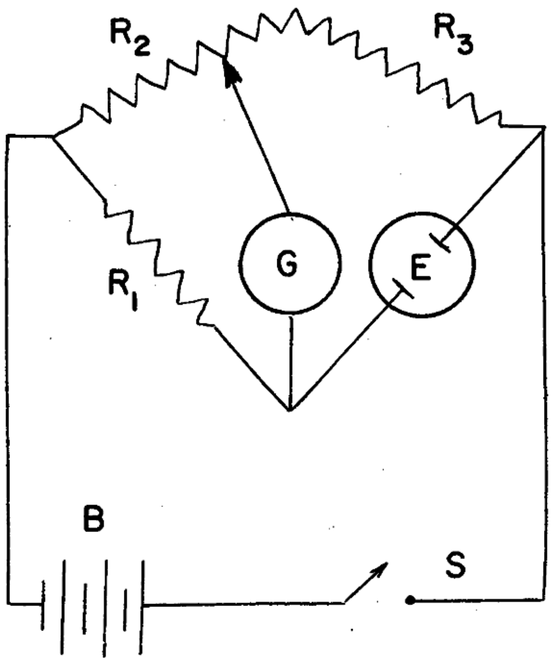


Figure 1: R_1, R_3 and R_3 are resistances; G - galvanometer; E - electrodes (conductivity cell); S - switch (momentary contact type), and B - battery. Sketch by Albert J. Klee.

In a similar manner, although hardness measurements are valuable to aquarists under certain conditions, they too, tell only a part of the story. Interest in the pH and hardness of aquarium water came about as a result of the observation that our domestic water supplies differed in these two measured quantities from water analyses gleaned from natural habitat data. Comparisons of domestic vs. natural habitat analyses show an additional striking fact; however the total dissolved solids is much less in habitat water (excluding brackish-water fishes and livebearers). For example, the dissolved solids content of habitat water of the so-called "problem fishes" usually lies between 20 and 70 parts per million. Among inland waters of the United States supporting a good fish fauna, only about 5% have a dissolved solids concentration under 72 ppm; about 50%, under 169 ppm; and about 45%, under 400 ppm.

All substances in solution in aquarium water collectively exert osmotic pressure on the fishes living in it and the aquatic life is adapted to the conditions imposed upon the water by its dissolved constituents. It is interesting to note that the practice of aquarists of softening water does not appreciably affect the dissolved solids content, for what is accomplished is merely to exchange calcium and magnesium ions (i.e., hardness) for sodium ions. Thus, we adjust the calcium and magnesium content to match the water of a fish's natural habitat and, at the same time, horribly mismatch the sodium content. In another instance, aquarists who "cut" their aquarium water with forms of distilled water are admonished to replace the hard salts lost with soft salts such as sodium compounds. Since the total (i.e., "hard" and "soft") salt content of habitat waters is frequently low, this is rather misdirected advice (bearing in mind, however, that fish cannot survive in pure distilled water). In effect, hobbyists fiddle with the salt content of aquarium water, but with the exception of hardness, have no quantitative idea of what they are doing.

As was brought out in Jorgen Scheel's articles in the November and December 1960 issues of the *Aquarium Journal,* electrical conductance is a quick method for determining the electrolyte concentration of aquarium water. The specific conductance of a dilute solution of a salt

TABLE I

mg/l NaCl	Conductance, micromhos
24	40
37	80
50	80
56	90
75	120
100	160
113	180

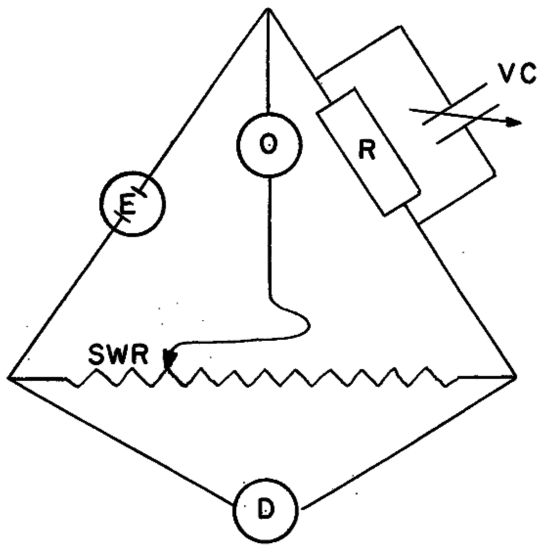


Figure 2: R - resistance box; E - electrodes (conductivity cell); VC - variable condenser; D - detector (can be headphones, AC galvanometer, etc.); O - AC current source, usually 1000 cycles/sec; SWR - slide wire resistance (the point of balance is found by moving the sliding resistance until the detector indicates balance). Sketch by Albert J. Klee.

is almost directly proportional to the ionic concentration of the salt, and the total conductivity of a given water is equal to the sums of the several conductivities resulting from the ionizable salts present. The determination of conductivity can, therefore, be related to the dissolved solids concentration. We think that Mr. Scheel's comments suffice to emphasize the importance of conductivity measurements and their use. Thus, our attention is now directed to conductivity measuring devices suitable for the aquarist.

Conductivity Measurements of Aquarium Water, Part II

[Aquarium Journal, May 1961. Note: This article was co-authored with Donald J. Stoneking, AJK being the Senior Author]

Last month we discussed the principles of conductivity measurement for the aquarist and took a quick glance at the electrical circuits that are used in conductivity apparatus. Since conductivity equipment based upon high-frequency AC current has several advantages over its DC counterpart, the authors have constructed a simple apparatus based upon the former. This equipment is shown in figures 1, 2, and 3. With the exception of the conductivity cell and an inductance used in the circuit, all are "store-boughten" parts. The total cost of our equipment came to about $10.00.

The circuit diagram for the equipment is shown in figure 4. As can be seen, two transistors are used and the values of the components are so arranged as to produce a 600-cycle/ sec circuit. The wiring is simple and, with the exceptions noted, all are stock parts. Even here, our home-wound inductance coil could be replaced by a stock filter choke (Allied Radio

TABLE II		
SOUTH AMERICA	In general, characins and cichlids	8-50 micromhos
	discus	16-32 micromhos
	Nannostomus	22 micromhos
	Exodon paradoxus	43 micromhos
	cardinal tetra	8-12 micromhos
AFRICA	killies (not including annuals)	20-60 micromhos
	annuals (*Nothobranchius*)	280 micromhos
	Lake cichlids (Lake Tanganyika)	305 micromhos
ASIA	In general, barbs, rasboras and loaches	24-64 micromhos

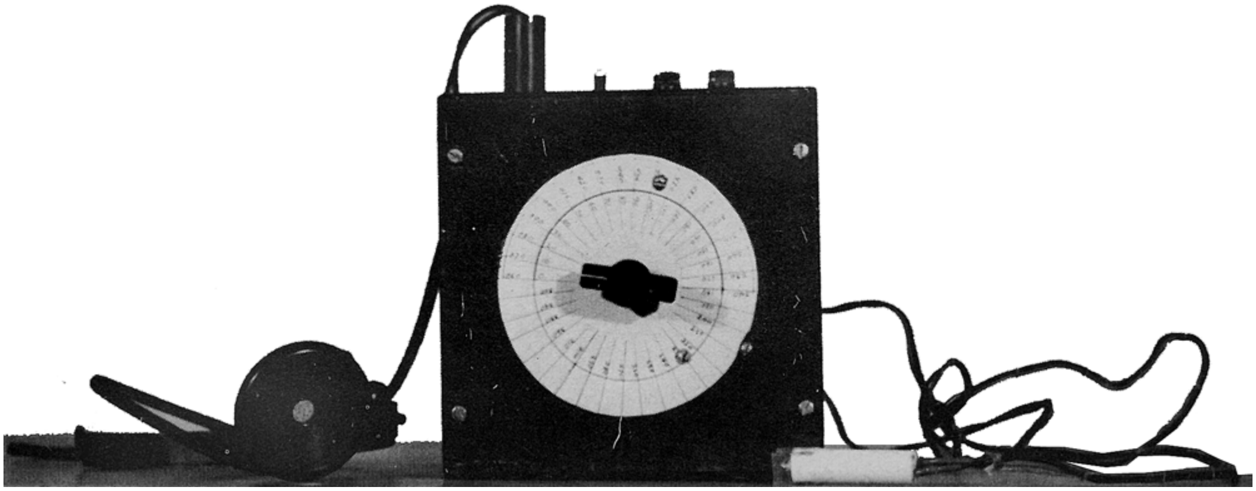


FIGURE 1: General view of equipment showing housing, headphones, and conductivity cell. All photos by the authors.

100 N. Western Ave., Chicago 80, Ill., sells a 0.8 Henry audio filter choke for $2.49. All the other parts with the exception of the cell may also be purchased from this concern). The component parts of the circuit are conveniently housed in a small metal cabinet although a homemade wooden one could have been substituted.

The electrode or conductivity cell is simply constituted of thin brass (0.005 inches) and polyethylene plastic. The slits in the plastic are so made that the brass electrodes fit snugly. Wires are soldered to the electrodes and are brought up through the plastic via a hole drilled down the center. Waterproof cement is used to prevent water from reaching the wires leading to the electrodes (we simply melted extra plastic into the holes). Carbon electrodes also could have been used. Of course, the best electrodes are made of platinum coated with platinum black but this material is expensive and the coating process involves a bit of chemistry. Since the aquarist is concerned only with approximate values, we have found that this equipment gives good, reproducible results within the range of aquarium interests. The electrodes, when not being used, should be kept immersed in distilled water. Otherwise, their calibration may change with time.

The apparatus is used in the following way:
1. The electrodes are immersed completely (the metal parts, that is) in a sample of aquarium water.
2. After the equipment is turned on, a hum will be detected in the headphones.
3. Adjust the variable resistance (this is the 10

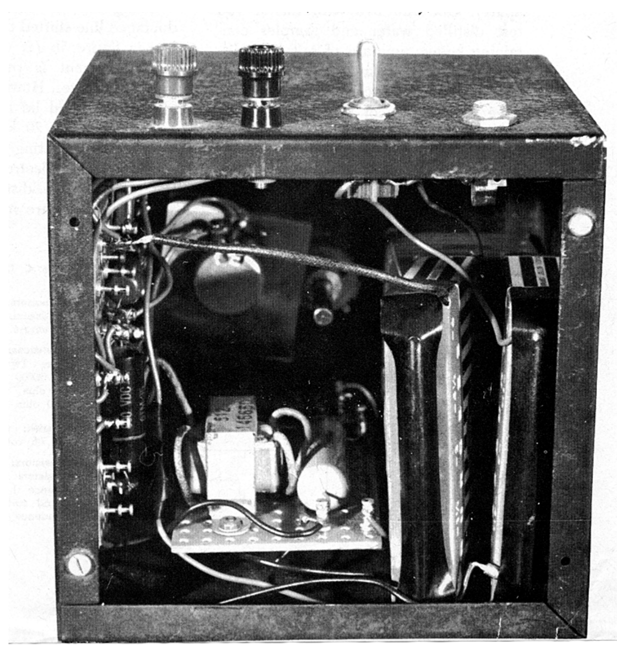


FIGURE 2: Rear view of equipment housing batteries and positioning of components.

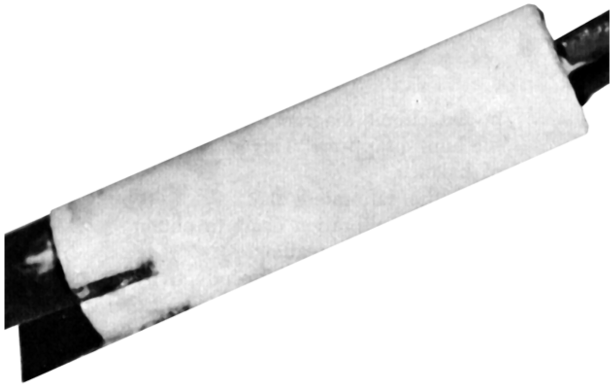


FIGURE 3: Close-up view of conductivity cell. The cell, in use, is immersed about halfway into the water sample.

kilo-ohm resistance shown in the circuit diagram) slowly until the hum disappears. This is the point of balance.
4. Read the calibrated dial.
5. Consult a calibration chart to obtain the conductivity reading.

It should be noted that conductivity is dependent upon, among other things, temperature. Therefore, the temperature of the aquarium water sample should be the same as the temperature at which the apparatus was calibrated. Calibration is relatively simple. Our apparatus was calibrated directly using an ohmmeter (we could have used known resistances instead), resulting in a plot of dial reading versus kilo-

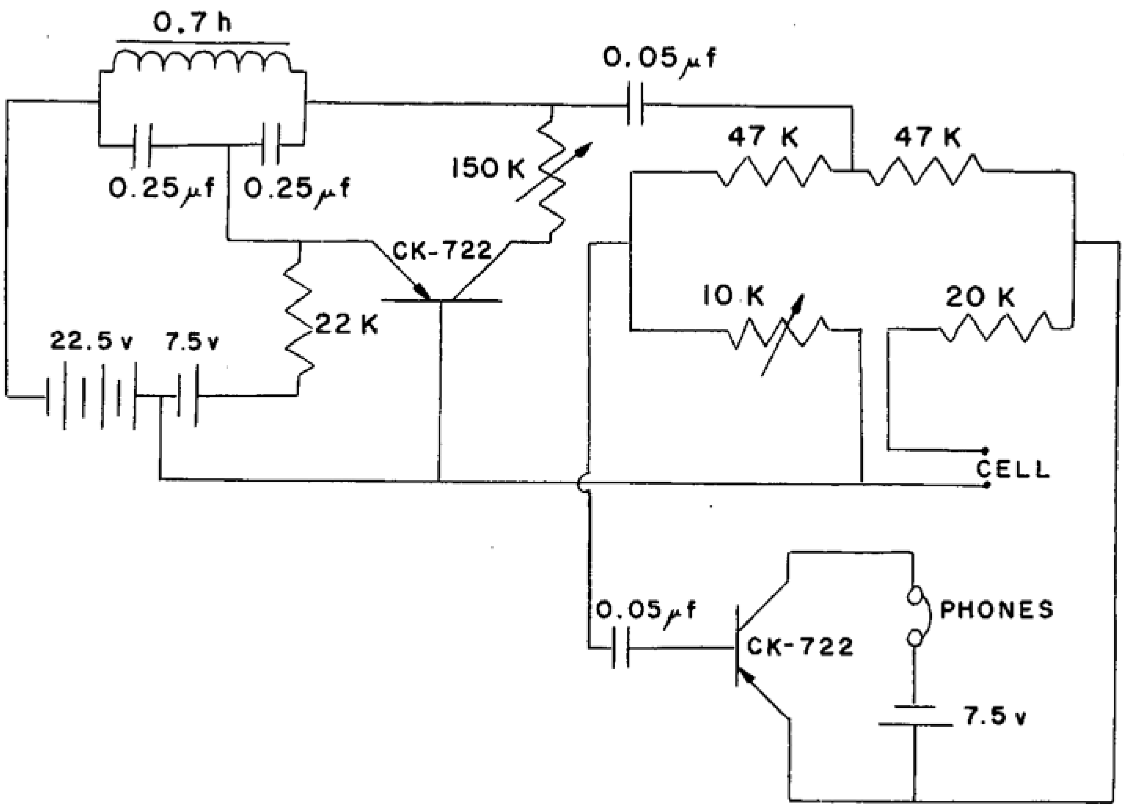
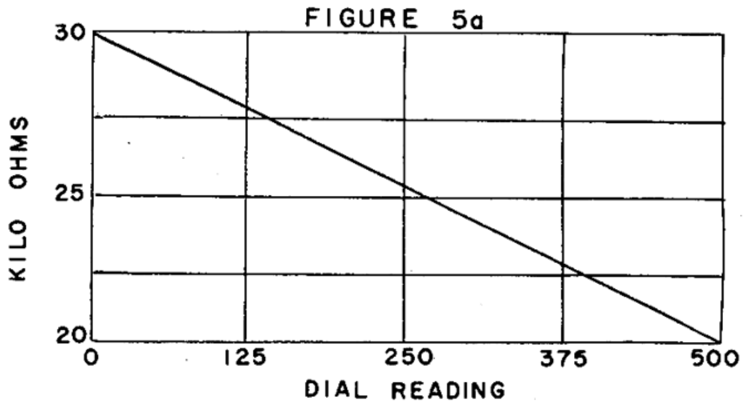
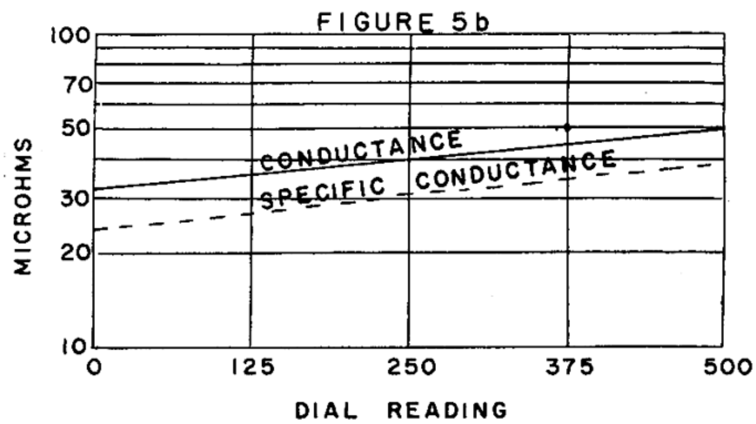


Figure 4. Circuit diagram. List of parts:
Condensers: Two 0.05 microfarad condensers; Two 0.25 microfarad condensers.
Resistances: One 22000 ohm resistor; Two 47000 ohm resistors; One 20000 ohm resistor; One 150,-000 ohm variable resistor; One 10000 ohm variable resistor.
Batteries: One 22.5 volt battery; two 7.5 volt batteries.
Transistors: Two Raytheon CK-722 transistors: one pair high impedence headphones; one wire-wound coil inductance, 0.7 Henry impedance.





ohms (thousands of ohms). This is the line in figure 5a. To get conductivity, one must take the reciprocal of the ohm readings and plot them against the dial readings. Since these reciprocals would give us very small numbers, we multiply them by 1,000,000 and the resultant number and conductivities in micromhos. This, unfortunately, is not a straight-line plot using ordinary graph paper. However, the use of semi-log graph paper results in a straight line (solid line in figure 5b).

If our electrodes were 1-centimeter square and exactly 1 centimeter apart, the calibration would also be specific conductivity. Since our electrodes were smaller and set more closely together, our conductivity calibration is not specific conductivity (actually, our readings were somewhat higher than specific conductivity due to the fact that the electrodes were only about 34 inch apart). One can live with this if you test distilled water and samples containing known amounts of salt (i.e., distilled water plus known quantities of sodium chloride, etc.). Thus, you will have a good idea of the impurity content of any sample tested on your equipment. However, the readings on your dial will mean nothing to other aquarists throughout the country and if you report your results, you should report them in units of specific conductivity. For this, you will need to test a solution of known specific conductivity. Then your conductivity line can be shifted (parallel) up or down to obtain a specific conductance line. Such a solution is as follows:

Take 0.774 grams of potassium chloride and dissolve it in one liter of distilled water at 68° F. Dilute 100 milliliters of this to one liter (again using distilled water), at 68° F. This final solution, at 77° F, has a specific conductivity of 147 micromhos.

Doing this, we found that our conductance line shifted down to the dotted line in figure 5b (it will be noted that our instrument is presently operating in a low range. However, other ranges of interest could be handled by either, (a) varying the 20 kilo-ohm resistance or (b), constructing a new cell with different sized electrodes or else with the plate-to-plate distance altered). If all our samples are measured at 77° F, then our results can be reported throughout the world as so many micromhos of specific conductance.

Since not all aquarists are handy with a soldering iron, there are ready-made apparatus available suitable for aquarium purposes. Dynalab

(Box 112, 625 Goodman St., South, Rochester 1, N.Y.) makes a conductivity meter selling for $29.50. It is called an Ionimeter and is of the unbalanced bridge type. A water sample is poured into the gadget, a button is pressed, and the parts per million dissolved salts (calculated as ppm NaCl) are read off directly. Its range is 0 to 50 ppm — a little on the low side but aquarium water can always be cut with distilled water to get a reading within scale. Afterwards, a simple calculation will give you the concentration of the original water sample. It is hoped that some manufacturer of aquarium equipment may be persuaded to manufacture such a device expressly for aquarists.

We have had, of necessity, to cover a lot of territory in a minimum of space. If you desire to use conductivity as a new technique (and it is highly useful in breeding killifishes and the "problem fishes"), we r commend that you reread Col. S eel's articles in the November-December 1960 issues of the *Aquarium Journal.* His articles provide the framework for the use of such measurements. The authors are already hard at work improving the present equipment (we are altering it so as to read specific conductivity directly and also to be able to switch to different ranges of conductivity) but we are well pleased with the whole concept and are sure that we are better aquarists for it.

Postscript to Conductivity Measurements of Aquarium Water

[Aquarium Journal, June 1961]

Since the recent series on conductivity measurements appearing in the *Aquarium Journal,* I have had an opportunity to experiment with a very simple and inexpensive conductivity device. Any aquarist could duplicate this apparatus in about 20 minutes. Briefly, I used the identical electrode (conductivity cell) previously described, and coupled it to a pocket AC-DC VOM meter (This is available from Lafayette Radio 165-08 Liberty Avenue, Jamaica 33, N.Y. The item is #TE-13, AC pocket VOM, catalog 613. Price $5.95 plus postage. Approximate shipping weight is 1 pound). The leads that came with the meter were soldered to the electrode leads (see figure 1). Since this meter has no on-off switch, a reading is obtained immediately after immersing the electrodes into a sample of aquarium water. Do not leave the electrodes in the sample water for more than the few moments it takes to ascertain the reading as this apparatus is of the non-null type and current flows across the electrodes; such current flow will cause electrolysis and polarization of the cell after a while, causing misleading readings. Of course, one could add a momentary-contact switch to one of the electrode leads to prevent such an occurrence.

This apparatus can be calibrated in exactly the same manner as described in the previous article. However, in place of this rather involved (but precise) procedure, the solutions of common table salt (NaCl) in Table I may be used, provided the calibration is carried out at 75° F.

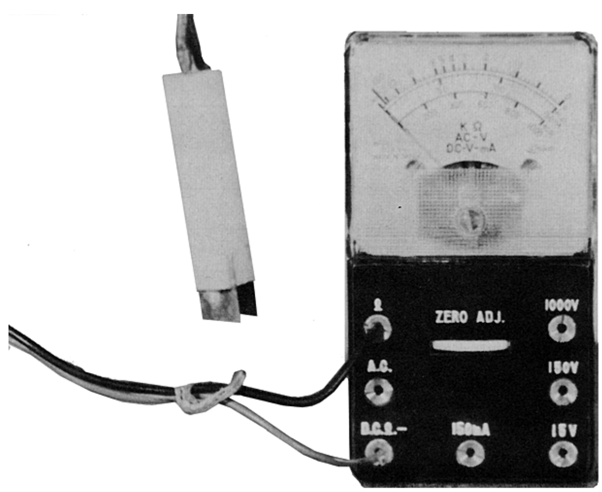


FIGURE 1: A simple, inexpensive conductivity meter. Photo by Albert J. Klee.

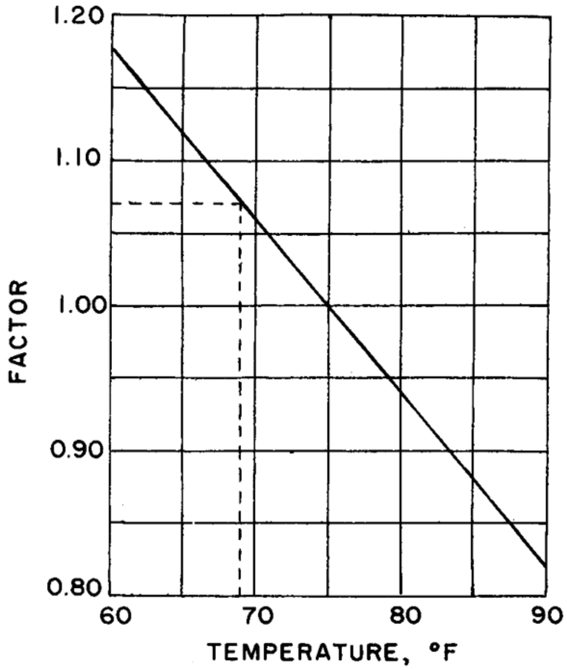


FIGURE 2.

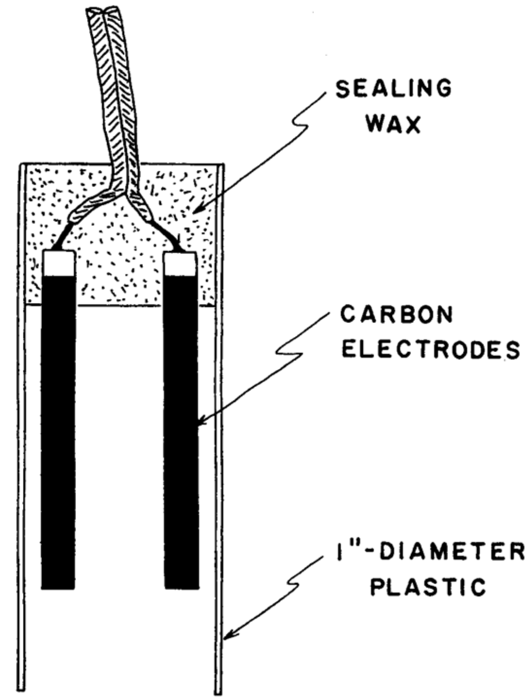


FIGURE 3.

Pieces of paper with these conductivity values types on them may then be pasted over the dial on the VOM meter at the appropriate places.

Since temperature affects the conductivity reading to a great extent, figure 2 has been provided to correct for deviations of the water sample temperature from the calibration temperature of 75° F. For example, if the sample is at 69° F, multiply your conductivity reading by 1.07, the factor read from the graph.

If one goes "off scale" on the VOM, then an electrode with altered dimensions is indicated. Of course, calibration must be repeated for each such electrode used. At present, I have two electrodes: one, an open brass electrode pictured in figure 1 and another, constructed from the carbon electrodes from a dry cell and a piece of 1" diameter plastic tubing (see figure 3). This latter electrode is of the enclosed type.

The natural habitat conductivity values shown in Table II may be used by the aquarist as a starting point for future experimenting.

As a final word, aquarists may occasionally encounter the European term, "micro-Siemen," abbreviated as μS. This is identical with the American term, "micromhos."

Aphyosemion christyi

[Aquarium Journal, April 1962. Note: This article was co-authored with Bruce Turner, AJK being the Senior Author.]

In the early 1950's, a species of *Aphyosemion* new to aquarists found its way to this country. For some strange reason, this fish did not "catch on" in the ranks of killifish fanciers and so subsequently appeared at irregular intervals, pausing to stay with us for a while, and then disappearing again. We say "strange" because the species in question was a pretty fish, although like many newly introduced fishes, the first importations suffered appearance-wise from the long and hazardous journey to our shores.

But this story really starts in 1949 when the famous Aquarium Hamburg in Germany received a shipment of fishes identified us "*Aphyosemion singa*" (figure 1 shows the general body and fin shape of the male. Note that this and succeeding figures are meant to illustrate body and fin shape only, and not pattern). The forepart of the male's body was a bright sky-blue, becoming brownish on the back. The base of the tail (a tri-pointed one at that) as well as the dorsal, caudal, anal and pectoral fins were bright, chrome yellow. Over the flanks appeared numerous red dots, and the reflection of these seemed to give the fish an overall orange-red cast. Red "worm-like" markings on the cheeks so typical of male aphyosemions were also present. All fins were liberally sprinkled with carmine dots and the dorsal, caudal and anal fins were edged in these red lines (occasionally, the anal fin was excepted from this characteristic). The females had their share of small brownish-red dots on both fins and body, plus a number of greenish scales about the gill covers, the latter being unusual for female aphyosemions.

Several years later, a variation of "*Aphyosemion singa*" was received by Aquarium Hamburg. The males of this variation had fewer red spots on their fins and body. Thus, their bright yellow colors were enhanced. In spite of the fact that the blue area on the body extended somewhat farther back, this fish still gave the impression of being a yellow edition of "*Aphyosemion singa*." Figure 2 shows a drawing made from a photograph by Guenther Senfft of this yellow variation. Unfortunately, the fins were somewhat folded and it is impossible to ascertain exactly what the dorsal, anal and caudal find shapes were on this fish.

At about this time, however, it came to the attention of aquarists that "*Aphyosemion singa*" should not, under any circumstances, be the correct name for this fish. Herein lies another story, fortunately short, and we take time out to tell part of it. In 1899, the great British ichthyologist, George Albert Boulenger, described a fish that he called, "*Haplocheilus singa*" (Boulenger's drawing of this fish is shown in figure 3). At that time, Haplocheilus included fishes we now include in the genera, *Aphyosemion*, *Epiplatys*, *Aplocheilichthys,* and *Micropanchax*. This particular species had a number of distinguishing characteristics including a rather pointed head, a short dorsal (8 rays) located over the last few rays of the anal fin, and a prominent lyretail, It was colored a sort of olive-green but the fins were greenish-yellow. The body and fins were well supplied with carmine spots. If it were not for the lyretail, any aquarist would immediately place this species in the genus *Epiplatys* rather than *Aphyosemion*, for the rounded physiognomy typical of species of the latter genus is

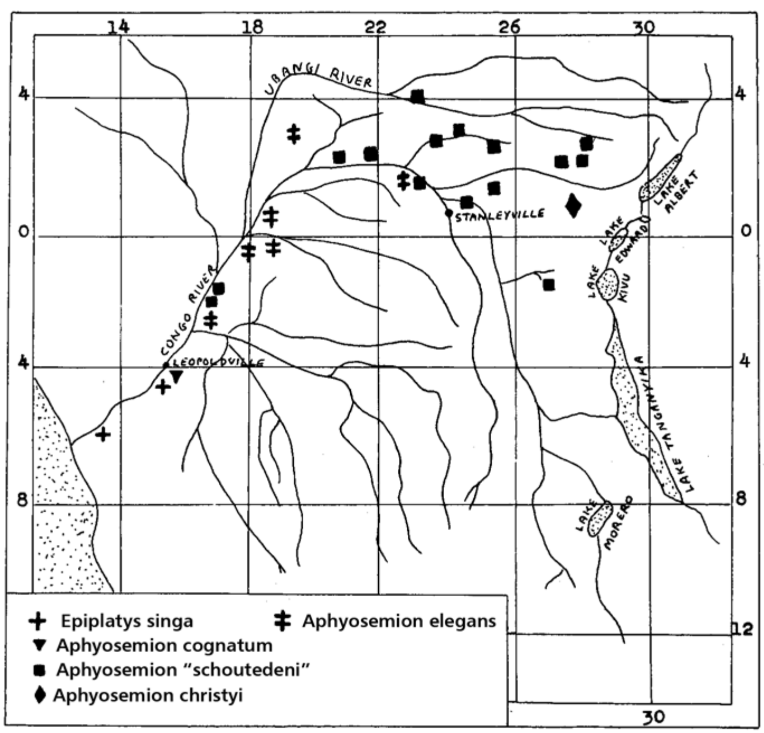


FIGURE 4

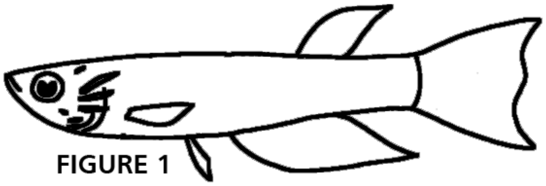


FIGURE 1

FIGURE 2

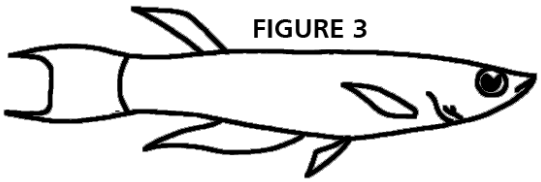


FIGURE 3

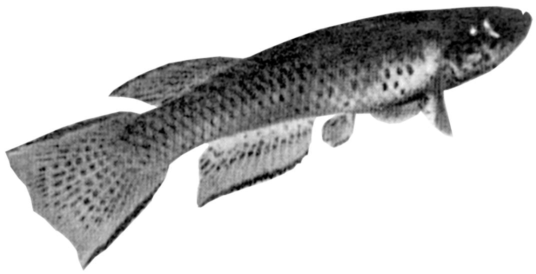
not evident in this fish. However, the notion that an African killie with a lyretail must perforce be an *Aphyosemion*, dies hard, in spite of the fact that there are species of *Aphyosemion* with rounded tails, truncated tails, trident tails and lyretails. As for *Epiplatys*, there are pintails, roundtails, and even swordtails! However, no *Aphyosemion* we know has a dorsal set so far back on its body that it begins over the last few rays of its anal fin (although *Aphyosemion cognatum* comes close). Dr. George Myers settled the matter once and for all by examining the type specimens in the then called, Musée du Congo Beige, and pronouncing it to be an *Epiplatys*. From figure 4, it can be seen that the true *Epiplatys singa* is found in the Congo basin but only before one gets to Leopoldville.

When this name ("*Aphyosemion singa*," that is) was proven incorrect, a vacancy was created. Specimens were sent by Roloff (the noted German aquarist) to Dr. Max Poll, a specialist in Congo fishes, and were identified as *Aphyosemion schoutedeni* (pronounced

SKOO'-TE-DEN-EYE). The specimens sent, however, were of a sparsely dotted variation with lyretails and short dorsals, in short, a version of the yellow type. Figures 5 and 6 show drawings made from photographs by Timmerman and Roloff, respectively. This is the version that was seen, albeit infrequently, in this country.

Recently, the famous Dutch aquarist, Arend van den Nieuwenhuizen, has developed a strain (figure 7) of yellow *schoutedeni* with more elongated and larger fins. Some European aquarists have called this fish a variation of *Aphyosemion cognatum*, complicating an already confused picture, for American aquarists have long referred to "green cognatums," "red cognatums," "blue cognatums," etc., whenever they receive superficially cognatum-like fishes for which they can supply no scientific name.

In October of 1961, one of the authors obtained seven pairs of what appeared to be a new species of Aphyosemion, from Wilmar Aquarium of Pinebrook, New Jersey. These fish, reported to originate from the Congo, were shipped under the name of *Aphyosemion labarrei* but it was quite apparent that, even on first glance through somewhat murky waters, this was not the case. While they appeared to resemble *Aphyosemion cognatum,* they were not that species either. Cognizant of the confusion already mentioned, one of the authors corresponded with Dr. Poll (for whose assistance the authors are extremely grateful) in order to learn the true name of this species. Dr. Poll's answer surprised us no end! He informed us that the fish known as *Aphyosemion schoutedeni" is* a synonym for *Aphyosemion christyi, "schoutedeni"* representing merely mostly a variation in markings and color, a form showing considerable yellow coloration and fewer red dots. It appears that *Aphyosemion christyi is* an extremely variable species with many intergrading forms. In color, it grades from a preponderantly chrome-yellow fish to a mostly orange-red form; in pattern, from a fish with few red dots to a form with numerous dots; in finnage, from a fish with short fins to forms



***Aphyosemion Christyi*, as photographed by Albert J. Klee.**

with long and larger fins. To illustrate this latter point, Dr. Poll examined 28 specimens of *"Aphyosemion schoutedeni"* and found the dorsal ray count to be as follows:

3 specimens with 8 rays
18 specimens with 9 rays
6 specimens with 10 rays
1 specimen with 11 rays

Thus, we have a single species, Aphyosemion *christyi,* but what a variable species it is! Figure 4 shows the tremendous range of this fish (the type species for *christyi is* shown apart from *"schoutedeni"* on this map). Over such a tremendous range, it is understandable how one species can develop local forms that vary widely in color, pattern, and finnage. Perhaps *"Aphyosemion schoutedeni"* is an incipient species, only time will tell. But for the present, due to the presence of intermediate forms between *christyi* and *"schoutedeni,"* we must catalog but one species. This is always difficult for the aquarist to understand for given only the orange-red form and the yellow form of *christyi,* they do appear to be distinct species. However, aquarists are shutting from their minds, all of the intergrading forms. For example, it has often been said that if there were only two races on this earth, viz. the Caucasian and the Mongoloid, Man would be divided up into two species by the scientists. But because there are so many integrading races between these two, there is no justification for two species. Thus Man is in but a single species and competes with *Aphyosemion christyi* for being a most variable species!

Aphyosemion christyi was described in 1915, then followed *schoutedeni* in 1920 and *Aphyosemion castaneum* in 1924. The description of *schoutedeni* in 1920 was poorly done and misleading, especially in the shape of the tail fin. This led Dr. Myers to describe *Aphyosemion castaneum* (figure 8) some four years later. Dr. Poll has shown all three species to be synonyms for *A. christyi.*
This leaves but two species for which comment is needed, viz., *Aphyosemion cognatum* and *Aphyosemion elegans.* The former is found in the vicinity of Leopoldville (see figure 4) and differs from *christyi* in that it *(cognatum)* has a smaller dorsal to anal length relationship, a chunkier body, and even more spots than the orange-red *christyi.* It is interesting to note that most (but not all) European aquarists have stumbled closer to the truth than their American counterparts, for they have tended to lump the "aberrant cognatums" under *schoutedeni* and not under *cognatum* as we have been wont to do.

Aphyosemion elegans has never been imported as an aquarium fish to our knowledge, and specimens recently reported to be this fish are most likely forms of *christyi.* The name, "elegans" means exactly that and the true *elegans* could not possibly be mistaken for any other *Aphyosemion* (or should we stick our necks out and say that?). A sketch of *Aphyosemion elegans* (figure 9) shows it to be an *Aphyosemion* with an extremely slender body and highly elongated fins, resembling no other member of this genus as we know it today.

In summary then, our conclusions are as follows:
1. *Epiplatys singa is* a valid term but applies only to an aberrant (with respect to tail shape) *Epiplatys* hitherto never imported as an aquarium fish.

FIGURE 5

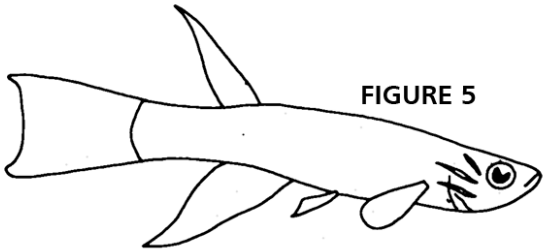


FIGURE 6

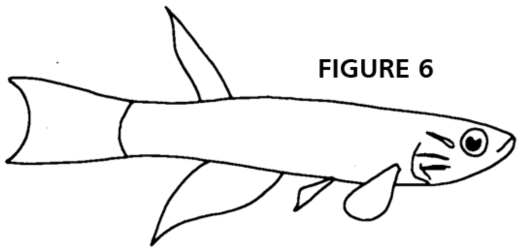


FIGURE 7

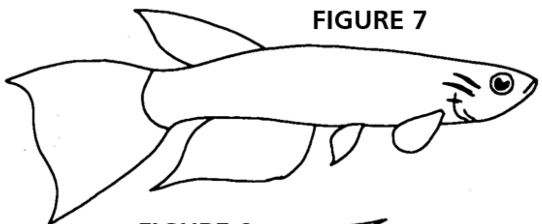


FIGURE 8

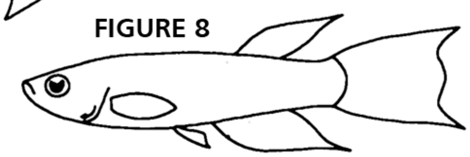
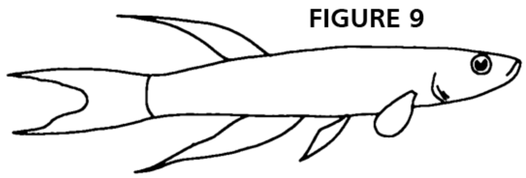


FIGURE 9



FROM TOP TO BOTTOM:
FIGURE 5: *Aphyosemion schoutedeni*, from a photo by Timmerman.
FIGURE 6: *Aphyosemion schoutedeni*, from a photo by Roloff.
FIGURE 7: Nieuwenhuizen's yellow form of *A. christyi*. Note the elongated finnage.
FIGURE 8: Dr. Myers' *A. castaneum*.
FIGURE 9: The true *A. elegans*.
Sketches by Albert J. Klee

2. *Aphyosemion singa* applies to no fish.
3. *Aphyosemion schoutedeni* and *Aphyosemion castaneum* are synonyms for *Aphyosemion christyi.*
4. *Aphyosemion christyi is* an extremely variable fish with a tremendously wide range, representing a number of intergrading forms. In color, the extremes are mostly bright yellow fishes and mostly orange-red fishes.
5. The so-called "aberrant cognatums" are, it appears, variations of *Aphyosemion christyi* and are not to be confused with the true *cognatum,* a fish that differs sufficiently from *christyi* to be a valid species in its own right.
6. *Aphyosemion elegans is* a valid species but like *Epiplatys singa,* applies only to a hitherto never imported fish. Fishes mistakenly called *"Aphyosemion elegans"* are, most likely, forms of *christyi.*

Our summary would not be complete if we neglected to add that the science of ichthyology is a fluid one (and we don't mean water!) and as knowledge increases, aquarists should expect commensurate changes in nomenclature. However, our summary reflects present knowledge as we know it today.

Soon after the authors' *christyi* were purchased, they were placed in a bare, ten-gallon tank. After half an hour, they colored up beautifully. The most striking features of this fish are the intense lemon yellow or orange edgings on the dorsal, anal, and caudal fins. These fins are sprinkled with red dots. The body is a bluish-gray color, becoming bluer about the head. The body also is sprinkled with large red dots that run together, forming longitudinal lines much the same way as in *Aphyosemion lujae.* The head region is covered with short, red bars or elongated dots. Larger males are inclined to show more yellow *in* the fins while smaller males exhibit more orange. These orange-red colors are much' dependent upon the light as the reflector was painted oyster white, under which the fish is exhibited. The females are, typically, colored brownish-gray with red dots in the dorsal and anal fins. Their bodies are unspotted.

After three days of conditioning, pairs were placed in individual 2-1/2 gallon aquaria for spawning purposes, and floating nylon mops were placed to receive the eggs. These efforts were rewarded four days later when the largest pairs started spawning. From then on, egg production was constant, amounting to 15 to 20 eggs per female, as long as live foods were fed. As the season changed and winter replaced fall, egg production fell slightly, probably due to the replacement of live foods with frozen ones. The size of the eggs and the newly hatched fry seemed to vary slightly, depending on the particular female used. Indeed, one rather large pair spawned some very small eggs that hatched in 7 days into very tiny fry. Also, some of the young tended to be weak and remained with their yolk sac for a week or more; these eventually absorbed their sac and swam as regular fry. However, in most cases, the fry were the same size as the fry of the killies that American aquarists call *"cognatum"* (and which may or may not be that fish). They are easily raised, with good feeding, requiring a minimum of effort. While they are somewhat slow growing, they are not in the same lazy league as *Aphyosemion lujae* or *Micropanchax myersi.* A majority of the young in our care happened to be females but there were enough males to say that breeding was very worthwhile.

Currently, the authors are attempting to cross this fish with *Aphyosemion cognatum* with a view towards determining the characteristics of the young. However, eggs of this species have been sent to a number of killifish hobbyists throughout the country to give this beautiful fish the eventual wider distribution that it definitely deserves.

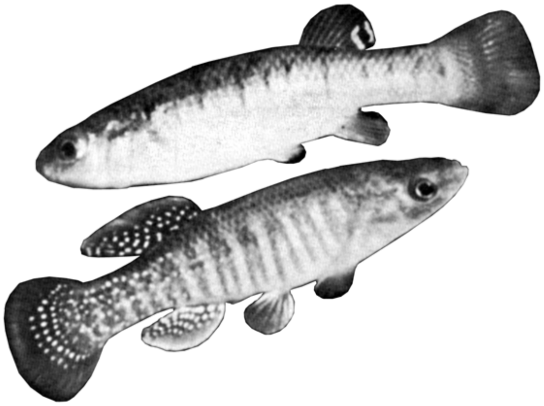
American "Annual" Killie

[Aquarium Journal, June 1962]

Good things are sometimes marked by inauspicious beginnings. Certainly this was true when I first saw the flash of a half dozen or so seemingly rather nondescript fishes moving in a dealer's tank. Now there is associated with all dyed-in-the-wool killifish fanciers a sixth or seventh sense which enables them to spot a killifish with the naked eye at distances that would tax even a moderately powered telescope, so the impression I received in this fleeting "Augenblick," as our German aquarist friends might say, spelled out "KILLIFISH" and, of course, brought me up short. A closer inspection showed that the killie in question was some sort of native fish of the genus *Fundulus* and luckily for me, a male and two females were in especially nice condition. My dealer friend could supply no name for the fish, merely that it came from Florida in a shipment of the usual "bread-and-butter" fishes.

After the trio was safely ensconced in a 5-gallon tank at home, I turned to the business of identification. This required some study as there are about 30 species (this figure varies with the ichthyologist consulted) of *Fundulus* currently known to Science. Representatives of the genus are found in more than half of the United States, southeastern Canada, Bermuda, northern Cuba and certain areas of Mexico. However, most of them (about 20 or so species) are found in the southeastern portion of the United States. The genus has quite an ecological range also, and is found in salt, brackish, and fresh water, but typically in waters of little turbulence.

Fundulus can be identified on the basis of body shape, fin count and dorsal/anal juxtaposition. In some cases, pattern may also be used but in a number of species (my fish included, unfortunately), the pattern is extremely variable, depending to a great extent upon its native habitat. In due time the fish was identified as *Fundulus confluentus* (pronounced, **FUN'**-DU-LUS CON-**FLU'**-EN-TUS, *Fundulus* meaning "of the bottom" and *confluentus* meaning "crowded, joining or flowing to-



A pair of *Fundulus confluentus*, as photographed by Albert J. Klee.

gether"), a species described by Goode and Bean in 1879. At that time only one specimen was available and the species was really poorly defined. In 1882, Jordan and Gilbert described *Fundulus ocellaris* but unbeknownst to them, they were merely describing a form of *confluentus.* Because of the fact that female specimens exhibit a pronounced ocellus in their dorsal fin, the name *ocellaris* has been commonly used for *confluentus* in the past. The variability of *confluentus* has earned it at least two other synonyms: *Fundulus chaplini* and *F. bartrami.* Unfortunately, immature specimens of *F. grandis, F. similus,* and *F. confluentus* look very much alike and so form one reason for misidentification by taxonomists and aquarists alike. However, the first two species have the front of the dorsal fin set distinctly before the front of the anal fin, while in *confluentus,* the dorsal is above or slightly behind the anal.

In nature the species is extremely variable. In one extreme the males are very dark and are thickly speckled with blackish-brown spots. They show only a trace of either dark or silvery bars and a dorsal ocellus is present. The females are much paler and show many blackish specks along with the usual series of narrow bars on the sides. In the second extreme, the fish are larger and the males lack the ocellus picking up, however, a pattern of silvery bars on their sides. Dr. Carl Hubbs believes these two extreme forms are ecological forms: one marine, represented by the second type mentioned and the other of brackish or freshwater origin. However, Florida and Louisiana specimens are intermediate between the two extremes.

After a few days, my trio of *confluentus* colored up nicely and much to my surprise, turned out to be one of the prettiest fish in my collection! The male developed deep yellow fins and the unpaired fins in particular, showed a reticulate pattern. On the sides of the body appear a number (20 or more) of narrow bluish-silver bars, alternating with dark olive bars, somewhat thicker. No ocellus is present in the dorsal fin. The females are much plainer than the males. Basically, they are brownish with dark gray vertical bars on the sides, somewhat fewer in number than in the males. There are numerous small dark brown spots on the female's body but these are confined mostly to the dorsal area and are hardly noticeable except under careful scrutiny. The fins are faintly lemon colored and there are a few steel-blue flecks on the gill covers. The ocellus of the female is located towards the rear of the dorsal fin and looks as if someone had pasted it on for it is shiny-black, contrasting considerably with the relatively clear fin proper. In Eddy's, "How to Know the Freshwater Fishes," he illustrates the form in which the female has many well-defined black or brown spots, but hardly-perceptible vertical bars.

In spite of the high probability that the fish I obtained are more closely allied to the marine forms, I have had no difficulty in keeping them in ordinary Cincinnati tap water (pH=7.2; hardness =180 ppm), the same water in which most of my other killifishes are kept. They are peaceful fishes (full grown, they do not exceed 2 inches exclusive of the tail and have only one fault … they tend to be quite shy, both as regards disturbances and lighting.

They eat canned or frozen foods readily and are not fussy eaters by any means.

The eggs of the marsh killifish (a plant spawner) are very large, about the same size as those of the goldentail rivulus *(Rivulus milesi).* Although the eggs of this *Rivulus* are normally considered yellowish, they are pale compared with the deep brownish-yellow of *F. confluentus.* Another characteristic of the eggs of the marsh killie is that they are quite “out of round,” and assume odd shapes for a fish egg (at least the fish eggs hobbyists are used to!). However, native killifishes are not noted for laying particularly round eggs, contrasting rather sharply with their South American, African and Asian relatives.
After five days, the embryos are well developed and after 10 to 14 days, can be hatched out with the aid of some microorganism culture such as microworms, infusoria, dried plants, etc. The young are dark-colored, large and will take microworms from the start, or if you prefer, newly hatched brine shrimp. My only reservation about breeding this species is that egg production although steady, is sparse.

I should state here that this is only an alternate way of handling the eggs of the marsh killie. Their eggs can be stored dry for months (much like those of *Cynolebias, Pterolebias* and *Nothobranchius)* and hatched out upon the addition of water. In this case I really mean “dry” … no peat moss is necessary! In 1959, a number of entomologists at the Florida State Board of Health were flooding dry and sod samples, cut from salt marshes, in order to hatch out the eggs of mosquitoes. Unexpectedly, they hatched out fish as well! The sod cuts in question were last under water about 2% months previously, the waters having receded, leaving the sod totally out of the water. A total of 65 fish, which subsequently turned out to be *Fundulus confluentus,* were obtained from a total of 14 sod cuts after being flooded with ordinary tap water. Fry were seen after 15 minutes after addition of water but mostly after 30 minutes.

A remarkable instance was that of a sod cut made on September 19. This particular sod was kept out of the rain but lightly sprinkled with tap water once a week. On December 23, the sod was flooded and hatched out a single fry … over three months (90 days) later! Therefore, as far as egg development is concerned, *Fundulus confluentus* is an annual fish, albeit of sorts. As a sidelight, one thing I learned from this research is not only a pretty fish in the bargain, peaceful and undemanding, but its mode of reproduction resembles the annual fishes in part. In this, it perhaps is somewhat unique at least little known among aquarists either here in this country or overseas.

New Annuals from Columbia

[Aquarium Journal, October 1962. Note: This article was co-authored with Bruce Turner, AJK being the Senior Author.]

In the fall of 1961, the authors and a small group of friends contracted with Mr. William A. Kyburz of Cali, Columbia, to undertake an expedition to Sincelejo (see figure 1) in order to obtain for them living specimens of two little-known species of killifishes. To partially defray the considerable costs of such a venture, members of the American Killifish Association were invited to participate and indeed, a number of members availed themselves of this once-in-a-lifetime opportunity. Luck was with us. The fish were collected on June 2 1962 and transported back to Cali. From there they were placed on a flight to Miami, subsequently arriving in New York at the rather inconsiderate hour of 2:50 a.m., on June 13. The thrill of participation in a venture such as this one cannot be described in mere words and most likely, only died-in-the-wool hobbyists would understand anyway.

Be that as it may, the pair of novel additions to the aquarium world introduced here are not

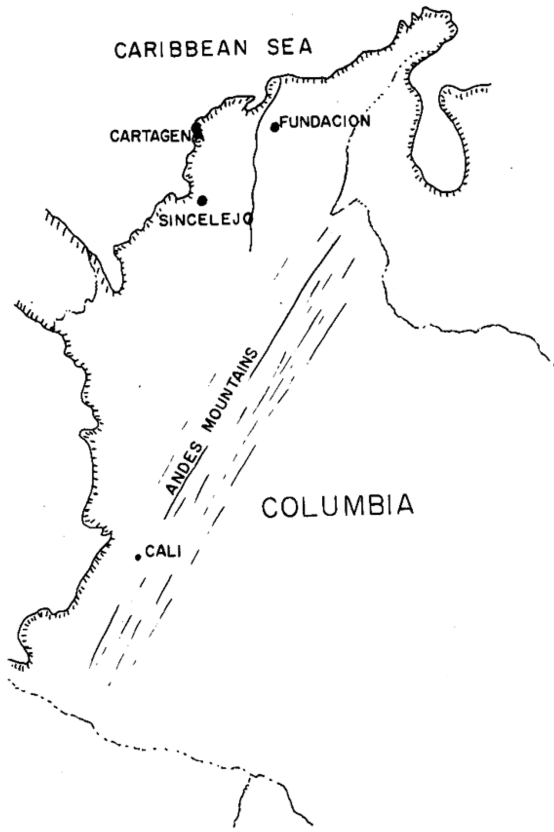


FIGURE 1: Principal localities involved.

only new to hobbyists, but they are rarities in the world of ichthyology as well. *Rachovia splendens* and *Austrofundulus myersi* were described in 1958 by Dr. George Dahl, Professor of Zoology at the Liceo Bolivar in Sincelejo, Columbia. Since even the two genera concerned were new to us, we were especially excited about the prospects of importing them. Both genera are contained in the subfamily, Rivulinae (of the parent family, Cyprinodontidae, or popularly, "killifishes"), a subfamily rich in aquarium genera as, for example, *Rivulus, Aphyosemion, Epiplatys, Nothobranchius, Cynolebias, Pachypanchax,* and others. In general, these genera form the backbone of the killifish fancier's stock in trade.

In 1912 the British ichthyologist, C. Tate Regan, described a fish from Columbia he called, *"Rivulus brevis."* Fifteen years later, Dr. George S. Myers considered that the fish merited its own ichthyological niche and he transferred it to the new genus, *Rachovia.* Actually, it had been imported as an aquarium fish as early as 1906 (figure 2). A well-known German journalist of that time, Hans Stueve, brought back a number of specimens (along with other aquarium and terrarium animals) from a "sabbatical" taken in Columbia that year. His careful documentation of the area in which he found this fish helped our collector, Mr. Kyburz, to relocate this same spot over 56 years later! Unfortunately, he was unable to locate any specimens and so went on to look for other killies for us.

There was never any doubt that *Rachovia brevis* was an annual … they spawned in the bottom and their eggs took 60 days to hatch. In those days, the eggs of annuals were kept in shallow dishes of water and few hatched out. As might be expected, the species soon died out and since Columbia was off the beaten path for fish collectors for years afterwards, the opportunity to re-import them never presented itself. This was unfortunate because the species was quite beautiful.

The next species of *Rachovia, Rachovia hummelincki,* was described in 1940 (from specimens obtained in 1937). This species (figure 3) is native to Venezuela and some of the Dutch islands in the Caribbean. It has never, to the authors' knowledge, been imported as an aquarium fish. Little is known about this fish but it can quickly be separated from the other *Rachovia* species in that it does not have caudal fin extensions. However, it does have the very distinguishing characteristic in that the lower lobe of this fin is pure white, setting it apart from the rest of the fin. No other *Rachovia* has this feature.

When we received our share of the fishes collected by this one-man expedition, the *Rachovia splendens* at first were a disappointment. Today, however, they are held in high esteem

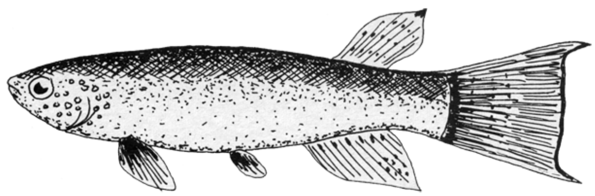


FIGURE 2: ***Rachovia brevis.***

not only by ourselves but by visitors to our fishrooms as well. As might be expected, any fish snatched from its native habitat, transported many thousands of miles and transferred to an entirely different kind of water, has to undergo a period of acclimatization before it can be judged fairly. In the case of *Rachovia splendens,* the transformation was spectacular. The fish colored up into brilliant specimens and the males grew long extensions on their tail fins, something not present in the newly shipped specimens.

Rachovia splendens is a robust bodied killifish and, in general, there is nothing delicate about its constitution, either. Its body coloration and patterning (males) is very close in appearance to that of *Nothobranchius rachovii,* being a herringbone design of dark red and blue. In this, the red of *R. splendens is* somewhat darker and not as brilliant as in *N. rachovii.* There is, however, a bright red marking on the nose and under jaw of the former, and this new fish could very well be called the "rummynose killifish"! The gill covers sport sundry light blue markings. The dorsal, ventral, and anal fins are marked with regular rows of burnt orange to brownish spots and the last two both have blue spots at their bases. The edge of the anal furthermore, is decorated with a dark orange border. The most interesting fin of all is the tailfin. Its base is sprinkled with orange spots and the rest of the interior portion of this fin is green, overlaid with light blue flecks. The top edge of the fin repeats the identical color and pattern of that found in the dorsal fin, i.e., dark orange spots on a yellow-brown background. The lower edge; however, is colored a burnt-orange. Perhaps the prettiest aspect of this fin is in its trailing edge. The fin is drawn out into two extensions (figure 4), upper and lower. About 1/8-inch from this trailing edge, the fin is colored a bright orange, set into a field of light blue. The trailing edge itself as well as the fin extensions is a very dark blue.

When one sees this fish for the first time, one is immediately attracted to the bright orange, inside margin of the tail for since this color is backed up by the deep blue, it forms an eye-catching contrast. In short, the fish is gorgeous. The very name, *"splendens,"* refers to the beauty of these males. Females, on the other hand, are almost colorless. Like the females of *Nothobranchius palmquisti,* they tend to suggest a herringbone pattern on their sides, due to a slight darkening of the scale edges at the proper places. The standard length of male specimens is about 2 inches, with females about 70% the size of males.

Rachovia splendens is a very hardy fish. Although losses en route from, Sincelejo to Cali among females were large, losses in shipment to the United States were negligible. It took but a week before the fish were spawning. Even more fortunate is the fact that they take almost any food (excluding dry) and the authors have observed them greedily taking frozen brine shrimp (adult), and mixtures of frozen beef heart and liver.

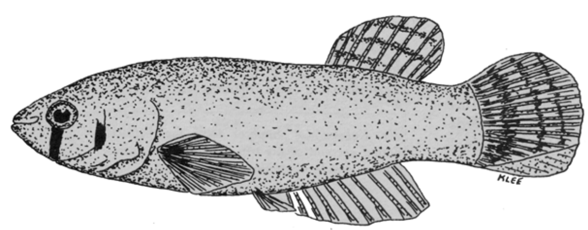


FIGURE 3: ***Rachovia hummelincki*** **(after DeBeaufort).**

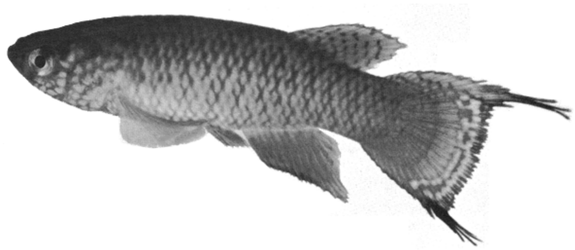


FIGURE 4: ***Rachovia splendens***
(photo by Albert J. Klee).

Breeding takes place in an aquarium containing a small plastic container holding peat moss to a depth of about one or two inches. Unlike *Pterolebias peruensis,* a fish that delights in scattering eggs all over the tank, *Rachovia splendens* is a dainty spawner. At least, housekeeping is a bit easier with this species! The eggs are deposited near the surface on the peat and are approximately the size of those of the blue gularis *(Aphyosemion gulare coeruleum),* in other words, relatively large eggs. In general, the eggs of South American annuals are far greater in size than those of their African counterparts in the genus, *Nothobranchius.*

When males and females are mixed together, there is a tendency for the caudal streamers to be torn off by rival males. We have, however, kept males without the presence of females and under such conditions, they are perfectly peaceful. Even in the presence of other species, *Rachovia splendens* is a mild-mannered tank mate.

In nature, *R. splendens* is found in small bodies of water rich in vegetation, especially floating plants. It is common in the savanna country west of the Magdalena but has been overlooked mainly because of the small size of the waters in which it lives, and because of its tendency to conceal itself in these floating plants *(Eichnornia* and others). The pond in which Dr. Dahl found his specimens was one, which dried out completely from January to April. The fish, therefore, is a true annual.

In 1932, Dr. Myers named a new genus and species of killifish from Venezuela, *Austrofundulus transilis* (figure 5). This was a deep-bodied fish, inhabiting the ponds and puddles in the savanna portion of the country. In 1949, Dr. Leonard P. Schultz described a new species, *Austrofundulus stagnalis,* and along with it, a subspecies of Dr. Myers' fish, *Austrofundulus transilis limneaus* (figures 6 and 7). Both fish were also from Venezuela and from the names, *"stagnalis"* and *"limnaeus,"* we get a feeling for the small, stagnant ponds in which these fishes live. The scientific descriptions of these members of the genus don't particularly excite the imagination as they are described from preserved specimens as being light brownish and mottled in pattern. Undoubtedly, the scientific descriptions sell these fishes short for in life the fishes may be beautiful. *Austrofundulus myersi* takes time to reach full coloration, and non-acclimated specimens are drab, indeed.

Austrofundulus myersi represents the first time the genus *Austrofundulus* has been found outside of Venezuela. It is a large fish, the authors having one specimen over five inches long. It differs from other members of the genus by its greater elongation of body, and in having a very under slung jaw (fig. 8). Body coloration of males is a mottled brown, shading to light orange as one goes from back to belly. There are a number of green spots on its sides. The dorsal and anal fins are greenish-olive, the former spotted with dark brown dots each sur-

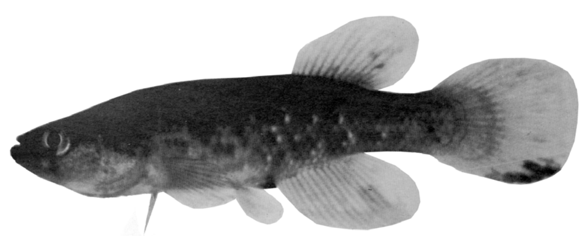
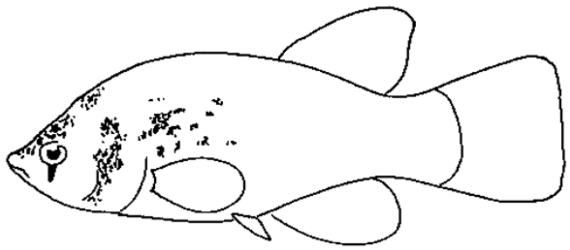
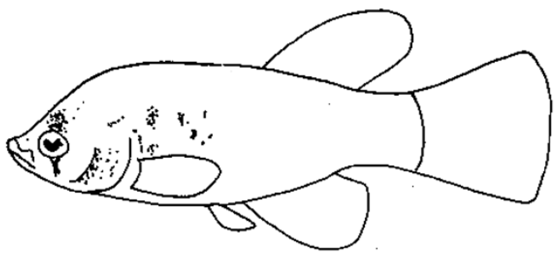
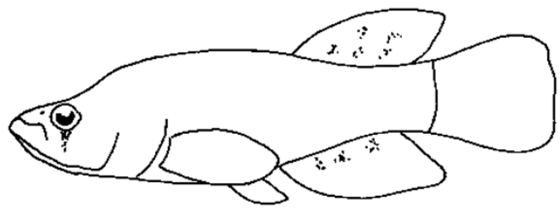


FIGURE 8:
Austrofundulus myersi
(Photo by Albert J. Klee).







FROM TOP TO BOTTOM:
FIGURE 5: Outline sketch of *Austrofundulus transilis* (after Myers).
FIGURE 6:
Outline sketch of *Austrofundulus transilis* (after Schultz).
FIGURE 7:
Outline sketch of *Austrofundulus stagnalis* (after Schultz).

rounded by a field of green color. There are brown spots on the anal also, but these are brown spots surrounded by an orange field. Most of the fish's color is to be found in its tail fin. This is, in general, yellow-orange, and it contains a number of greenish flecks that run with the fin rays. The lower portion of this fin is bright electric blue (the dark spot in the photograph), a very distinguishing and pretty characteristic. The top edge of this fin is rosy-red. All in all, the fish is not as pretty as *Rachovia splendens.* Females are drabber and present a fairly mottled pattern on their sides.

This fish is definitely a predator, Dr. Dahl reporting that even comparatively large prey such as female *Rachovia splendens,* are sometimes attacked (he found the two species together in the same waters). Their food preference is definitely for living animals . . . mosquito larvae are especially relished. When spawning, these fishes are rather bellicose. In one instance, a male killed a female during shipment from one city to another, while in a small plastic bag. Even totally in the dark, the male attacked. This is a frequent occurrence with *Pachypanchax playfairii,* also.

Austrofundulus myersi is also an annual and there is some evidence that in nature, this fish spawns twice a year, during the months of December and July. There is a less-distinct and far less drastic dry season extending from late June or July, to late August or early September in their natural habitat. Females with mature eggs have been found by Dr. Dahl from June 28 to July 16, and also from October to December 23.

The probable result of this venture suggests that *Rachovia splendens* will take its place as a favorite among killifish fanciers; the prognosis for *Austrofundulus myersi is* not as favorable due to its lack of brilliant coloration, its large size and its pugnacious disposition. Within a month, the first eggs of *Rachovia splendens* should be hatching out (an incubation time of 60 days is being used … the substrate is a fairly dry peat) and the process of disseminating this beautiful species throughout the aquarium world will begin. Perhaps this time, *Rachovia* will take a permanent place among the genera of available aquarium fishes.

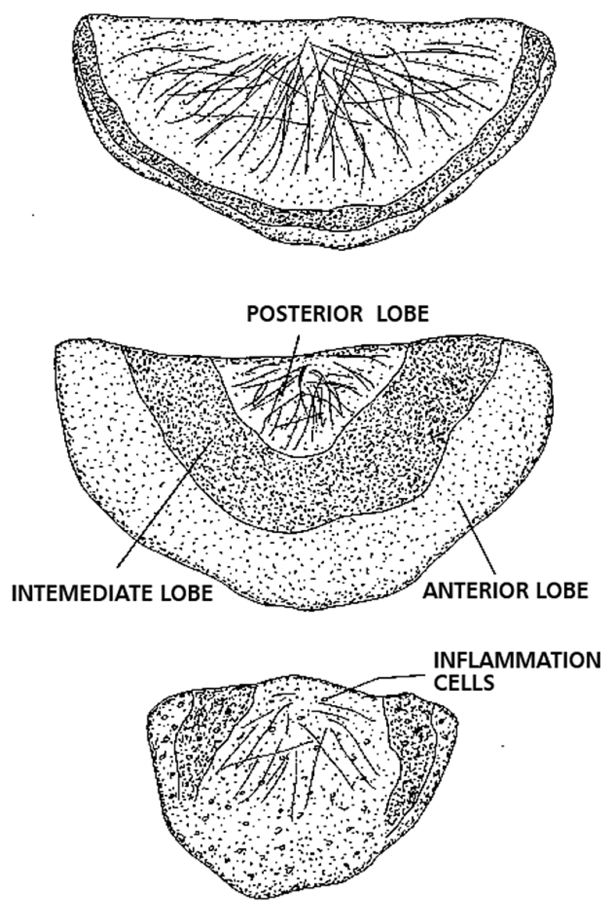
Pregnancy Urine and Problem Fishes

[Aquarium Journal, October 1962]

Just as in our own human species, fishes produce hormones, a number of which are concerned with reproduction. Most aquarists realize that sex hormones are manufactured in the gonads (ovaries in the female, testes in the male); in other words, the gonads produce sex hormones as well as germ cells. Indeed, a number of aquarists have experimented with certain of these hormones (methyl testosterone in particular). However, it is not so well known that the hormone activity of the gonads is dependent upon the action of another gland, the pituitary. This gland produces hormones called gonadotrophins, in the absence of which the gonads fail to develop and thus are prevented from producing their own hormones. As a matter of fact, the first link in the chain of awakening sexual activity in either young fishes or seasonal reawakening in older fishes is the pituitary gland. The proper stimulation of this gland causes the release of hormones, which activate the gonads. If other conditions are suitable, reproduction on the part of the fish commences as soon as eggs are produced.

In the course of his investigations of certain aquarium fishes, Dr. A. Stolk (Histological Laboratory, Free University, Amsterdam) came to the conclusion, as had many other workers in the field, that the lobus anterior of the pituitary gland influences reproduction. To simplify matters somewhat, we may consider the pituitary gland to consist of three sections: the anterior lobe (lobus anterior), the intermediate lobe (lobus intermedius), and the posterior lobe (lobus posterior). In some species of fishes, the anterior lobe appears to be well developed, in others it is less developed or sometimes scarcely developed at all. Since the lobus anterior influences the production of gonadotrophic hormones, Dr. Stolk felt that there might be a correspondence between its inferior development and the difficulty of reproducing the species in captivity.

As a specific example, let us consider one of the coolie loaches, *Acanthophthalmus kuhli.* The pituitary gland of this fish (female) displays a large posterior lobe and very small intermediate and anterior lobes (see figure 1-A). Now it is believed that the anterior lobe can be activated by certain substances of which the urine of gravidae (from pregnant animals) is most easy to use. Recall that, formerly, bitter-



FROM TOP TO BOTTOM:
FIGURE 1-A: Normal state of pituitary gland of *Acanthophthalmus kuhlii.*
FIGURE 1-B: Same gland after treatment with pregnancy urine.
FIGURE 1-C: Gland of sterile male *kuhlii* loach.

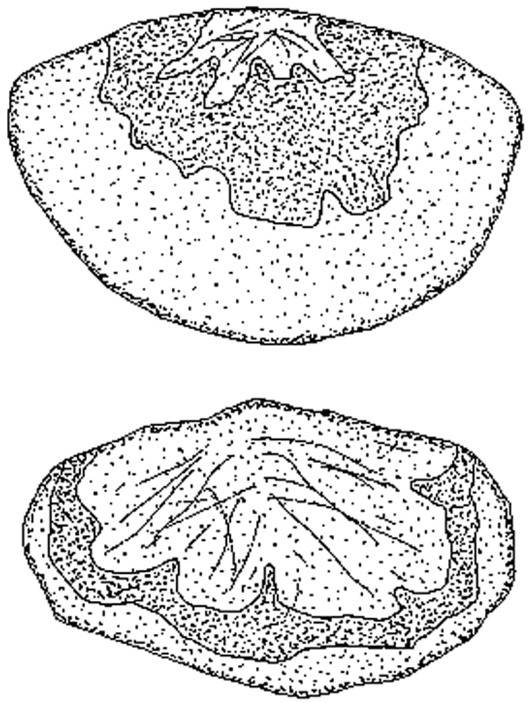


FIGURE 2.
TOP - Pituitary gland of *Nannostomus trifasciatus* (female) after use of pregnancy urine.
BOTTOM - Same gland before use of pregnancy urine.

lings *(Rhodeus sericeus)* were used in pregnancy tests for humans. The test was simple and consisted merely of placing a quantity of urine in an aquarium containing a female bitterling and subsequently observing the ovipositor of the fish. In a matter of hours, the ovipositor would extend to an inch or more if the woman were pregnant. It was postulated that the urine of human pregnancy contained hormones that affected the pituitary gland of the bitterling. As every experienced aquarist knows, however, there are many factors that may initiate spawning activity - changes in lighting or temperature are among them. As a result, the test was unreliable and later was discarded. Now if a small quantity of urine from a pregnant woman is added to an aquarium containing coolie loaches, significant changes take place in the pituitary gland (see figure 1-B) in a matter of one to four weeks. The anterior lobe and intermediate lobe both enlarge while the posterior lobe becomes reduced in size. During this time, certain changes are perceived in the appearance and demeanor of the fishes themselves. The females begin to show an enlargement of their midsections as their ovaries fill with eggs, while the males remain slender. Embracing of the sexes begins and if other conditions are optimum, the fish will spawn.

In one investigation, Dr. Stolk examined the pituitary gland of a sterile male coolie loach and found that an inflammation had destroyed a good portion of the gland, notably in the lobus anterior and intermedius. The relationship between sterility and the abnormal pituitary was very clear in this case (see figure 1-C).

Dr. Stolk and a number of Dutch aquarists have experimented with other species as well. The technique proved useful with *Barbus everetti,* the clown barb, *Caecobarbus geertsi,*

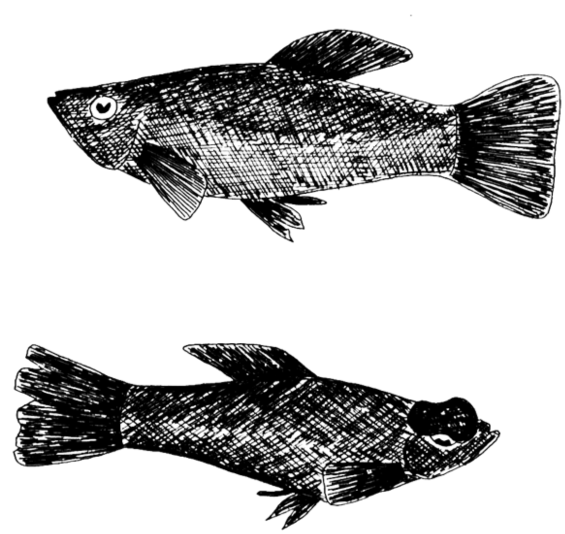


FIGURE 3:
TOP - *Mollienesia* x *Lebistes* hybrid.
BOTTOM - Same cross showing deformed hybrid. All sketches by the author.

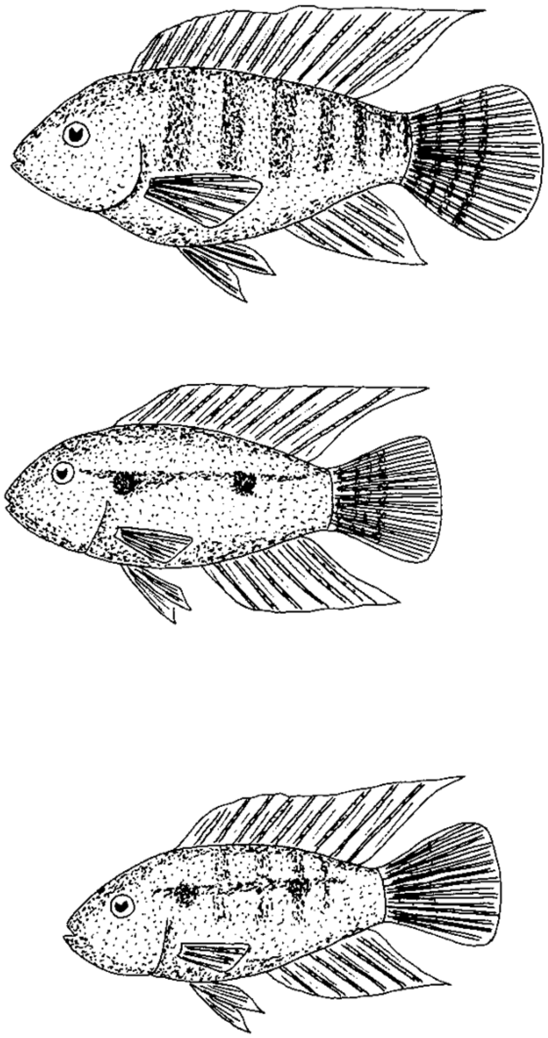


FIGURE 4, TOP TO BOTTOM:
***Aequidens pulcher* (female).**
***Aequidens curviceps* (male).**
Aequidens pulcher* x *Aequidens curviceps
hybrid.
Sketches by the author.

the African blind cave barb, *Anoptichthys jordani,* the Mexican blind cave characin, *Hyphessobrycon rosaceus,* the rosy tetra, and also *Nannostomus trifasciatus,* the pencil fish. In the case of the last-named species, the differences in the pituitary gland before and after the addition of zwangerenurine (the Dutch name which I will use as a synonym for the urine of a pregnant woman) are shown in figure 2.

On the other hand, the technique frequently brought fishes to visual spawning readiness without resulting in actual egg production. For example, addition of zwangerenurine to the tank of the hatchet fish, *Carnegiella strigata,* resulted after a period of four weeks in very active sex play. No eggs were laid, however. In the case of the chocolate gourami, *Sphaerichthys osphromenoides,* an addition of zwangerenurine was made with no results two weeks later. Then, another addition was made. A month later, they spawned.

In hybridization experiments, a female guppy *(Lebistes reticulatus)* was crossed with a male black molly *(Mollienesia sphenops).* Three weeks after the first treatment, a change of water was made, again using zwangerenurine. After 7 weeks, pairing was observed and subsequently 14 young were delivered. Two of the young were deformed. The young had a length, after a year, of from 1 X to almost 2 inches; the base coloration was blackish with local flecks of a greenish or bluish hue. The gonopodium of the males remained anatomically between that of a *Lebistes* and that of *Mollienesia.* Examples of normal and deformed hybrids are shown in figure 3. The fish were found to be sterile.

In another successful hybridization, a male *Aequidens curviceps* was crossed with a female *Aequidens pulcher* (the blue acara). Three weeks after the addition of zwangerenurine, the fish spawned. Although egg development and hatching was normal, the fry started to die off after two weeks. Nevertheless 12 young survived to maturity. The head of the hybrid was less curved than in *curviceps,* but more curved than in *pulcher.* The coloration of the hybrid, which was in general more faded than in either of the parents, was a compromise - the horizontal bands of pulcher were present as well as the dark marks on the longitudinal band of curviceps (see figure 4).

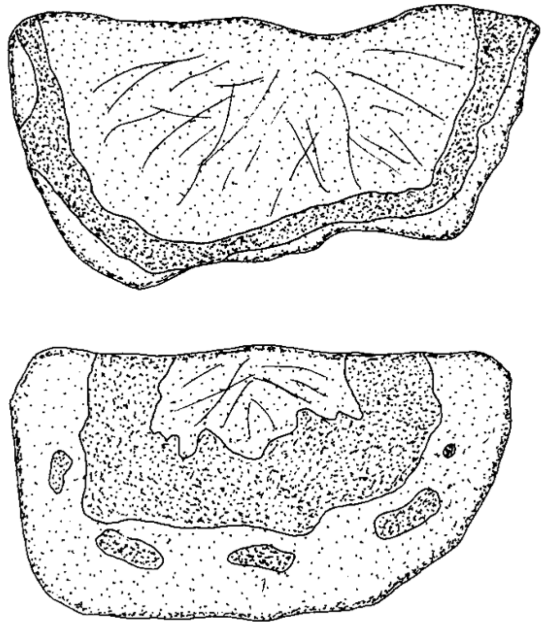


FIGURE 5:
TOP - Pituitary gland of an imported specimen of the chocolate gourami (*Sphaerichthys osphromenoides*).
BOTTOM - Same gland of an aquarium-raised chocolate gourami. Both examples are from female fishes.

Although we have not attempted any hybridization experiments, Mr. Wayne Hatfield and myself have conducted experiments on coolie loaches, neon tetras and a number of other species. The initial dose we used was 0.5 ml (cc) per liter of tank water, the zwangerenurine being supplied by a woman in the 8th month of pregnancy. In some instances, the zwangerenurine caused a clouding of the water but filtration of the aquarium cleared this up rapidly. Occasionally, an extra 0.5 ml/l was added two weeks after the first treatment. Over a period of from one to four weeks, the results were remarkable. The neon tetras took on an intense coloration and the females became very rotund. In the case of the coolie poaches, the changes were even more apparent since the females became quite heavy.

In evaluating our results, however, we conclude that stimulation of the pituitary gland in this manner is not necessarily synonymous with egg production.

Time after time, fishes were brought to "breeding condition" in the visual sense as interpreted by the aquarist, only to have the process stop there. In correspondence with Mr. Hoedeman, the Dutch ichthyologist and aquarist, we have confirmed the value of zwangerenurine in prompting sexual activity in problem fishes. However, Mr. Hoedeman feels that, for fishes other than these, the technique is superfluous. For those fishes whose lobus anterior is regularly well developed in captivity, the addition of zwangerenurine would be of no help. From figure 5, we can see that this is not the case with a typical "problem fish," however, such as the chocolate gourami. The difference between import and tank-raised fish may be great.

There are a number of questions that remain unanswered. Does aging of the zwangerenurine destroy its effectiveness? Over a period of two months, this did not seem to be the case in our investigations. Certain solid materials did settle out, however, and it is not known what effect this has. How does the month of pregnancy influence the potency of zwangerenurine? Finally, what other materials might be used to produce the same effect as zwangerenurine?

Although we did not experience any difficulty, a few Dutch aquarists did lose some fish in the process. Unfortunately, we do not know either the doses used by these aquarists or the type of water the employed. * To some extent, I regret having to pose more questions than I have supplied answers, but it is hoped that other aquarists will supply some of the missing details.

***For the most part, our water was neutral before the addition of zwangerenurine, and about 100 ppm hardness. After the addition of zwangerenurine, the water became somewhat alkaline.**

Aphyosemion beauforti

[Aquarium Journal, December 1962. Note: This article was co-authored with Bruce Turner, AJK being the Senior Author.]

Not too many years ago, the situation regarding the identification of sundry species of African killifishes was often described as almost hopeless. The vast majority of these fishes were discovered, described, and named many years ago and in those relatively early days of ichthyology, descriptions were not all they really should have been. This is not to say that the ichthyologists were necessarily at fault, however. As more and more fishes are discovered, any classification system is bound to become More and more complicated, and due to the fact that African killies tend to develop very local characteristics, even as one goes from one isolated pool to another located just a few hundred yards away, these fishes present very special problems in ichthyology. It should also be pointed out that almost all of our African killies were described by Europeans and preserved in European museums for posterity. During World War II, some specimens of fishes in European museums were destroyed in the course of hostilities, making new studies of these older materials very difficult indeed.

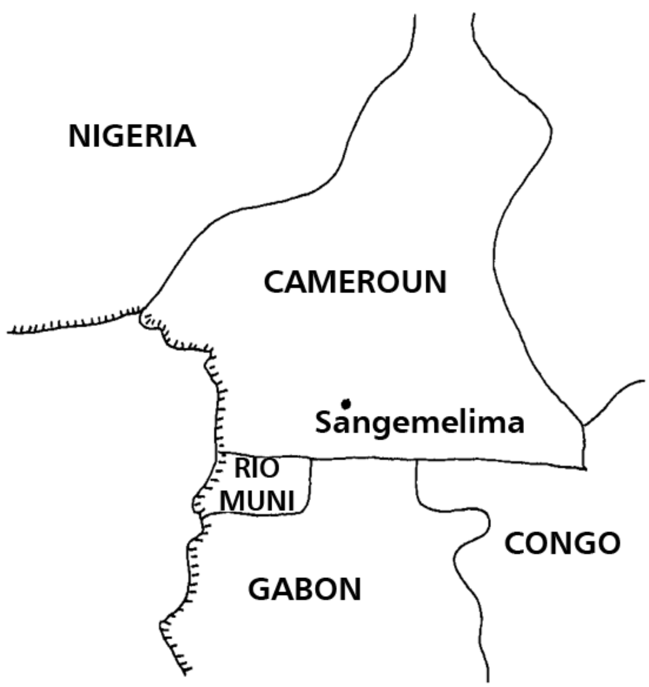
Bit by bit, however, several missing pieces in this rather extensive killifish puzzle have been filled in by present-day workers. Certainly, the problem although formidable, is not hopeless. Among specific African killifish mysteries is one that might be called the *arnoldi-filamentosum-gardneri* puzzle. Here are three fishes, which, from time to time, seem to have appeared in the tanks of aquarists and they, being of an inquisitive nature, have raised questions of identification pertaining to these fishes. Certainly, this problem is by no means solved and our present subject may tend to further cloud the

FIGURE 1: Male *Aphyosemion beauforti*.

picture . . . but we hope not!

Aphyosemion beauforti was described by Ernst Ahl in 1924 (Dr. Ahl named the fish after the famous Dutch ichthyologist, Dr. F. F. de Beaufort), some 9 years too late for inclusion in Boulenger's massive, "Catalogue of the Fresh-water Fishes of Africa." For several years now, this fish has roamed about the collections of European aquarists and just recently, has appeared upon our own shores. A description of this fish has never appeared in the aquarium literature (including foreign) and we take pleasure in removing this deficiency now.

At first glance, *Aphyosemion beauforti* appears to be nothing more than our old friend, *Aphyo-*



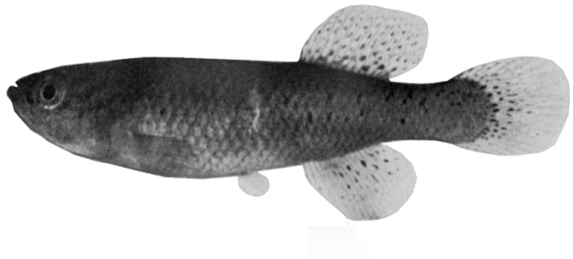


FIGURE 2: Female
Aphyosemion beauforti.

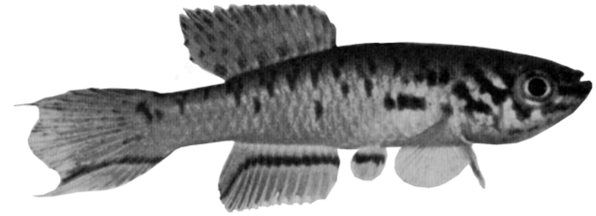


FIGURE 3: Male
Aphyosemion filamentosum.

semion filamentosum (see figures 3 and 4). This, however, would be decidedly a hasty conclusion for there are a number of important differences between these two fishes. The first obvious difference is that *Aphyosemion beauforti is* a very large fish as killies go. The largest male in the authors' possession measures about 6 inches from tip of snout to the middle of the tail, while our largest female is five and a half inches, measured in the same manner. This, of course, far exceeds the usual size for *Aphyosemion filamentosum.* Even with small specimens of *A. beauforti,* however, the two species are easily distinguished by virtue of a pattern difference between the females. As killie fanciers familiar with *A. filamentosum* know, females are marked with a quite discernible pattern of short, dark bars and spots, much in the manner of females of *Cynolebias whitei.* Females of *A. beauforti,* on the other hand, are relatively unmarked. Just what the relationships of *A. beauforti* are we shall explore in detail later on.

The colors of the male *Aphyosemion beauforti* are outstanding, to say the least. The body basically is a vivid, electric blue-green, with its dorsal surface tending to brownish-yellow and its ventral surface approaching white. The flanks are covered with dark red markings, especially prevalent about the gill covers (the common, "aphyosemion worm-like markings"). An outstanding characteristic is a "jaw stripe" (a la *Epiplatys chaperi)* of a dark maroon color. The dorsal of the male sports extended rays and in general, is colored brownish-yellow. A number of dark red markings are present and the fin is edged with a very thin dark red line. There is also an intermarginal area of blue-green. The anal is bluish at the base and brownish-yellow near the edge. This fin sports a very outstanding, dark red stripe running almost longitudinally. The caudal fin has many dark red markings, the upper lobe being brownish-yellow, and the lower lobe blue-green. Similar to the anal, there is a dark red stripe on the lower lobe. Although the pectorals are clear, the ventrals are bluish with red markings. We can safely state that this fish is one of the most highly colored aphyosemions we have seen in quite a while. Females, on the other hand, are brownish-yellow with many pepper-like small red spots on their fins, with a somewhat smaller number found on their bodies.

Aphyosemion beauforti may be cared for in the same manner as *A. gulare coeruleum* (the blue gularis) and *A. filamentosum.* As large fish, they greedily devour earthworms and quickly dispatch frozen beef liver and beef mixtures

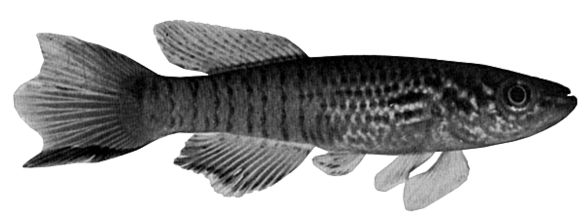


FIGURE 4: Male
Aphyosemion gulare coeruleum.

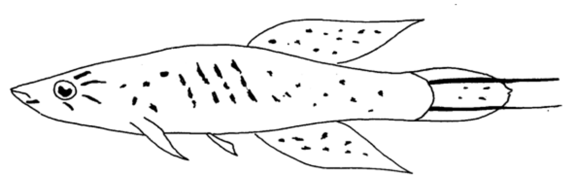


FIGURE 6:
***Aphyosemion batesii* (after Boulenger).**

(available as baby foods). One point not in their favor, however, is that they are very, very aggressive, more so than either *A. gulare coeruleum* or *A. filamentosum.* The females constantly nip and bite one another, and there is nothing mock about the battles the males have! If more than a trio must be kept together, the aquarium should be well planted, or else supplied with nylon mops for refuge.

Courting and spawning are the same as for *A. filamentosum* and *A. gulare coeruleum.* The males are not as inclined, however, to provide as many gaudy displays. After three or at most four attempts to impress a female with his stretched fins and magnificent color, the male becomes impatient, swims on top of the female and forces her down to spawn. *Aphyosemion beauforti* may be spawned in either mops or peat moss, the authors preferring the latter method using a dry peat incubation period of two months. A two and a half gallon tank is big enough for a trio but if possible, larger tanks should be used for the protection of the females. This species appears not to be as prolific as either *A. filamentosum* or *A. gulare coeruleum* but after three weeks, there should be at least 100 to 150 eggs in the peat. As in other bottom spawning aphyosemions, the eggs may either be incubated dry or in trays of water. Although the eggs are not very adhesive, the species will accept a bottom mop for spawning.

The size of the egg varies, among other things, with the age of the female. The average-sized egg is, however, about 1.0 mm in diameter. They are water-clear at time of spawning but become slightly amber after a few days. As with other bottom spawners, the hatching time for the eggs varies considerably. The shortest development time we have recorded to date was 43 days and we have eggs in our possession that are over 4 months old. Dr. Knaack of Austria reports eggs that are still viable after 9 months! After immersion of the peat containing the eggs, a 60% hatch is customarily noted after which, subsequent re-wettings at intervals of two weeks produce still more fry. The fertile eggs seem to be highly resistant to fungi and bacteria.

The fry are quite large at birth and can be fed newly hatched brine shrimp immediately. They grow very rapidly, more so than *A. filamentosum,* and have fin markings viewable after four days. They are quite robust and easy to raise. The water should be partially changed frequently and the fry should be given a large tank in which to grow if they are to reach their full size. For 100 fry, anything less than a 30-gallon tank should not be considered. The males are easily detected after two weeks and they are completely sexed and in full color after 8 weeks. So far, the broods appear to run fairly evenly as to sex but this might not always be the case as many other factors seem to act to alter this ratio (temperature, for example). If at all possible, females should be removed at an early age and grown separately, otherwise large numbers of them will be destroyed by the young males who seem only to want to eat and to spawn.

Although as we have previously mentioned, *Aphyosemion beauforti* and *A. filamentosum* resemble each other markedly in the males, *A. beauforti* has closer affinities (according to Ahl) with *A. gulare coeruleum* (figure 4) and *A. batesii (figure* 6). The latter is the only member of the *Fundulopanchax* subgenus (although the subgeneric divisions within *Aphyosemion* are now largely outmoded, *Fundulopanchax* fishes are mostly those fishes we recognize as bottom-spawning species) found in the Congo Basin.

Both *A. gulare coeruleum* and *A. beauforti* share a rather pug-like snout and except that the latter is much chunkier in body than the former, the females of both species are very close (see figures 5 and 6). Our photograph of a male *Aphyosemion beauforti* does not show any tail fin extensions although they customarily do have them (our specimen pictured subsequently grew beautiful tail fin extensions a la *gularis).*

The type localities for *Aphyosemion beauforti* were given by Ahl as Sangmelina in the Southern Cameroons, and the Upper Lobo River in general (see figure 7). The fish in the authors' possession, however, were from a shipment out of Lagos in Nigeria. In attempting to shed some light on the relationships of this fish, we have tried crosses with both *Aphyosemion gulare coeruleum* and *A. filamentosum,* and we have had considerable success with the former type of cross. The best results of all were obtained by crossing a male *gulare coeruleum* with a female *beauforti,* much better than with a male *beauforti* and a female *gulare coeruleum. Aphyosemion beauforti* has been referred to in European aquarium circles as a "giant filamentosum," but so have some other fishes (which to date, still remain unidentified) and in view of its close relationship with the blue gularis, is a rather unsuitable popular name in any case. In summary, if you like a big, beautiful killifish, *Aphyosemion beauforti* is for you.

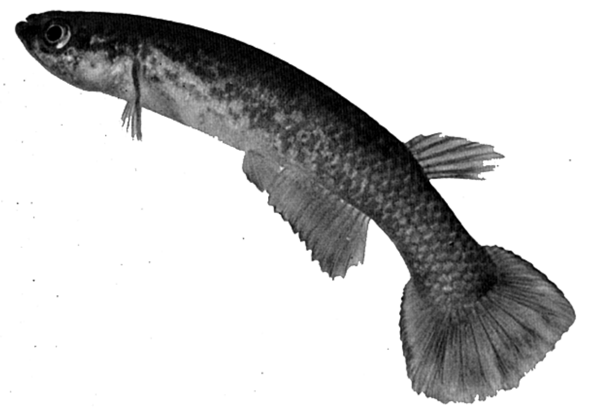
Rivulus beniensis

[Aquarium Journal, October 1963]

Within the genus *Rivulus* there is an assemblage of non-Guianan species that are poorly defined and apparently closely related to each other and to the Guianan forms. They are characterized by dark longitudinal markings on their sides and, to date, comprise the following species: *dibaphus, ornatus, strigatus, beniensis, taeniatus, compactus, punctatus, obscurus*, and *atratus*. Although from time to time several of these species have made an appearance on the aquarium scene, all such appearances have been brief and indeed, the only member of the group that will be recognized by even a small minority of aquarists is *Rivulus strigatus*, due chiefly to its inclusion by Dr. Innes in his classic work, *Exotic Aquarium Fishes*. However, even this species has not been in the hands of aquarists for many years. This article will introduce a member of the group, which is destined to receive widespread attention as it already is known both here and in Europe, and is currently receiving considerable acclaim.

In 1927, Dr. George S. Meyers described a new Rivulus from Bolivia, which he named, *Rivulus beniensis* (pronounced, BAY-NEE-**EN'**-SIS). It received its name from the river near which it was found, a river that separates the Bolivian provinces of Pando and Beni (see map). This area is quite close to the contiguity of Peru, Bolivia, and Brazil. The pertinent provinces here are (a) Madre de Dios in Peru, a province taking its name from a river which originates in Bolivia but which ends in Peru, (b) Acre in Brazil, a province taking its name from a river originating in that country but which ultimately flows along the Brazil-Bolivia border and the Brazil-Peru border, and (c) Pando in Bolivia which we have already mentioned. Dr. Meyers described two subspecies, the first being *R. beniensis beniensis*, originating in Ivon, a town on Beni River, and the second, *R. beniensis lacustris*, originating in lagoons along the shores of Lake Rogaguado, a lake located south of Ivan but still in Beni Province.

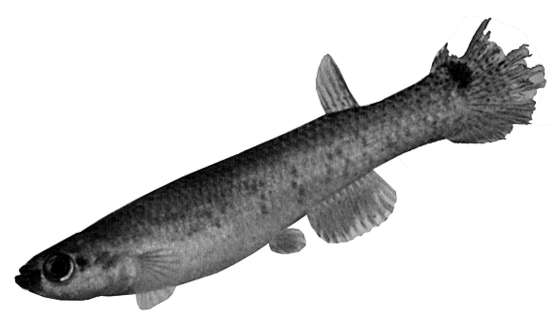
The original description was brief and lacked accompanying illustration. Males were described as having dark-brown, longitudinal lines between scale rows and no caudal ocellus. The light interspaces were reddish. Females, however, were described as having a very large, black caudal ocellus.



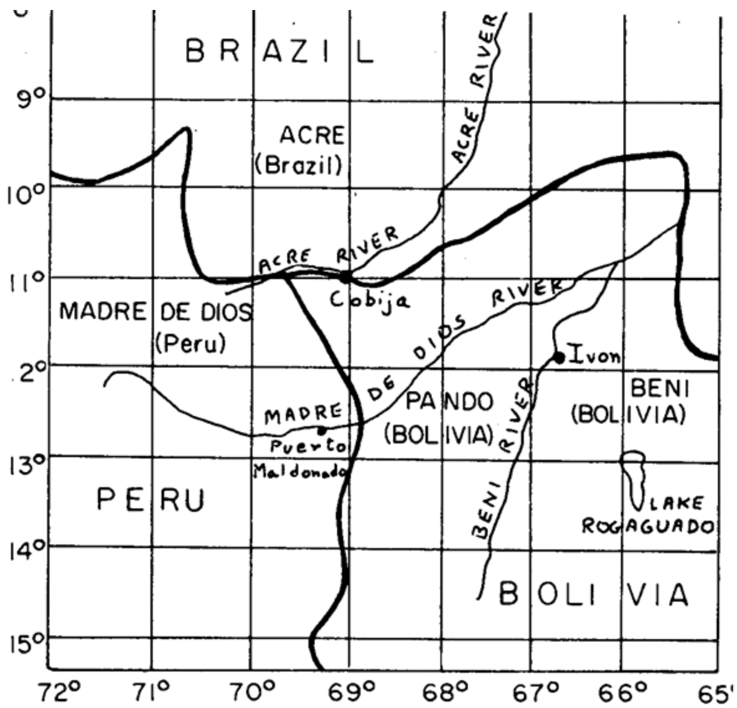
***Rivulus beniensis*, male. Photo by author.**

Earlier this year, Dr. Richard L. Stone and Mr. James Thomerson (bath from Louisiana, the latter at Tulane University) very kindly sent the author numerous specimens of an unidentified fish, then commercially known as the "Peruvian long fin rivulus." This was a striking fish, embodying structural elements of both *Pterolebias* and *Rivulus* with the color of an *Aphyosemion*. It was impossible, however, to make a certain identification and the author enlisted the aid of Mr. Neal Foster, an ichthyologist at Cornell University. Fin and scale counts were done but the results were somewhat confusing. The fish was very close to the *strigatus - beniensis - taeniatus* group but it definitely could not be strigatus since this fish was known to us already, and the habitat of *taeniatus* (i.e., Columbia) was far from the reported location of the new fish. Later, the author learned that the fish came from the vicinity of the Acre River in Peru (rather than Iquitos as first reported) and with this information, plus counts on additional specimens, its determination as *Rivulus beniensis* was confirmed.

Since no description of live specimens exists in the literature, aquarium or otherwise, the following will be as detailed as possible. Reference will be to adult specimens, with sexual differentiation made later. *Rivulus beniensis* is a very beautiful fish when adult (i.e., about 2g inches standard length for males, 2 inches for females). It has numerous longitudinal rows of orange (almost cinnamon) spots on a greenish-yellow background, the spots being in nice straight lines and often running into one another. The dorsal area of the body is brownish-red, purplish in the ventral area. The caudal fin is edged top and bottom in a thin, orange line and each are submargined in a much wider band of bright yellow. The middle of their fin is light violet but the rays are distinctly reddish-orange. The anal fin is colored very much like the caudal . . . a thin margin of orange and a broader submargin of orange-yellow. The dorsal is less intensely colored but it is light reddish-orange, tipped in light yellow nevertheless. Ventral fins are light yellow-orange bordered in bright red. The pectoral fins are almost devoid of any color whatsoever. It is quite important to note that juvenile specimens frequently do not present the vivid orange-yellow overall impression of the adults. They are much darker dorsally, in general. The author had the embarrassing experience while visiting in Chicago of misidentifying juveniles of this fish even though he had just made extensive observations on adults! To complete the description, it should be noted that there are yellow-green scales about the head, and that a large black ocellus is present on the upper base of the tailfin. This typical "arched back" position of a *Rivulus* at rest is frequently assumed.



***Rivulus beniensis*, female. Note the torn fins on this specimen, received in the spawning act.**



Locality of Rivulus beniensis.

Rivulus beniensis is not a particularly easy fish to sex, especially when juvenile. Both sexes have a familiar "rivulus spot" and frequently in identical intensity. However, in grown males the ocellus becomes fainter. Females in good condition are much more rotund, giving an impression sometimes of the fullness of body exhibited by *Nannochromis nudiceps*. They may also sport numerous tiny black dots on their tailfins although this is a variable feature, also. An important sex indicator is the fact that in the caudal and anal fins, where yellow normally predominates, females tend to a deep orange. With experience then, aquarists can distinguish females by their darker ocellus, rotund body, and deeper-orange markings. It should be noted that preserved males lose their ocellus, explaining why Dr. Meyers stated, "no caudal ocellus" in the males in his original description. In our specimens, the ocellus virtually disappeared in preservative within a month.

In its lack of clear-cut sexual dimorphism, *Rivulus beniensis* is somewhat atypical, although there are other species in this category as well. However, *R. beniensis* is even more atypical in that it is comparatively hard on members of its own species. Invariably, tailfins are ragged on both males and females as a consequence of constant rough and tumble fight among themselves. Females especially, have a hard time of it and the aquarist who does not provide abundant cover (mops, etc.) for these victims of oppression, is risking dead fish indeed. Consequently, it has been exceedingly difficult to photograph a female with undamaged finnage.

In spite of this, breeding is not at all difficult although results are always dependable. For my own part, a trio of fish (one male, two females) were placed into a 3-gallon, bare-bottom aquarium containing three or four floating nylon spawning mops. The fish were fed almost exclusively on frozen adult brine shrimp (they will eat a variety of foods such as white worms, beef heart, etc., indicating a carnivorous nature) and after a while, the first eggs were gathered. Surprisingly, the eggs (which are quite yellowish) average out at a diameter of 1.9 mm, a size which is quite small by *Rivulus* standards (being greatly exceeded by those of *R. cylindraceus, R. milesi* and *R. urophthalmus*). The usual sticky thread bundle is found on each egg. After a period of about two weeks, the fry hatched out and were raised with little difficulty, starting with newly-hatched brine shrimp.

Rivulus beniensis is an atypical *Rivulus* as aquarists know the genus. Perhaps future importations of other members of the assemblage described earlier in this article will show that what is typical is really atypical, and vice versa. We have a lot to learn about the members of this genus.

A Thirty-one-Year-Old Aquarium Mystery Solved - Part I

[Aquarium Journal, January 1964,]

The swordtail characin, *Corynopoma riisei* (illustrated along with its very rare cousin, *Corynopoma aliata,* in figure 1) was first bred by aquarists in 1942 and to this day, this native of Venezuela, Columbia and Trinidad has remained a popular aquarium fish, favored by beginners and "old hands" alike. Although basically a silvery fish and hence precluding fame as a brilliant beauty, the swordtail characin is graceful of form and motion, unassuming, easy to keep and to breed, and peaceful with both other fishes and oftentimes, even with fry. The lower lobe of the male fish is elongated in the form of a sword, thus giving rise to its popular name. Furthermore, the gill cover of the male fish bears a filamentous process that resembles a paddle *(Corynopoma* means "gill cover with club"). These last two features make the swordtail characin a very unique fish in the aquarium world.

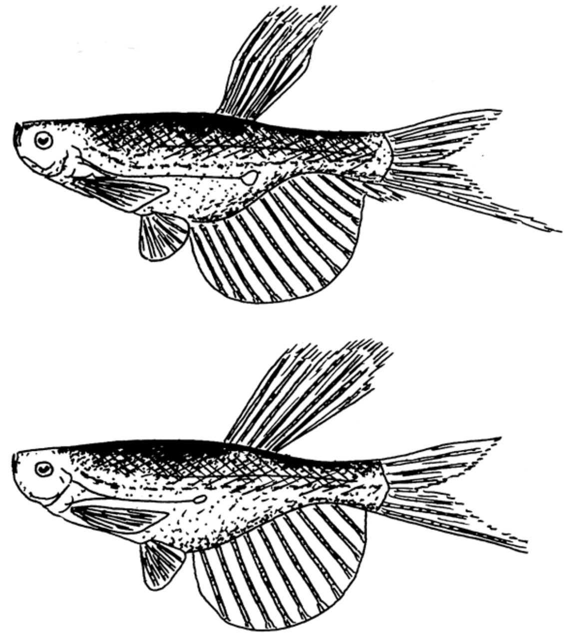


FIGURE 1: TOP - *Corynopoma aliata*. BOTTOM - *Corynopoma riisei.* Sketch by the author.

Contributing to this privileged position, however, is the additional fact that in the swordtail characin, fertilization is internal, a characteristic it shares with several other members of the family, Characidae. In other words, the male need not be present at the time the female lays fertilized eggs. It would be helpful at this point to review the spawning act in this fish but in considerably more detail than has appeared in the aquarium literature to date. Courting commences with the male swimming round and round the female, both above and below her. The net result is a rather constant pursuit of the female. At certain intervals, the male darts at his partner much as if the intention was to grasp the lower lobe of her caudal fin. Usually, however, when he comes within an inch above the female the male turns and approaches her at an angle, rapidly at first, then slowing down. Simultaneously and together with his other unpaired fins (dorsal, tail fins), he quickly spreads his anal fin with a quivering, trembling movement. Following this, the male then bends his anal fin and rubs it or jabs it against the female. At the same time, he folds the bottom lobe of his tail fin towards her. This approach is quite similar to that used by male *Nothobranchius* towards their females (e.g., *Nothobranchius guentheri).* If males are isolated from females for any considerable amount of time prior to bringing them together for spawning purposes (say from 10 days to 3 or more months), then the males will intensify their courtship displays. As a matter of fact, they may even court with other males.

The female swordtail characin usually responds in either of two ways; (a) she remains motionless for a short while and then swims away or (b), she swims in the same direction

FIGURE 2: The gill cover appendage of *Corynopoma* (after Kutaygil).

as the male. In most instances, if the female is in good condition, the male induces her to the latter course and they swim away parallel to each other. An interesting point is, however, that she undertakes this parallel swimming in a manner that suggests readiness to attack the paddle nearest to her. She is attracted, thusly, by the movements of the male. At times, she may turn and face the male ventrally, trembling. On rare occasions, the female may even follow the male, thrusting at him. Then, by swimming away, she forces the male to follow.

Eggs may be released at any time. All that is needed for females that have been impregnated to lay eggs frequently and in large quantities, is a spacious aquarium, well planted. *Ceratophyllum, Elodea, Riccia,* etc., are all quite good. Individual females may lay as many as 10 to 35 times a year with at least 15 and often as many as 30 to 60 eggs at a time. These eggs are released one by one in rows of from 5 to 15, preferably on plants but also on rocks or even on the gravel.

This account of the spawning of the swordtail characin leaves, however, two very basic questions unanswered:

1. How does insemination take place?
2. Of what use are the gill cover paddles of the male, and how do they relate to the spawning act?

These questions form the basis of an aquarium mystery that has puzzled aquarists for 31

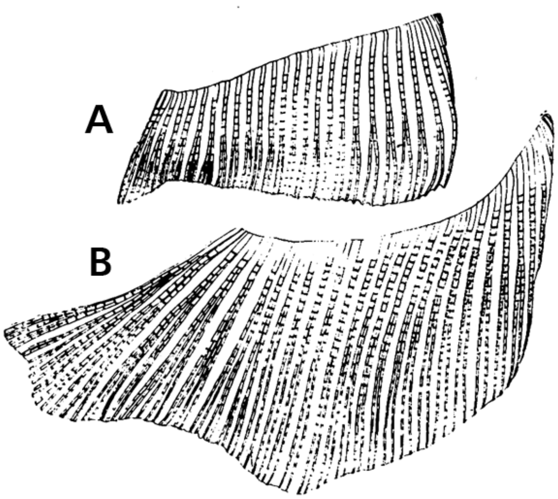


FIGURE 3: The anal fin of *Corynopoma* (after Kutaygil)

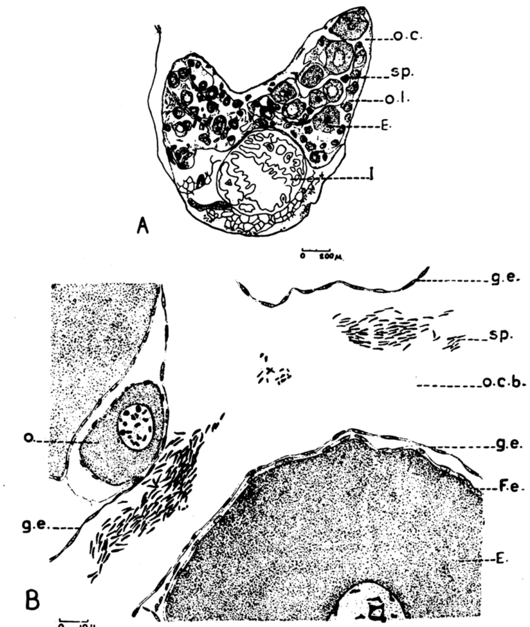


FIGURE 4. (A) Cross section of gonad of inseminated female *Corynopoma*. (B) Magnification of same. Note the sperm are clearly seen.

Code:
o.c.. = ovarian cavity
sp. = spermatozoa
o.l. = ovarian lobe
E = egg
I =intestine
g.e. = germ epithelium
o.c.b. = ovarian cavity branch
F.e. = folicle epithelium
o. = oocyte (after Kutaygil).

TABLE I (after Kutaygil)		
Results using males with both paddles plus anal fin amputated, and virgin females.		
Exp. No.	**Time Together**	**Results**
1	10 days	Dissection revealed female received no sperm.
2	20 days	"
3	25 days	"
4	3 months	"
5	10 months	Eggs did not develop. No sperm found in micropipette examination of female.
6	15 months	"

years. Although the author has made previous contributions towards the solution of this mystery (see reference), he has only recently learned that it has now been solved in its entirety by a Turkish scientist. Before presenting the solution, however, additional background information must be considered.

The gill cover of the male ends in an appendage, as was stated previously, which lies on either side of the body. It is rather thin and ends in a spoon-shaped tip (figure 2). The gill cover of the female, on the other hand, terminates in but a very slight projection. It has long been known that males use these paddles to attract the attention of the female. When approaching a female during courting, one or more of these paddles is turned at an angle towards the female. The female approaches this "lure" and thus proximity of male to female is assured. If, for example, one of the paddles is amputated, the male will court with the other. Amputated paddles are regenerated with time but with each re-amputation, the regenerated organ becomes smaller and shorter. The paddles do not appear in the males until the fish has attained a length of approximately one inch, and the paddles (the complete organ, stalk plus spoon) themselves reach a length of about three-fourths inch when the males reach a length of about one and a half inches.

TABLE II (after Kutaygil)		
Results using males with only both paddles amputated, and virgin females.		
Exp. No.	**Time Together**	**Results**
1	10 days	Eggs dropped by female developed.
2	13 days	"
3	21 days	"
4	55 days	"
5	3 months	Dissection of female revealed sperm in ovarian cavity and oviduct.
6	6 months	Eggs dropped by female developed.

It is well known that in many fishes in which internal fertilization takes place (e.g., our familiar aquarium livebearers), the anal fin is often modified into an organ of insemination (gonopodia). In the swordtail characin, however, no such modification is apparent. The anal fin of the male is considerably higher than that of the female, and its posterior edge is convex (figure 3). Under magnification, very tiny hooks can be seen on rays numbers 3 through 10, said hooks pointing towards the base of the fin. Frequently, these hooks catch in the netting when capturing the fish.

To answer the questions posed previously, Dr. Nebia Kutaygil of the Zoological Department of the University of Istanbul (Turkey) conducted a series of brilliant experiments (see reference). To examine females for presence or absence of sperm, either of two techniques were used: (a) dissection, (b) injection of a NaCl solution into the oviduct with a fine pipette (micropipette), and withdrawal of this solution for examination of the products thus obtained. To examine males, two techniques were also used: (a) dissection, (b) squeezing the body and subsequently examining the products thus obtained.

The first series of experiments involved amputation of both paddles plus the anal fin of the male. As a result, the males had great difficulty in putting on a courtship display. A male would spread his dorsal and tail nervously and thrust at the female with the lower lobe of his tail fin. As if it had not been removed, he would attempt to bend the part where his anal fin had been before amputation. The results of this series of experiments are shown in Table I.

In all experiments in this series, female failed to become impregnated. Over long periods, both paddles and anal fin re generated but they were re-amputated (every 7 to 10 days (as soon as their initial reappearance). Clearly, either paddles anal fin or both were necessary for sperm transfer and successful breeding. In the second series of experiments only the paddles (both of them) were amputated. These results are shown is Table II. In this case, sperm transfer was effected in every instance. Next, experiments were conducted with only the anal fin amputated, the results appearing in Table III.

TABLE III (after Kutaygil)		
Results using males with only the anal fin amputated, and virgin females.		
Exp. No.	**Time Together**	**Results**
1	20 days	Dissection of female revealed no sperm.
2	23 days	"
3	26 days	"
4	30 days	"
5	40 days	"
6	45 days	"
7	73 days	"
8	1 year	Eggs did not develop. Micropipette examination revealed no sperm.

A Thirty-one-Year-Old Aquarium Mystery Solved – Part II

[Aquarium Journal, February 1964]

In all instances in Table III, then, fertilization was not achieved. When males were allowed to regenerate their anal fins, however, they were then found to be able to fertilize females. When this fin was regenerated, so were the hooks. In two experiments in which the hooks only were removed, and in which the males were left with the females for a period of one month, micropipette examination of the females showed no sperm transfer whatsoever. This clearly demonstrates that the hooks are absolutely necessary to sperm transfer.

In summary then, and in answer to our first question, the male uses his anal fin hooks to hold onto the female's anal fin or ventral scales enabling him to draw his genital papilla (the equivalent of the female's ovidepositor) closely enough, and for a sufficient length of time, to permit sperm transfer. In this, his genital papilla serves as a sort of penis. The answer to our second question is that the paddles are only ornamental organs, serving at most to attract the female and have nothing whatsoever to do with sperm transfer.

At one time it was thought by some that female swordtail characins swallowed bundles of sperm known as "spermatophores," thus effecting fertilization. This is, of course, patently untrue. In a fertilized female, sperm is found everywhere in the genital system and in especially great quantities in the oviduct (figure 4). Mostly, they are found clustered in groups but never are such groups found surrounded by a covering or membrane-like capsule which defines the word "spermatophore." Instead, such clusters or groups of sperms are held together by a mucous-like substance, most likely secreted by the sperm duct of the male. The correct term is, therefore, "sperm parcle" or "sperm package" (in my 1961 article I had incorrectly used "spermatophore" as a synonym for "sperm parole," although I noted that no membrane was present). Nor are spermatophores found on the genital papilla or in he male, either. In the male, the sperm is agglomerated into groups as in the female. Some fishes (e.g., *Horaichthys)* do have true spermatophores, equipped with "helping" organs, the sperm being subsequently released by the action of the oviduct fluid, but *Corynopoma* is not one of them. The survival time of the sperm inside of the female *Corynopoma is* quite long, Dr. Kutaygil having shown in additional experiments that, on the average, it is 8.7 months with a minimum of 7.5 months and a maximum of 10 months for a series involving six different females.

When left together night and day, insemination of the females is virtually assured within 10 days, something breeders might note. Further-

TABLE IV (after Kutaygil)			
INSEMINATION IN FEMALES LEFT WITH MALES ONLY DURING THE DAYTIME (examination by micropipette)			
Exp. No.	Time Together	Last and before last times examined	Female inseminated?
1	9 days	9th, 6th days	Yes
2	28 days	28th, 15th days	Yes
3	31 days	31st, 21st days	Yes
4	40 days	40th, 25th days	Yes
5	60 days	60th, 50th days	No
6	62 days	62nd, 60th days	No

more, insemination is apt to take place during hours other than the daytime (probably twilight or the early hours of the morning). Table IV shows the results of leaving males with females only during daylight hours.

The time to achieve insemination is somewhere between each pair of numbers in the third column of Table IV in the first four females (the last two never became impregnated), and as can be seen, these figures average considerably higher than the maximum time of 10 days for females left with males continually.

The swordtail characin is a member of the subfamily, Glandulocaudinae, a subfamily characterized not only by decided external differences between the sexes, but also by the presence of a fairly large pouch under the tail fin, made up of glandular tissue, in the males. Figure 5 shows this gland and how the lateral line bends to miss it. The pouch contains secretory cells but their function is not known. It will also be noted that a spur is present under this fin; again, in the male only.

Yes, after 31 years, the mystery of the swordtail characin is finally solved and the explanation brings to mind something that Epictetus once said in his discourses: "Things either are what they appear to be; or they neither are, nor appear to be; or they are, and do not appear to be; or they are not, and yet appear to be. Rightly, to aim in all these cases is the wise man's task."

Klee, Albert J. "An Unusual Tribe of Characins," TROPICALS MAGAZINE, Fall 1961, pp. 10-14, 41.
Kutaygil, Nebia, "*Stevardia albipinnis* Gill 'de dollenme cinsi differensiasyon ve sekonder esem karakterlerinin telkiki " ISTANBUL UNIVER SITESI FEN FAKULTESI MECMUASI, Seri B, Cilt XXIV, Sayi 1-2, Temmuz 1959.

New Fish From Peru

[Aquarium Journal, February 1964, AJA10]

The number of species of *Rivulus* currently known from Peru total four, *viz., Rivulus micropus, R. urophthalmus, R. peruanus,* and *R. beniensis.* These four species include representatives from each of the three main groups of the genus as proposed by the Dutch ichthyologist, J. J. Hoedeman (i.e., *breviceps* group, *marmoratus* group and the *cylindraceus* group) [3]. The writer has recently reported upon and added to the original description of *Rivulus beniensis*[4], a fish whose range is now known to extend from at least northern Peru to northern Bolivia.[5]

Since that time, another Peruvian rivulid has come into my possession, viz., *Rivulus peruanus* (pronounced PER-ROO-**AY'**-NUS). This fish is a member of the *isthmensis* complex of the *marmoratus* group consisting of the following four fishes (together with their type locality and in order of discovery):

R. isthmensis - (1895, Rio San Jose, Costa Rica)
R. peruanus - (1903, "Perim," Peru)
R. hildebrandi - (1927, Boqueta, Panama)
R. volcanus - (1938, Chiriqui, Panama)

Until now, only *Rivulus isthmensis* (figure 1) has been known as an aquarium fish (imported under the erroneous name *of "Rivulus flabellicauda"* in 1909) but it has not served this purpose for many years and now is all but forgotten. *Rivulus volcanus* is a slender species of reported uninteresting coloration (figure 2) and R. *hildebrandi* even less so (there is no drawing extent of this species').

Rivulus peruanus was described by Regan[6] in 1903 as coming from "Perim," Peru. However, no subsequent investigator has been able to locate this place *on any* map and therefore, its type locality has been a minor mystery. It is known, however, that its collector, Simons, operated from Huaras which is located on the

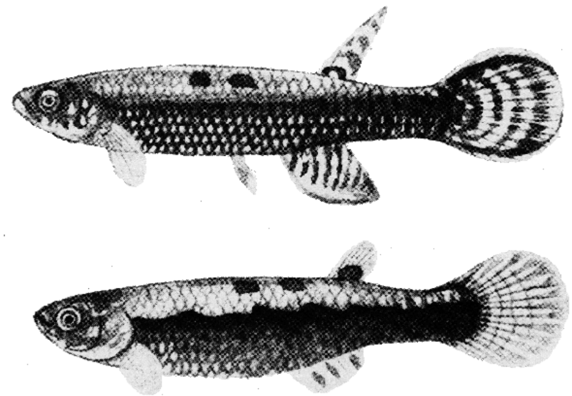


FIGURE 1: *Rivulus isthmensis*, male above, female below (from Arnold & Ahl).

Pacific coast of the Peruvian Andes. The original description was rather brief and devoid of any illustration and therefore, the following short account serves to re-describe the fish, especially from life, and to provide hitherto missing locality, ecological and behavioral information.

Regan's original account gave the following information: "Dorsal 10-11, Anal 14-16 ending below last 2 or 3 rays of the dorsal." A subsequent account, however, changed these figures to "Dorsal 9-10, anal 13-15." My own specimens averaged dorsal 10, anal 16, with the anal fin edging below the second from the last ray of the dorsal.

These fishes were taken in Tournavista, Peru, located in the lower left hand quadrant, 8° to 9° latitude, 74° to 75° longitude (see figure 3). This town is located only about 190 miles from Huaraz and borders the Rio Pachitea not too far from the latter's junction with the Rio

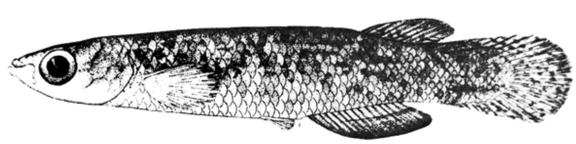


FIGURE 2: Rivulus volcanus (from Pizzini).

Ucayali. The nearest town (the one on most maps, that is) is Pucallpa, Peru.

A description of a live male (see figure 4) is as follows:

Body - heavily pigmented; reddish-brown dorsally, sides greenish, belly reddish-violet; orange-red marking on gill covers and sides (upper forward markings are in longitudinal lines, tending towards isolated, rust-colored blotches lower and/or rear).
Fins - green of body extends into caudal middle and lower half; caudal heavily pigmented and is overlaid wit several moon-shaped series of reddish blotches; upper caudal edged in ms color, lower caudal edged in deep purple; dorsal fin with orange marking and edging; ventrals tiny with low (portions edged in black; pectorals color: less to yellowish; anal with series (orange dots near base, base of an: greenish, edged in black.

A description of a live female is s follows (see figure 5):

Body - also heavily pigmented; reddish-brown dorsally and on sides, violet on belly; reddish spots on sides more regular than in male, also smaller and more numerous (however, they are much lighter and less noticeable); several blackish spots on dorsal surface of caudal peduncle forming a caudal ocellus but this part of body usually so dark that it doesn't appear especially prominent.
Fins - dorsal, anal, and caudal yellowish with rust-colored markings; pectorals colorless to yellowish.

These specimens were collected from behind the Tournavista compound of Verco Tropical Fisheries by Mr. Jon Krause of Columbus, Ohio, the pioneering collector in this area. They were found in a moderately fast-flowing stream, over a rocky bottom, with no additional fishes present other than sundry Loricariidae *(Plecostomus* types). The water was

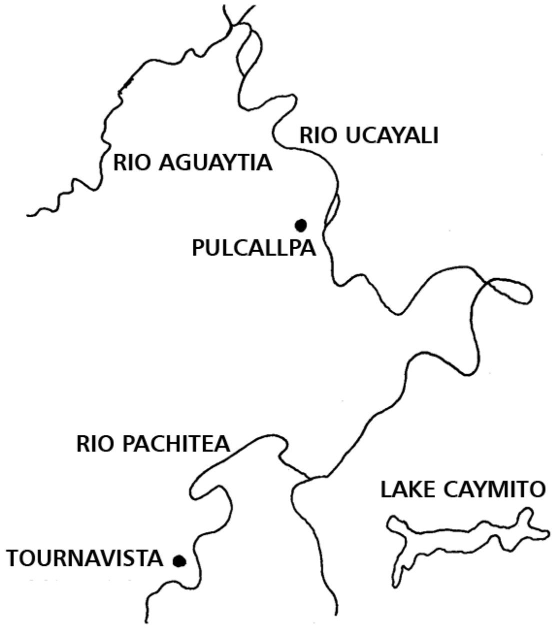


FIGURE 3: Habitat of *Rivulus peruanus*. Sketch by author.

78° F, pH 7.2 and clear. In such a habitat, *Rivulus peruanus* were found in groups near the surface.

Some of my adult males measure 3-1/2 inches overall (including tail) but it is known that they do grow somewhat larger. The species is large and robust but takes well to captivity. During the long transit from Peru they suffered heavy fin damage, mostly due to fighting amongst themselves, but quickly responded to standard treatment for fin rot. My specimens avidly take frozen brine shrimp (adult), and 1-inch fry of *Fundulus olivaceus* were consumed quickly also.

Breeding was successfully attempted in a bare-bottomed, 3-gallon aquarium equipped with an inside filter and three, circular nylon spawning mops. A trio, one male and two females, was used. It cannot be emphasized strongly enough that male *R. peruanus* are extremely hard on females (as in the case of *R. beniensis).* Females must be provided sufficient shelter so that they may safely retreat when necessary. An excess of spawning mops serves this purpose nicely. It has been noticed that when the mops are removed to be examined for eggs, the male often takes the opportunity to badger the females which then, of course, have no refuge. However, females that are "full" suffer little or no damage, while those not ready to spawn suffer most.

Rivulus peruanus lays eggs in the "large" *Rivulus* category (the writer categorizes *Rivulus* eggs as follows:

large - 2.0 mm, e.g., *R. milesi*
medium - 1.7 mm, e.g., *R. hartii*
small - 1.5 mm, e.g., *R. urophthalmus,* since they average 2.00 mm in diameter.

They are yellowish and possess the usually sticky threads. Figure 6 shows a photograph of a newly laid egg alongside of an egg of *Epiplatys macrostigma* (diameter 1.0 mm) for comparison purposes. Not too many eggs are laid daily, 2 to 4 being the average tinder the conditions described. The eggs are laid at the top of the mop or else in the vicinity of the top.

As might be expected the fry are large (hatching after 10 days at 75° F) and can immediately be given brine shrimp nauplii. They grow fast, also. *Rivulus peruanus* can be kept together with fishes their own size and disposition without too much trouble. They are active and robust, however. If kept with a fair number of their own species in a tank of 10 to 15 gallons, damaged fins will be kept to a minimum. Since *Rivulus peruanus is* a large, very

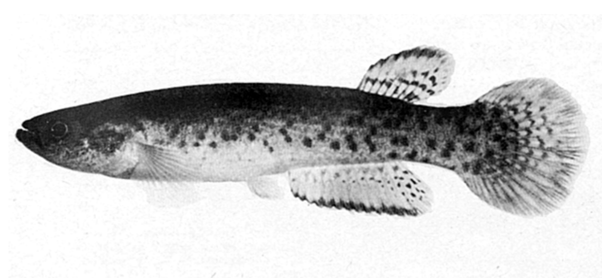


FIGURE 4: *Rivulus peruanus*. Photograph by author.

FIGURE 5: *Rivulus peruanus*, female. Photograph by author.

attractive rivulin, the extra effort needed is well worthwhile.

REFERENCES

1. **Eigenrnann, C. H., and Allen, W. R., *Fishes of Western South America*, pp. 345-6, The University of Kentucky 1942.**
2. **Hildebrand, S. F., “A new Catalogue of the Fresh Water Fishes of Panama,” ZOOLOGICAL SERIES, FIELD MUSEUM OF NATURAL HISTORY, Vol. XXII, No. 4, Publication 425, pp. 313-319 1938.**
3. **Hoedeman, J. 1., “Preliminary Key to the Species and Subspecies of the genus *Rivulus*,” BULLETIN OF AQUATIC BIOLOGY, Vol. 2, No. 18, pp. 65-74, February 1961.**
4. **Klee, Albert J., “A New *Rivulus* from Peru,” Aquarium Journal, pp. 450-454, October 1963.**

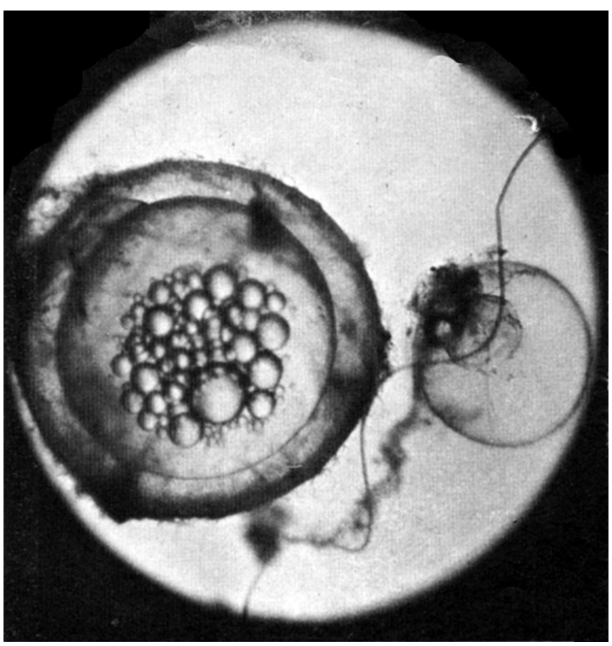


FIGURE 6: Egg of *Rivulus peruanus* (large) compared with egg of *Epiplatys macrostigma* (small). Photo by author.

5. **Lueling, K. H., “Ist *Pterolebias peruensis* wirklicn ein echter Saisonfisch?”, DATZ, heft 11, pp. 330-334 1963.**
6. **Regan. C. T., “Descriptions of New South American Fishes in the Collection of the British Museum,” ANN. MAG. NAT. HIST., (7), XII, pg. 626 1903.**
7. **Regan, C. T., “A Revision of the Poeciliid Fishes of the Genera *Rivulus, Pterolebias*, and *Cynolebias*,” ANN. MAG. NAT. HIST. (8), X, pp. 494-508 1912.**

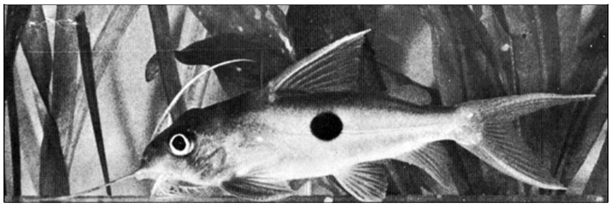
A “Spot-Check”?

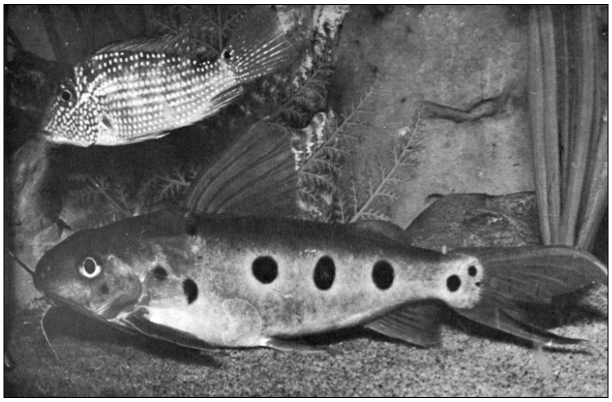
[Aquarium Journal, April 1964. Note: This article was co-authored with Braz Walker, AJK being the Senior Author.]

In a previous issue of the AQUARIUM JOURNAL[1], one of the authors (Walker) discussed his difficulties in properly identifying a certain mochokid catfish of the genus *Synodontis*, family Mochokidae.

To *Synodontis,* pronounced, SIGH-NO-**DON’**-TIS, belongs the familiar upside-down catfishes from Africa. It appeared that for the catfish in question, names such as “*Synodontis notatus*” (notatus = spotted), “*Synodontis binotatus*” (binotatus = two spotted), “*Synodontis trinotatus*” (trinotatus = three spotted) etc., were arbitrarily assigned by dealers and hobbyists alike without regard to scientific nomenclature, according as to the number of body spots possessed by a particular specimen. Furthermore, it was observed by that author that such catfishes in his care added to the total number of body spots with time. The purpose of this brief note is to clear up the questions caused by too many spots!

Figures 1 and 2 illustrate our “spot problem” very nicely. The first figure depicts the typical appearance of our fish when young, while the second reflects the increased number of body spots attained after the fish had grown some. Thanks to our friend and authority on African fishes, Jacques Lambert of Belgium, we can now identify the fish in figure 2 as *Synodontis*





TOP: FIGURE 1 - *Synodontis notatus ocellatus* (young fish).
Photo by Albert J. Klee
BOTTOM: FIGURE 2 - *Synodontis notatus ocellatus* (adult fish).
Photo by Braz Walker.

notatus ocellatus The common or "garden" form of this species is *Synodontis notatus notatus* and bears only a single black spot on each side (figure 1). However, some populations of this species do bear more spots and it is very likely that these supplementary spots only appear at a given size and/or age. Multiplication of the number of spots with size and age has been observed in many fishes and among them some other *Synodontis* also, e.g., *Synodontis longirostris.*

Actually, in addition to the type species, two subspecies of *Synodontis notatus have been described 3, ‘.* The original *notatus* was described from the upper reaches of the Congo River but the first subspecies, S. *notatus binotatus,* was described somewhat southeast of that location, by Pellegrin in 1928 (see figure 3). The next subspecies, S. no*tatus ocellatus,* was discovered in Katanga (and described by Poll in 1938, along with another fish of interest to aquarists, viz., *Nothobranchius brieni),* southeast of the location of the type species (see figure 4). Thus, there are distinct geographical locations associated with each of these subspecies.

Although leopards may never change their spots, this is decidedly not the case with *Synodontis notatus ocellatus,* and aquarists need not necessarily swear off John Barleycorn should an informal inventory of said spots show an increase with time!

REFERENCES

1. **Walker, B., "Synodontid Catfishes," AQUARIUM JOURNAL, Vol. XXXIV, No. 8, pg. 351, August 1963.**
2. **Lambert, J., Personal Communication to Albert J. Klee, October 13 1963.**
3. **Pellegrin, J., "Poissons du Chiloango et du Congo recueillis per 1'expedition du Dr. H. Schouteden," ANN. MUS. CONGO BELGE, Zool., Ser. I, T. III, Facs. 1.. pg. 30 1928.**
4. **Poll, M., "Poissons du Katanga (bassin du Congo) recoltes par le professeur Paul Brien," REV. BOT. AFR., XXX, pg. 405 1938.**

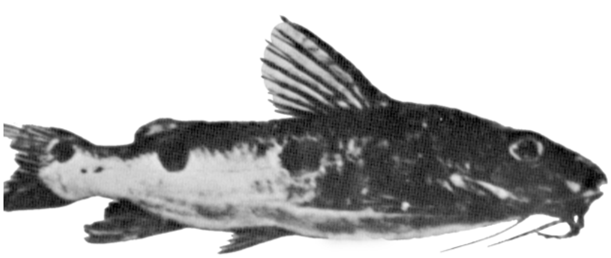


FIGURE 4:
***Synodontis notatus ocellatus* (after Poll).**

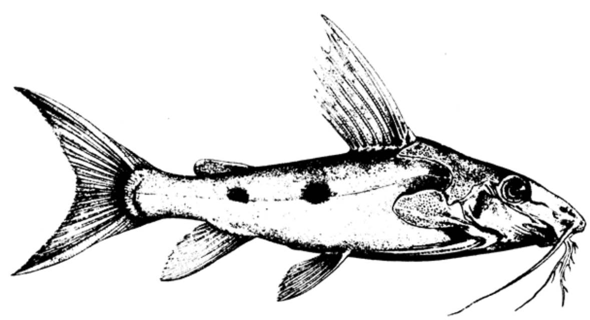


***FIGURE 3: Synodontis notatus binotatus* (after Pellegrin).**

A Congo Jewel

[Aquarium Journal, June 1964]

In the beginning of the 1900's, Dr. W. J. Ansorge collected a number of robust, square-tailed lampeyes from the Lucola River near Cabinda, the capital of the Portuguese Congo (an Angolian enclave of about 3000 square miles and like its capital city, also named Cabinda). In 1911, the great ichthyologist, George Albert Boulenger, described the fish as *"Haplocheilus cabindae"* (pronounced KA-**BIN'**-DEE). Then, during his Chiloango and Congo expeditions of 1920-1922, Dr. H. Schouteden discovered a lampeye from the Lombo River, an affluent stream of the Loeme of Gabon. In 1924, this fish was described as *"Haplocheilus loemensis"* (pronounced LOW-EH-**MEN'**-SIS), by the French ichthyologist, Dr. Jacques Pellegrin. These events then, were to set the background for our own experiences almost 60 years later.

In mid-January of 1963, the authors were indeed fortunate in acquiring through the kind cooperation of Paramount Aquarium of Ardsley, New York, five rather exotic species of killifishes imported by that firm from the "Congo" area (in quotes because, as we shall see, there are many "Congos"!). The first four were quickly identified by the authors as *Aphyosemion labarrei, Aphyosemion striatum, Epiplatys duboisi,* and *Epiplatys macrostigma.* The fifth, how ever, was new and remained for a while, without a name. Because of the relatively high placement of its pectoral fins, however, there was no doubt that it belonged to that subfamily of killifishes known to aquarists as "lampeyes." Shortly afterwards, a careful examination of the scientific literature indicated that our fish was *Micropanchax cabindae,* an identification later confirmed for us by Mon. Jacques Lambert, the noted Belgian specialist in Congo fishes. However, Mon. Lambert has just informed us that *cabindae* actually belongs to the genus *Plataplocheilus* (pronounced PLAT-AP-LOW-**KYE'**-LUS), a

FIGURE 1: *Plataplocheilus cabindae*. Male above, female below. Photo by Albert J. Klee.

conclusion concurred in by the well-known Danish zoologist, Stenholt Clausen. He (Mon. Lambert) arrived at this conclusion after comparing this species with syntypes of *Plataplocheilus ngaensis* and two new species (i.e., P. *chalcopyrus* and P. *miltotaenia), which* he discovered in Gabon. In preparation is a new definition of the genus since presently, it is rather ill defined. Perhaps we may say more about this in a future article.

There is no doubt that the Cabinda lampeye is a beautiful fish. Furthermore, it is a large enough fish so that aquarists do not have to strain their eyes to appreciate its beauty, i.e., about 2 inches total length for males at maturity (females slightly less). As with most lamp*eyes,* however, they should he viewed using oblique lighting for maximum effect. Such fishes do not rely upon pigments for their beautiful coloration, but upon irridiophores, which impart color by refraction. The basic body coloration of the male is a nondescript gray but on its sides, it displays an electric-blue sheen, concentrated along the lateral line into a particularly intense effect. A very thin line of electric-blue" also runs along the ventral keel. Both the lateral and the ventral lines continue into the caudal fin, the former moving up, the latter down, so as to follow the con-

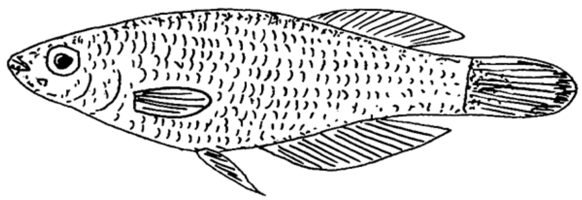


FIGURE 2: ***Micropanchax loemensis*** **(after Pellegrin).**

figuration of, this fin to act as submarginal borders.

There is an orange basal stripe in the dorsal fin, and another in the anal except that the orange stripe in the latter is not quite basal, being not only oblique but also separated from the base of the fin by a hand of the same electric-blue found on its sides (figure 1). Females, although *they* display the bluish coloration (hut much less intensely), do not have these orange bands in the dorsal or anal fins.

Besides being a large, deep-bodied member of the genus (and in these characteristics it is similar to *Aplocheilichthys spilauchen), P. cabindae* has a very truncated tail fin. It is, therefore, easily distinguished from its close relatives and in particular, from *M. loemensis.* It is necessary now to digress for the moment to consider this last-named fish for it has, more than once, been confused with *P. cabindae.*

Micropanchax loemensis is essentially almost identical in pattern and coloration to P. *cabindae.* It is, however, different in a number of ways. For one thing, P. *cabindae* is generally somewhat deeper-bodied than *N. loemensis.* Unfortunately, some specimens of *cabindae* are more elongate than others so this is not a reliable indicator unless taken with other facts as well. It is found that the area on the back from the head to the dorsal fin is very much straighter in *cabindae* than it is in *loemensis.* In *loemensis,* the back starts in a convex curve right behind the head (figure 2). The tailfin in *cabindae is* always more truncated than in *loemensis*. In the former, it is either straight or even slightly concave; in the latter it is always nearly rounded although sometimes a solitary specimen may carry nearly straight tails but even then, the tail will still be slightly convex. Finally, these two species differ in dorsal fin count and on 56 specimens of P. *cabindae* from the Tissala River and from an area between Pointe Oire and Sundra, and on 7 specimens of *M. loemensis* from Mindouli, Mon. Lambert found the data summarized in Table I.

Since the counts do not overlap, they are an excellent means of distinguishing between the two species (our specimens had counts of from 9 to 10 rays).

Figures 3 and 4 show some of the habitat localities for both P. *cabindae* and *M. loemensis* (figure 4 is an enlargement of a selected portion of figure 3). From these, it can be seen that both species are concentrated in the French, Belgian and Portuguese Congos. In these western areas, however, *M. loemensis* is frequently found somewhat farther inland. Unlike *loemensis, cabindae is* relatively widely distributed throughout Africa. Not only has it been described from Dililo in the Belgian Congo and Angola (see figure 3), but we

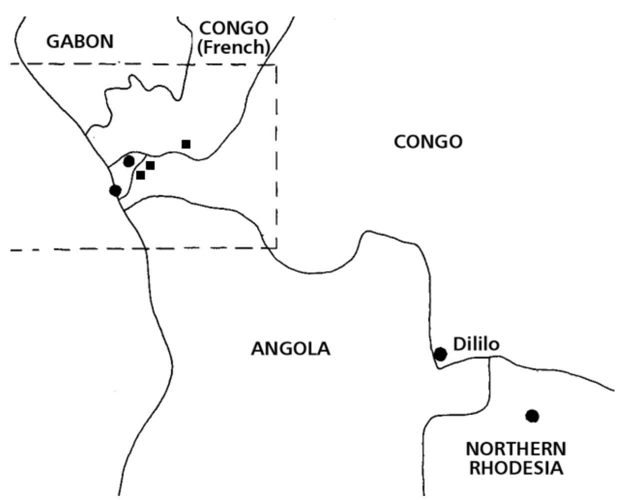


FIGURE 3: Localities of *Plataplocheilus Cabindae)* circles) and *Micropanchax loemensis* (squares).

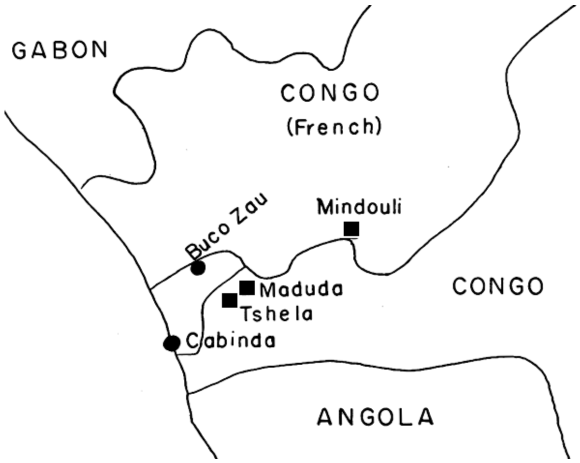


FIGURE 4: Enlargement of dotted area of FIGURE 3. *Plataplocheilus cabindae* (circles) and *Micropanchax loemensis* (squares) distribution shown.

have received preserved specimens from Dr. R. A. Jubb of the Albany Museum in Grahamstown, South Africa, of *cabindae* taken by Mr. Bell-Cross from the headwaters of the Upper Zambezi River (where it shares a watershed with the Congo system) in Northern Rhodesia!

In the Northern Rhodesian area, the biotope of P. *cabindae* is one of high summer rainfall, tropical, and consists of what is locally called "sponges." Sponges are swampy areas, frequently the source of a river, sited on a plateau. During the dry season, these swamps may at places suffer from lack of oxygen due to rotting vegetation, but during the rains they again become fresh with a reasonably high oxygen content, and empty down both sides of the plateau. If the plateau happens to he a watershed, these swamps become a link between two major drainage basins and small fishes reaching the plateau can pass from one basin to the other. Lake Dililo, in northeastern Angola, lies on the watershed between the Congo and the Zambezi, and most assuredly forms an interesting spot as a link between the two systems, to which the wide distribution of *cabindae* attests.

Concerning the biotope of *M. loemensis,* Mon. Lambert has kindly supplied the authors with the following information:

"... the fish is generally found in fast-running, clear waters, with a bottom of sand and pebbles. These waters arc slightly acid but in the Loeme itself, the water is also clear and fast running, though much darker and probably more acid (no measurements were taken). This species was also caught in an estuarine lagoon in which there is a constant stream of freshwater coming from the Loeme but where a certain mixture of seawater may occur at high tide. In this lagoon, true estuarine forms such as *Aplocheilichthys spilauchen*, *Batanga lebretoni* and *Dorichthys aculeatus* are found with *M. loemensis*. I would not consider the last-named as an estuarine fish but rather take its presence in the lagoon as 'accidental,' merely showing that as long as it gets clear, running water, this fish seems rather tolerant of a wide pH range."

In the aquarium, *P. cabindae* is quite active, even for a lampeye, and does not "pose" as do many killies. Indeed, its activity is scarcely less than that of the common *Danio* species. Thus, it can be appreciated that this species does better on the whole in aerated aquaria. An inside filter in their aquarium is sufficient to make them quite comfortable. It has been our experience in general that briskly-moving lampeye species fare better as aquarium specimens in more elongate aquaria, and this thesis is certainly applicable to P. *cabindae.* It appreciates adequate room to swim in and is constantly moving about, searching for food. Surprisingly, P. *cabindae* seems to inhabit equally, all levels of the aquarium, having no preference for the top stratum, as do other types of lampeyes. There are no rigid temperature requirements in the ordinary sense for this species nor is it by any means delicate as long as provided with moving water. It has been our experience that, if housed in a small aquarium without aeration, the fish will shortly be seen to gasp for air at the surface. Evidently then, its oxygen requirements are fairly high. Also, the colors of the male seem to increase in intensity with an increase in motion of the water.

P. cabindae is neither rambunctious nor given to displays of "temperament." Two or three males will occasionally appear to nip one another in what may seem to be an aquatic free-for-all, but little or no damage is done in these encounters. In general, one quickly gets the impression that this species is "too busy" moving about to be pugnacious. Females make motions towards one another but again, no damage is done. In short, torn or ragged finnage in groups of these fish are hardly ever observed. As far as feeding is concerned, P. *cabindae* readily takes frozen adult brine shrimp, beef liver and chopped beef, as well as live foods such as tubifex worms and brine shrimp. They will even pick up such foods from the bottom of the aquarium.

The spawning act follows the usual lampeye procedure, adhesive eggs being laid on nylon mops after the prenuptial play consisting of circling and close contact between the sexes. Although one of the authors obtained eggs from all strata, the other found that they laid their eggs predominantly on the upper portions of the mop. Furthermore, when given a choice between light-green and dark-green mops, they invariably selected the latter! The ways of fishes are indeed strange at times, making it difficult to write about them in generalities.

The sexes may be left together without danger at all times, and this holds true of course for spawning as well. Two males to five females is ideal but trios are excellent also. There appears to be no decided tendency to consume the eggs but for the sake of efficiency, the eggs should be removed and hatched separately. The eggs, which possess a particularly sticky thread bundle, are large, averaging about 1.8 mm in diameter (see figure 5). In this, they are about the same size as the smaller Mi*cropanchax pumilis* and *M. katangae.* We note that a good deal of nonsense has been written about the egg size of *Micropanchax,* and for that matter, about lampeyes in general. When newly laid, the eggs are quite yellowish, an indication that in nature, such eggs are liable to a degree of exposure to sunlight. The yellow coloration filters out the bluish rays of the spectrum, a band that is especially lethal to fish eggs.

The fry hatch in 12 to 16 days and immediately are able to take brine shrimp nauplii. They are easily raised, moderately slow-growing and attain maturity in from 8 to 12 months of age.

In our article, we have attempted to discuss *Plataplocheilus cabindae* and related topics with some thoroughness. However, it is not to be denied that fishes are adaptable animals and that their behavior patterns are not always rigid. Furthermore, there is still a great deal to be learned about the Cabinda lampeye, both from the aquarium and the scientific points of view. Finally, there is no doubt that we can, with excellent justification, recommend P. *cabindae* to all aquarists whether their first love he killifishes or not.

ACKNOWLEDGMENTS

The authors would like to express their appreciation to Mon. Jacques Lambert, Roulers, Bel-

TABLE 1

DORSAL RAY FREQUENCIES

	Plataplocheilus cabindae			*Micropanchax loemensis*		
No. of rays	**8**	**9**	**10**	**11**	**12**	**13**
Frequency	**2**	**33**	**21**	**1**	**4**	**2**

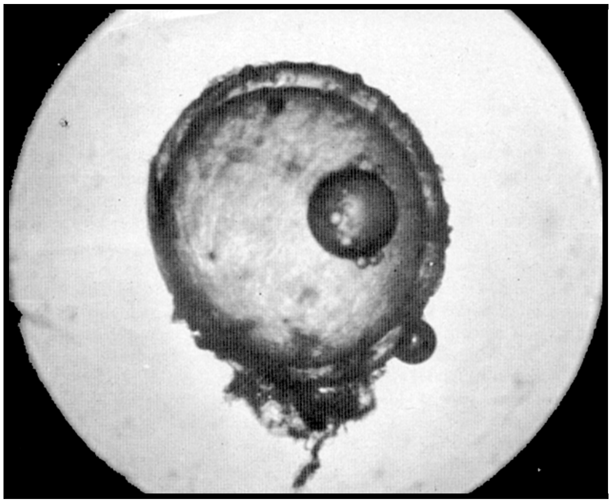


FIGURE 5: Egg of *Plataplocheilus cabindae*. Photograph by Albert J. Klee.

gium, for his invaluable assistance in confirming our identification of *P. cabindae*, and for supplying original meristic and ecological observations. Also, we would like to thank Dr. R. A. Jubb, Grahamstown, South Africa, for his kindness in supplying preserved specimens and ecological notes pertinent to Northern Rhodesia forms. Finally, we wish to thank the Paramount Aquarium of Ardsley/, New York, for making available to us, our original specimens.

ADDENDUM

Some time after we completed our article, preserved specimens of the Rhodesian forms were sent to Mon. Lambert for his examination since they appeared to possess certain unique qualities. We have just received his reply and, much to our surprise, these Rhodesian forms appear to be of a brand new species and will be described by Mon. Lambert in a professional journal. When available, this information will be passed on to aquarists. In the meanwhile, the reader should understand that *Plataplocheilus cabindae*, although widely distributed, is therefore not known from Rhodesia and that the information furnished in regard to this form pertains to this new species only. - The Authors.

Aphyosemion spurrelli

[Aquarium Journal, September 1964. Note: This article was co-authored with Bruce Turner, AJK being the Senior Author.]

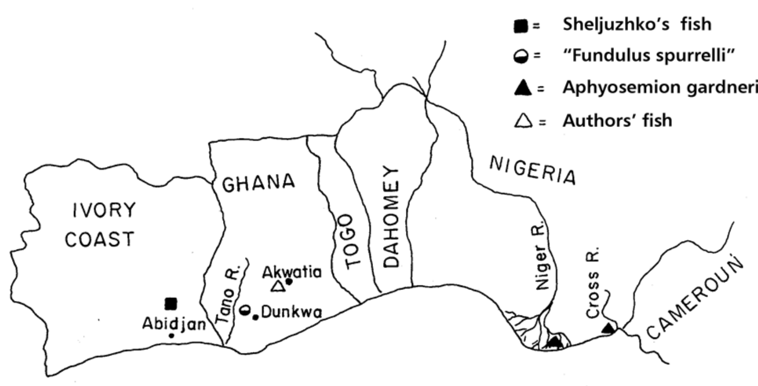
Some fifty-one years ago, the great Anglo-Belgian ichthyologist George Albert Boulenger, described "*Fundulus spurrelli*" from fish specimens collected by Dr. H. Spurrell near the Tano River in what was then the Gold Coast, a British colony on the Guinea coast of Africa and what is now the independent state of Ghana. The Tano River itself is situated near the border between Ghana and the Ivory Coast (see figure 1). The exact location of the new fish was given as, "Vicinity of Bibianaha, near Dunkwa, between the watersheds of the Tano and Ankobra Rivers." Dr. Boulenger described the coloration of these specimens as follows:

"Male pale yellowish-green with numerous narrow, often paired, vertical bars of dark carmine; sides of head metallic green, variegated with carmine; gular (branchiostegel) region of a dark rich blue; pectoral fins whitish with an oblique crimson streak, ventral with red tip; vertical fins grey, dotted with carmine and broadly edged with yellow or orange, the yellowish bands occupying the upper and lower fourth of the caudal. Female paler, more translucent, at times pinkish; fins white, dorsal and anal dotted with carmine."

From this vivid description, we surmise that it was based upon live specimens, perhaps the field notes of Dr. Spurrell.

From the placement of dorsal vis-à-vis the anal fin there is no doubt that Aphyosemion spurrelli is a member of the Fundulopanchax subgenus of Aphyosemion. In his description, Boulenger briefly remarked, "**Allied to *F. gardneri*.**" *Aphyosemion gardneri*, although similar in fin and scale counts, was described from the headwaters of the Cross River System, east of the Niger Delta. Additional specimens were also collected from the eastern Niger Delta, some 600 miles away (see figure 1).

There is no conclusive evidence that *Aphyosemion spurrelli* was ever kept in aquaria prior to the early part of the last decade (there are no ichthyological records of it since its description). In 1953, Prof. Sheljuzhko sent to Herr A. Werner of Munich, Germany, an Aphyosemion species, which he collected some 40 miles north of Abidijan, Ivory Coast (a photograph of this fish is shown in figure 2). These specimens were identified by H. Meinken as "*Aphyosemion gardneri*" that same year. However, in his review of several Guinean Aphyosemion species, Col. J. J. Scheel (see reference) called attention to the fact that Sheljuzhko's fish were found only 75 miles away from the type locality of *spurrelli* and suggests that the fish in question is better identified as that species. In this we quite agree with Col. Scheel. The existence of the "Togo-Dahomey Gap" in the west coast rainforest, which acts as a natural barrier, further supports this conclusion.



In 1956, the authors received a fish identical to Sheljuzhko's Aphyosemion but it lacked the vivid yellow and orange noted in Boulenger's original description. It was referred to at that time as "Aphyosemion gardneri" but we are certain now that this was *A. spurrelli*. Not being a particularly brilliant strain, the fish quickly passed from the scene.

In the summer of 1963, we received a shipment of live fishes from our friend Mr. T. Stuart McClure of Akwatia, Ghana. The shipment included several species of killifishes collected near that area, viz., *Epiplatys sheljuzhkoi, Micropanchax normani* (= *M. gambiensis*) and what appeared to be a brand-new *Aphyosemion*. Our fin and scale counts on 10 specimens are compared with Boulenger's data for both *spurrelli* and *gardneri* in Table I.

The coloration of our fishes is as follows:

Males (see figure 3): Sides bluish-violet, ventrum light-brown, dorsum brown; reddish to maroon markings on entire body, most numerous in predorsal regions; edges of gill covers and adjoining throat region a deep maroon; typical "wormlike" markings in red or maroon on head and gill covers. Pectoral fins yellowish, reddish submargin and bright blue edge; ventrals yellowish, red submargin and blue edge; dorsal yellowish and covered with red spots, edged in yellow-to-yellow-green, submarginal band of red; anal bluish-white at base, yellow-green otherwise with red edge and covered with rows of red spots; caudal fin edged in red both upper and lower lobes, broad submarginal areas of yellow, middle of fin clear to bluish with red to maroon spots. Eye light blue.

TABLE I

Fin and Scale Counts on Three Aphyosemions

	Dorsal	Anal	Lateral scales	Transverse scales
A. gardneri	12-13	14-16	28-32	22-26
A. spurrelli	13-14	15-16	29-31	24-26
Our specimens	12-14	14-16	28-31	24-26

FIGURE 2: Sheljuzhko's killie from the Ivory Coast. Photo by Dr. W. Foersch.

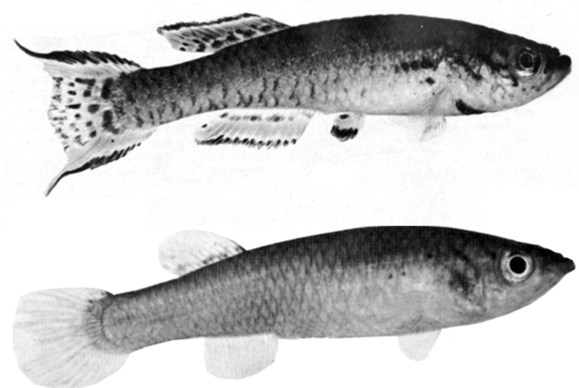


FIGURE 3 TOP: *Aphyosemion spurrelli* male.
FIGURE 4 BOTTOM: *Aphyosemion spurrelli* female.

Females (see figure 4): Sides brownish with suggestion of violet, ventral areas lighter. All fins clear to yellowish with some spots occasionally on dorsum; red markings on gill covers. Eye pale green.

The coloration and geographical origin of our specimens lead us to conclude that our fish is properly identified as *Aphyosemion spurrelli*. In this, Dr. Stenholt Clausen and Col. Scheel concur with us. Whether *A. spurrelli* is a synonym for *A. gardneri*, is a matter to be decided by qualified ichthyologists. There is a current divergence of opinion on this matter among specialists, however. Some take the view that *spurrelli* and *gardneri* are identical, while others take the view that *filamentosum* and *gardneri* are identical. Since *spurrelli* in no way resembles *filamentosum*, this is a rare state of affairs indeed! The problem is, of course, that we know practically nothing about *gardneri*. In counts and pattern it seems to have affinities with *spurrelli*, and in geography it appears to relate to *filamentosum*. Presently, we prefer to consider *A. arnoldi, A. filamentosum* and *A. spurrelli* as species that can be identified as having been kept by aquarists, and to consider the case for *A. gardneri* as "not proven."

It will be noted that Boulenger's drawing (see figure 5) and Sheljuzhko's fish do not indicate extended filaments on the upper and lower lobes of the tailfin. Our imported specimens also had shortened lobes but our tank-raised stock produced very nice filaments indeed. We have noted three basic color varieties in our stock of *A. spurrelli*. The edging to the unpaired fins may be white (rare), yellow, or orange. Occasionally, fins may be found that have yellow-edged dorsal and anal fins with a caudal edged in orange, or vice versa. White has been, so far, always noted alone. This chromatic polymorphism is common among *Aphyosemion* species. The white versus yellow dichotomy can be observed in *A. nigerianum* and *A. christyi*, to name a few. Col. Scheel has studied this variability extensively and has found it to be typically Mendelian in nature.

McClure informs us that our *A. spurrelli* were found in a small roadside stream with slowly flowing water, little vegetation and at a temperature of about 77° F. *Epiplatys sheljuzhkoi* and several young examples of an *Alestes* species with a red adipose fin, were also to be found in the same waters. The bottom was mixed mud and gravel with a few water plants and much organic matter, most of it filamentous in nature.

A. spurrelli can be kept and bred in aquaria following the more or less standardized tech-

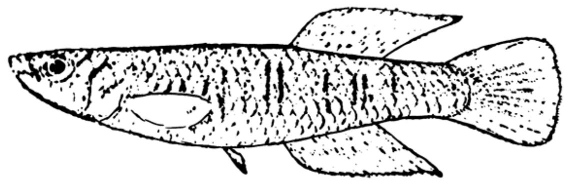


FIGURE 5: From Boulenger's original drawing of *Aphyosemion spurrelli*.

niques for the genus already developed by aquarists. There is no need to further elaborate in detail on these techniques here. Specifically, however, it can be handled as per *A. nigerianum*. *A spurrelli* tends to deposit most of its eggs in the lower levels of the aquarium. This, however, is of little importance to the aquarist as modern breeding techniques, which emphasize small aquaria and nylon mops, tend to minimize the differences between plant spawning and soil spawning *Aphyosemion* species. The authors have spawned the species on both floating and bottom mops, and in peat.

The eggs; which are clear and measure 1.4 mm in diameter (see figure 6), can be dried in the manner of *A. filamentosum* but drying does not increase the hatching percentage and is unnecessary. If kept in water, most of the eggs hatch within a period of five to six weeks; there are few "resting eggs." Drying seems to prolong the incubation period, and incubation times of 45 to 60 days were found to be advisable in our experiences. The fry can eat newly hatched *Artemia* upon hatching, and they grow at the same rate as *A. nigerianum* fry. The sexes can first be noted after four to six weeks, and sexual maturity is reached about a month after.

The species lives for well over a year in aquaria and continually spawns for most of this time. Isolated specimens reach spectacular heights of beauty and size (average size 3 inches for males, 21,i inches for females). As with many other species of Aphyosemion, fry can often be noted in aquaria containing a small number of adults; these are not harmed and can reach maturity in the same aquarium. In the aquarium, *A. spurrelli* reminds one of a smaller and less pugnacious version of the blue gularis, and has much of the "personality" of that species. The authors are happy to introduce the species, and recommend it highly.

ACKNOWLEDGMENTS

The authors would like to thank Mr. T. Stuart McClure for sending to the U.S. our original breeding stock of *A. spurrelli*, and Dr. Stenholt Clausen and Col. J. J. Scheel for their help in its identification. Finally, we once again acknowledge our debt to our good friend John L. Gonzales of Philadelphia, Pa., surely one of the most accomplished killifish breeders in the world for his assistance in cataloging variations and making helpful suggestions re our notes on this species.

REFERENCES

Boulenger, G. A., "Description of three new fishes discovered in the Gold Coast by Dr. H. G. F. Spurell," PROC. ZOOL. SOC. LONDON, pp. 52-53 1913.

Klee A. J., "Remarks on the identification of three aphyosemions," AKA KILLIE NOTES, Vol. I, No. I, pp. 8-10, Feb. 1962.

Scheel, J. J., "*Aphyosemion arnoldi*," Aquarium Journal, Vol. XXXIV, No. 5, pp. 162-166, May 1963.

Sterba, G., *Süsswasserfische aus aller Welt*, Leipzig/Jena, Urania-Verlag, Plate 112 1959.

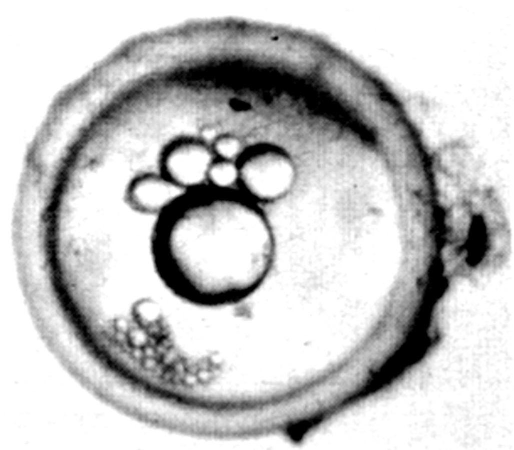


FIGURE 6: Newly-Laid Egg of Aphyosemion spurrelli.

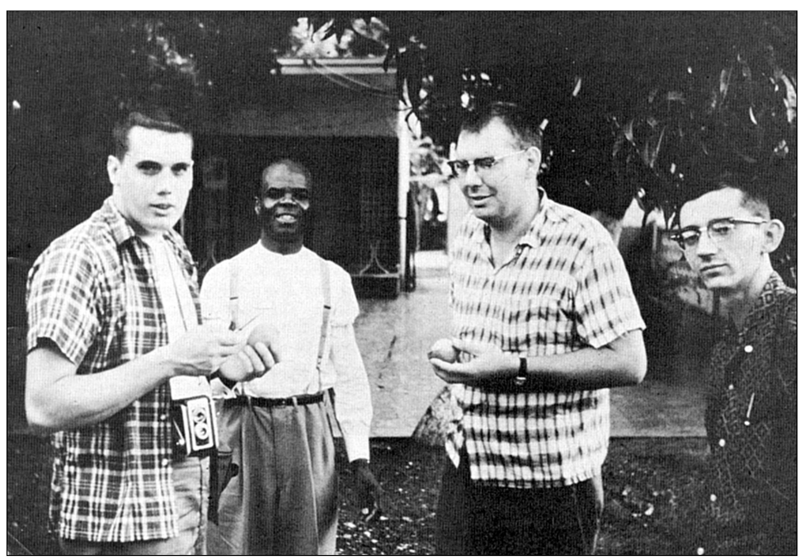
A Peruvian Adventure – Part I

[Aquarium Journal, January 1965]

This is the story of a collecting trip to hitherto unexplored regions of Central Peru, but it is not the usual type of story that one might read in the aquarium literature. A good many trips have been made by aquarists to foreign lands, it is admitted, but assuredly never before has one been made such as the one to be described! Furthermore, it has been observed that some of the reports made of previous expeditions are stereotyped pap where the reader may easily guess the next line. Strong words these may be but for nine people who came within inches of losing their lives for their hobby, we intend to mince no words. Another observation that can be made is that all too often, reports of trips really do not tell the reader anything about the trip itself, its planning, problems, and execution. This we intend to remedy. In addition, there is often an element of forced mystery about such expeditions regarding the mundane details and consequently, the participants are frequently looked upon as aquarium "gods." Rest assured that anyone with a little spirit of adventure and determination, could repeat any or all of them, including ours. One does not have to be a millionaire, a Frank Buck or a "distinguished world traveler" to join these over-exalted ranks. Thus on the one hand, we make light of our accomplishments but on the other, our trip was something special to the nine persons who made it, and will forever remain the one great adventure of our lives. If then, we think out loud as we share our experiences, we hope that you will understand.

During the summer of 1963, I was fortunate to renew an old acquaintance with Jon Krause of Columbus, Ohio. Jon is a former metallurgical engineer who became interested in aquarium fishes while working at Battelle Institute in Columbus, and subsequently gave up metallurgy to own and operate the Verco Fish Hatchery, a wholesale operation in that city. One of Jon's other interests is aviation, like aquarium fishes, a relatively recent focal point in his life. After enjoying himself with light planes for several years, Jon thought that the addition of a twin-engine cargo plane would be helpful in his business. Consequently, he managed to bid on, and obtain, an old B-25 bomber, built circa 1944. He spent over a year rewiring the craft and installing radio equipment necessary for long flights. When Jon bought the plane, he knew neither how to take off nor how to land it. A commercial pilot acquaintance went up twice with Jon, pointing out all that could be indicated in two short trips up and down. Then, Jon was on his own. On his first landing, he used the entire runway Columbus Airport (Port Columbus) had but he made it! A quiet, unassuming, but confident man, Jon Krause is my candidate for the title of "Most Unforgettable Character I've ever met."

Afterwards, he decided to fly his B-25 down to South America to pick up a cargo of aquarium



Munching mangoes in Kingston, Jamaica. Left to right: Win Rayburn, a Jamaican friend, Jim Thomerson, and Jerry Anderson.

Andros Island in the Bahamas Islands as seen from the nose cone.

fishes from local collectors. His first trip was to Iquitos, Peru, where most of the large fish importers have compounds. Jon nearly lost his life when, in trying to find Iquitos, they ran low on fuel and were forced to fly right above the surface of the Amazon River in order to find that city. But Jon's big dream was to locate a compound of his own in a different area.

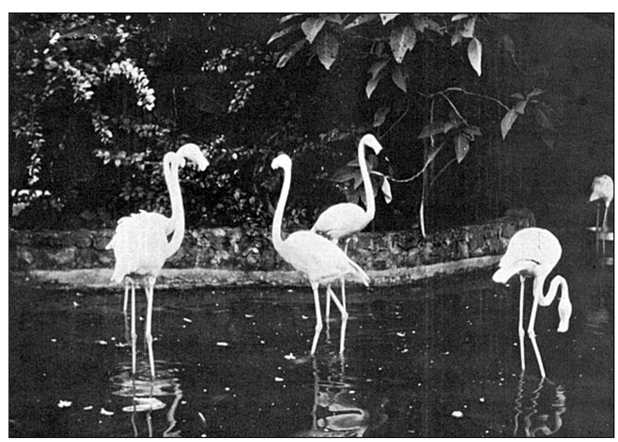
Asking around, someone told him of a sort of missionary way station called Tournavista, located in the jungles of Central Peru (more about which we shall relate in detail later). He found it and subsequently established his long sought-after compound. At the time I met Jon, he had just completed construction.

Jon's accounts of his experiences were, of course, thrilling to me and I mentioned that I would give almost anything to make one such trip. "Why not?" said Jon. After pinching myself to assure that I was awake, we discussed the matter further. "Would there 'be a chance that some of my friends might come along?" The answer was affirmative and we set a tentative date for the following summer.

As news began to leak out about the trip, I was approached by many who wanted to go along. Selecting five was a difficult task indeed. From the start, we wanted to make this a balanced, well-planned trip, incorporating people of diverse interests and talents (we did not want a "one-man show"). As it turned out, five of the six of us (three crew members completed the roster) were members of the American Killifish Association (and we converted the sixth en route!) although little in the way of killies was expected to be found at our destination. It is the unique character of the killifish fancier, however, that generates a hobbyist who is resourceful and willing to put up with hardship in a cheerful manner. It was not the guppy fancier who beat upon our door; rather it was the aquarist interested in fishes such as cichlids, killies, and "oddballs."

As a group we desired to get away from the artificiality of the hobby and to communicate with its most primitive and basic elements. It was not the blacklace angels we wanted to see but the wild ones with fins torn as a consequence of attacks from predators such as *Hoplias* and *Erythrinus.*

Among the first two who accepted my invitation were James Thomerson and Richard Stone, both of New Orleans, La. Jim, a towering Texan, is currently completing the requirements for his Doctor's degree in ichthyology at Tulane University. He is an inveterate and skillful collector, good-natured and willing to help anyone whenever he can. Without doubt,



Flamingos at the Hope Zoo in Kingston, Jamaica.

One of the parrots at Hope Zoo, Kingston, Jamaica.

Jim worked harder at collecting fish than any of us, and the splendid collection of preserved specimens he brought back to Tulane (and live ones too!) forms a significant addition to the little-known fish fauna of Central Peru. Jim, by the way, is a Trustee of the American Killifish Association. His good friend, Dick Stone, is Chief of Psychiatric Services at the Veteran's Hospital in New Orleans. "Doc," as he is affectionately known, is a walking encyclopedia with a photographic memory to boot. Beside his interest in fishes, he is avidly interested in insects and mollusks. Dick spent his time in Peru with a fish net in one hand, a butterfly net in the other, and a fishing rod clutched under his right arm! He introduced me to the lore of the rhinoceros beetle, and the giant Peruvian cicada. Never complaining, always ready with either a smile or the generic name of some "bug," Dick (and his medical skills) were a comfort to our group.

One of the most improbable members of the expedition was Emanuel Ledecky-Janacek ("Zeke," for short), Curator of Fishes and Reptiles at the Cincinnati Zoo. A native of Czechoslovakia, Zeke was the only other professional on the trip in addition to Jim. With his full beard and moustache, Zeke was more of a wonder to the natives than we were to them! The courage of this man is, however, hard to understate and his capture in bare feet, of a bushmaster, and his crocodile wrestling in the dark, we will take time out later to relate.

Jerry Anderson of Waukegan, Illinois, also a Trustee of the American Killifish Association, formed member number five of the expedition. Jerry was the "half-pint" of our group, weighing but 121 pounds wringing wet, but I have yet to see more "guts" per pound than Jerry has. Since he most likely saved my life at one point, I may be biased but other events serve to back up my claim also. Jerry's sense of humor saved the day on numerous occasions and we will long remember his, "Lot's o' luck, fellas!" whenever we proposed some dangerous, hare-brained scheme (he always went along, however!). Expedition member number six was Winfield (Win) Rayburn of Cincinnati, Ohio. Win is a real devotee of hunting and fishing, and was the only' member of the expedition who took down more arrows than he brought back. Win was a great one for hunting with bow and arrow, and his favorite complaint was that he couldn't get deeper into the jungles to hunt game! In spite of his hunting proclivities, Win is a sucker for animals and was the first in the group to adopt one … a baby squirrel monkey.

Two more people rounded off our complement. Our co-pilot, Bill Kretchmer of Columbus, Ohio, is a young, good-looking fellow of easy manner and pleasant personality. More to the point, he is an excellent airplane and engine mechanic to boot. Bill kept our old B-25 flying under all conditions, and some of them were very difficult indeed. More than anyone else, Bill probably made the greatest sacrifice of all of us in going on this trip, as he was married but one week before we took off! Our last crewmember was Felix, a Peruvian working for Jon but living in the United States. Felix, a young bachelor without a seeming worry in the world, made us feel close to all Peruvians. His famous "I are tired peoples!" made us laugh time and time again. He acted as worker par excellence, interpreter, and good friend. It is significant to close these remarks about the people who went on this expedition with a statement by one of the group: "You know, if I had to do it all over again, I would want to have the same people along!"

One might wonder what sort of clothes and equipment are needed for a trip such as this one (which extended over a period of 22 days). Therefore, I present my own personal list of what I actually took along.

Clothing: Khaki trousers (3), khaki shirts (4), T-shirts (6), shorts (6), handkerchiefs (6), socks (6 pair) 1 pair boots 1 belt 1 light jacket 1 heavy sweater 1 pair tennis shoes, I towel and facecloth 1 cap 1 pair dungarees 1 duffle bag plus clothes worn down on trip (sport shirt, slacks).
Personal: Shaving gear, mirror, toothpaste and brush, soap (4 bars), insect repellent (3 bottles), suntan lotion, pair extra glasses, foot powder, pocket knife, nail clipper, toilet paper (2 rolls), lighter, sunglasses, first aid kit, and flashlights (2) with extra batteries.
Miscellaneous Equipment: Rope, hunting knife, handbag, army blanket, and life jacket.
Special Equipment: Field water testing laboratory, formalin (2 quarts), small plastic bags, labels, rubber bands, vinyl tape, notebooks and pens, camera and equipment 12 rolls 36-exposure color film (Kodachrome X), tape measure and hand net.
Documents: Passport, shot card and visas.

The equipment brought along by the others was similar but our special equipment varied considerably. Jim Thomerson, for example, brought much more materials for preserving specimens; Win Rayburn brought bow and arrows along with a spinning rod and reel; Zeke brought snake bags and snake catching equipment. The special equipment was tailored to suit each member's own particular goals and interest. Also, remember that we had our own plane and could carry more than if we had to travel via commercial airlines.

Financing varied somewhat but roughly, it went as follows:
$250 - Jon Krause's services for aviation fuel, oil, landing fees, etc.
$50 - clothing and equipment not already owned
$200 - expenses incurred while on trip (meals, accommodations, local transportation, souvenirs, etc.)
$500 total.

A rainforest area in Central Peru.

In addition, there were some extra expenses of an individual nature as, for example, my own connected with my job as "official photographer" for the expedition. This startlingly low figure, however, is a result of two factors:
(1) We were willing to live and travel as the ordinary Peruvians or Indians might do (cigarettes in Peru, for example, cost only 6c per pack!), and
(2) We were willing to make our flight in this old B-25 (cramped, cold, uncomfortable, no oxygen and take your chances!)

While the rest of us were preparing our clothes and equipment, Jon and Bill were busy working on the plane. Both engines were quite old and had over 1,000 hours each operating time. In addition, the hydraulic system was in poor shape. The latter was corrected with relatively little difficulty but we were plagued again and again with engine trouble. Every time we looked, something else was found in need of repair. One Sunday, Jon took off for Chicago with a trailer and purchased an old B-25 engine for spare parts. This helped some but our departure date continually was being delayed to fix something else.

Consequently, six of us had to juggle vacation dates and to square things with our employers at frequent intervals. Finally, on a Friday evening, August 14, Jon called and said, "Everything set to go! Can you collect the fellas and get ready to leave Sunday?" Ready we were and take off from Columbus was scheduled for 2 p.m. Sunday, August 16. Our trip was on its way!

A Peruvian Adventure – Part II

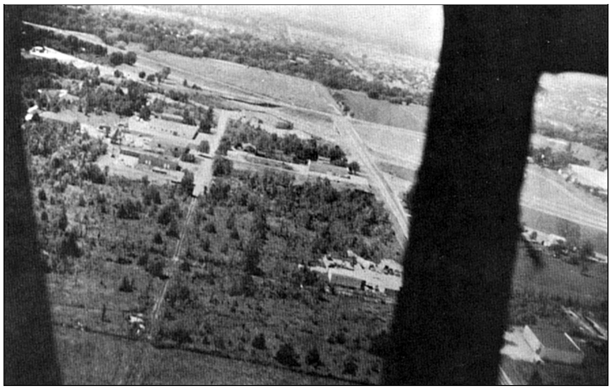
[Aquarium Journal, February 1965]

Nine Nuts in Search of a Bolt

We had arranged to have Jerry Anderson arrive in Cincinnati one day before takeoff and to stay over night with Zeke. On Sunday morning Win Rayburn picked up both Jerry and Zeke and proceeded to my house. At though my wife prepared a robust break fast for all of us, we really were too excited to taste the food. All equipment was transferred to my station wagon and off we went to Columbus. Our equipment jutted from the rear of the car, poked out of windows and spilled over to the luggage carrier on top. We came as close to resembling gypsies as we ever would that day!

Jon Krause, Win Rayburn, and Jim Thomerson collecting rosy tetras in Central Peru.

Upon arrival at Jon Krause's hatchery in Columbus, we and our equipment were transferred to one of Jon's trucks, and then we proceeded to Port Columbus airport. Missionary cargo was being loaded into the plane and a score of well wishers were there to see us off. Although Win, Zeke, and I had already seen the plane, this was Jerry's first look at it. What Jerry saw was an old B-25, some 20



Looking out from the nose cone of the B-25 just after liftoff from Columbus airport. All photos by the author.

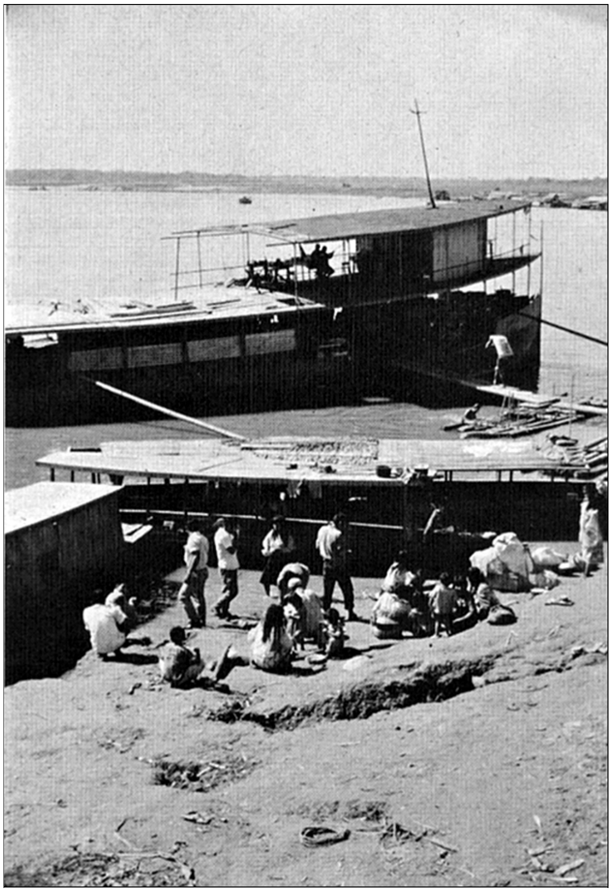
years old to be exact, that looked as if it had flown around the world about a million times. The paint (what there was of it) was flaked, the seats in the pilot's compartment were worn down to the springs, and the general interior suggested a scene in the Cincinnati workhouse rather than, shall we say, United Airlines. Jerry seemed a bit concerned about a few oil leaks here and there but we told him that after all, nothing was perfect. He then disappeared for a while, muttering something about a last will and testament.

At this point in the proceedings, Jerry could have killed me, if looks could kill, that is. After loading our own personal baggage and equipment, it remained to ascertain who would occupy what space in the aircraft. Jon Krause (pilot) and Bill Kretschmer (co-pilot) were automatically decided, and Felix elected to take the top gunner's seat (the top gun turret had long been removed). The tail, including the rear gunner's blister was chockfull of cargo so this left the nose cone and the area behind the bomb bay (the bomb bay was also full of cargo!). Then I piped up, "Jerry and I will volunteer to take the nose cone!" Before Jerry could say anything, Win and Zeke promptly dove into the rear section, pulled up the hatch door, and locked up. "Well," I said to Jerry, "At least the nose cone has a nice view … and you did want to take pictures, didn't you?" I ducked a flying wheel chock just in time.

Now there are two ways to enter the nose cone of a B-25. If you are on the ground, a ladder can be brought up to the nose cone hatch. In any event, one can get to the nose from the midsection (which has its own door) via a narrow tunnel that is located beneath the pilot's compartment. This tunnel is so constricted that one cannot even go through it on hands and knees . . . so, one must pull oneself along on one's belly. Normally, two men in a nose cone are "cozy" but with the cargo it carried to balance our heavy tail, we carried "togetherness" to a ridiculous extreme. The word was given to "button up" and Jerry and I fastened the hatch. Promptly the temperature (this was in August) rose to over 100° F! The first engine turned over and the nose cone vibrated like an air pump. When the second engine turned over, we began to vibrate also! The racket was fantastic and Jerry and I could communicate only by shouting into each other's ear (I think Jerry was shouting "Help!" at that time but the din was so bad that I really couldn't be sure). However, since we were so crowded, we didn't have to move far to do this.

The view from the nose was fantastic, though. We lay on our stomachs and pointed our cameras out as the plane taxied. Jon then gunned

A jungle waterfall where *Plecostomus* abound.



Chapeba Indians in Pucallpa, Peru, docking on the Ucayali River.

both engines. The noise and vibration had us both shaking in our shoes and we didn't know what to expect. Then the O.K. was given for takeoff. Heavily laden, the B-25 lumbered off the runway, with Jerry and I taking pictures all the way. Once in the air, however, the vibration and noise decreased considerably. When the plane went into a sharp bank, so did my stomach but we both were really enjoying every moment of it. We then began to relax for the long, 5½-hour trip to Miami where we were to pick up Jim Thomerson and Dick Stone.

One of the first things we discovered was that the nose cone leaked like a sieve. Since we were flying at 10,000 feet, the air was ice-cold. Fortunately, Bill had tossed up a roll of plastic tape to plug up the holes and cracks. Nevertheless, we managed to keep from freezing only by wearing sweaters, jackets and blankets. The view remained spectacular, however, and we even managed to obtain a picture of a rainbow a while later. Then we ran into rain clouds and if we thought cold air coming in was a nuisance, cold water had it beat a mile! Furthermore, the tape could not hold back the water as it did the air. The only thing we could do was to drape an uninflated vinyl air mattress over us, to try to keep dry.

We finally flew out of the rainsquall and some hours later, set down at Miami International Airport. The temperature in the nose cone rose from 40° F to 105° F within 10 minutes, and we were tearing off our clothes in accordance. As soon as the wheels touched ground, we ripped off the outside hatch to get some cool air. We were certainly glad to squeeze through the tunnel and get back on terra firma once again!

Waiting for us at Miami were Jim and Dick. After loading their equipment, a small panel truck drove up alongside of the plane with additional missionary cargo. This cargo made the plane tail-heavy so guess what? Yep! More cargo in the nose to balance it out! Jerry and I groaned but good.

After looking at the plane, Jim and Dick suggested a good, stiff drink, so we repaired to our hotel room. The next day we were ready and raring to go, however. Jon had to file flight plans and in the meanwhile, Bill supervised the refueling operation. Our next destination was Kingston, Jamaica but because Cuba lay in our path, we could not take the direct route. That was all Castro would have needed … a U.S. B-25 flying over his territory! Consequently, we had to fly near the Bahamas and then through the narrow straights that separate Haiti and Cuba. We were going to hold our breaths on that one! Jim and Dick elected to share the radio area with Felix, and the rest of us took our familiar places. It was back in the nose cone for Jerry and me.

Prior to takeoff from Miami, Jerry asked Jon if he could smoke during flight in the nose cone. Jon said "Yes" (under certain conditions, e.g., not during landing or takeoff, or if we ran into trouble) so while we were making the 4½-hour flight from Miami to Kingston, Jerry lit up a cigarette. Now although I don't smoke cigarettes, I am a heavy cigar smoker. I proceeded to light up a nice big "stogie." Jerry gave me a disapproving look, but there was so much air coming into the nose cone from around the old Plexiglas, that the smoke blew away from us right down the center of the plane into the tail. Thus, Jerry and I were quite comfortable while smoking.

Unfortunately, the boys in the tail knew nothing of this. After a while, smoke started to billow forth from under the cargo, giving Zeke cause to think that the plane was on fire! Win and Zeke spent the remainder of the flight to Jamaica trying to find, and extinguish, a non-existent fire. Both were nervous wrecks upon arrival in Jamaica, and only by fast footwork was I able to avoid having a box of cigars crammed down my throat after I explained what had happened. I promised not to smoke cigars in flight again!

Kingston was a perfectly delightful place. Before the propellers came to a halt, an airport official pedaled out to our plane on a bicycle and enquired, "What airline is this?" Jon broke up the group with laughter when he unhesitatingly shouted back, "Krause International!" After sampling the free rum punch that the Jamaican Tourist Board gives to all newcomers to the Island, we proceeded to find accommodations for the night. The next day, four of us hired a car and driver (we wouldn't dare to drive ourselves … left-hand side of the road driving, you know!) and toured the city and its outskirts. We saw the residential, business and wharf areas but one highlight was a visit to the Hope Zoo. This was a perfectly delightful, colorful, unfettered display and we recommend it highly should you ever visit Kingston. We returned to the airport to find that some oil was discovered on the left engine nacelle and the left rudder of the aircraft. Evidently, some sparkplugs were fouled. Bill changed these, however, and we were ready to proceed.

Our next stop was planned for Tocumen Airport, on the Pacific side of Panama, a trip of about 31/2 hours. With Jerry and I in the nose cone again, off we went. The tunnel leading to the nose cone was sealed off at the rear end by cargo after we enplaned, so once in, we were in until landing. I managed to slip halfway into the tunnel and promptly dropped off to sleep. There was no use in staying awake to take pictures since we were over the Caribbean with nothing to photograph.

This plant, located in Panama, was bigger than three members of our expedition put together. All photos by the author.

About 11/2 hours out of Kingston, I was awakened by Felix who was in the radio compartment with Dick and Jim. He promptly handed me (through the 8-inch space over the cargo) two life jackets. "Put these on!" he shouted. "We've lost an engine and are going to ditch!" I was stunned at the news. I crept back to Jerry who asked, "What did he say?" I will never forget the look on Jerry's face when I told him. We put the life jackets on before we realized that we already had our own personal life jackets in the nose cone with us. In his excitement, Felix had handed us the life jackets belonging to Jon and Bill!

Our original altitude was 10,000 feet but we slowly lost this, the water coming closer and closer. Jerry and I wondered what would happen when we hit. Surely the nose cone would be torn off, or perhaps would just go under water? At 2500 feet, the B-25 held altitude and Felix motioned for me to enter the tunnel. "Jon thinks we can make it on one engine at this altitude!" he yelled. I went back and told Jerry, much to his relief. At intervals, Felix would give us a sign that all was well but unfortunately, he saw no difference between "thumbs up" and "thumbs down." Consequently, we never knew whether we were going to be all right or whether we were going down. The strain was tremendous.

Then, we entered a terrible storm. The nose cone was covered with a sheet of water and as usual, the water entered and soaked us to the skin. This time, it wasn't the water that worried us, however. It got quite dark and the plane was buffeted about, bouncing us considerably in the process. Every time the B-25 lost altitude in the storm, we failed to regain it. Even at maximum power, this was the best our lone working engine could do. The Caribbean was coming closer and closer. Jerry and I prayed like we never prayed before. We shook hands and said our "goodbyes."

A Peruvian Adventure – Part III

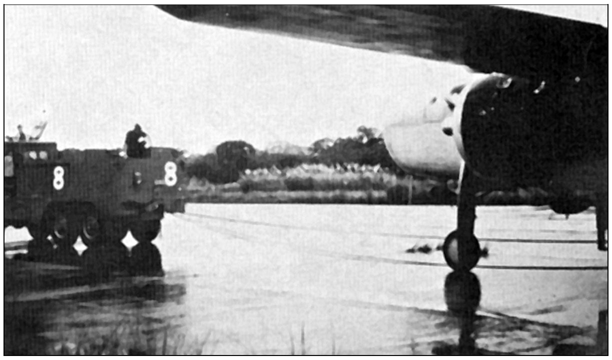
[Aquarium Journal, March 1965]

COFFEE, TEA, OR MILK?

We radioed to the U.S. Air Force stationed in the Canal Zone for help and fortunately, contact was made. The first comforting thing that we heard was that they were sending out a C-46 to try to find us, in order that when we ditched they would be able to fix our position and relay it to rescue boats. Jerry and I did not kid ourselves, however. The violent storm had whipped the waves below into frenzy, and we knew our chances of surviving a ditching was like that of a newborn guppy in a tank full of zebra cichlids. The Air Force had us in their radar, however, and they attempted to guide us to the Panamanian coast.

I didn't know what was in Jerry's mind during all of this . . . we didn't do much talking. It helped somewhat to shift the nose cone cargo to the right, with us on the left, so that when we crashed, the cargo would propel forward

The B-25 made it down alright, but at a slightly unorthodox angle!



Due to its awkward angle of landing, the B-25 was unceremoniously towed off the airstrip by a fire engine!

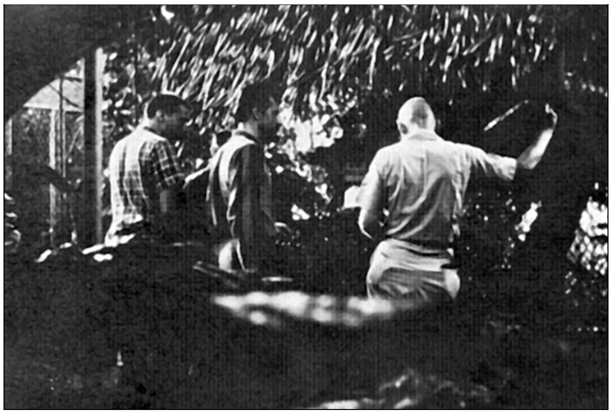
through the Plexiglas, missing us in the process. We also discussed our strategy after hitting and we agreed that if the nose cone went under water, we would wait until it had almost completely filled with water before trying to get out. There was no sense in fighting the rush of water through the hatch. All our calculations, of course, were assuming that we were still conscious after we hit the water.

Just then Jerry, who was somewhat in front of me, shouted, “Land ... land! I see land!” True enough, we were over the coast of Panama. We could even see lights from isolated buildings since the plane was no higher than 400 feet from the ground. At this point, the Air Force suggested that we land at one of their airports on the Atlantic side but there was a 2800-foot hill in front of it, something we just could not negotiate on one engine. As an alternative, they described a World War II landing strip in the jungle known as France Field. It had no tower, no lights, no nothing (it was used only for occasional Ranger training) but it had the one thing we needed desperately . . . it was at sea level.

By a stroke of luck we found the field on our first pass. Unfortunately, our one engine developed very little hydraulic power and our landing gear took too long to get down. Jon had to gun the left engine to miss the trees at the end of the strip. The plane cleared these by 15 feet, went out over the ocean, and almost collided with a ship! When a plane nearly hits a ship, you know that is flying low! Jerry and I, being in the nose cone, saw everything first and closest and believe me, it did nothing for our morale. We were now at 200 feet of altitude, unable to get any higher. The waves were lapping at the plane and the two of us were having what might be called a “joint hemorrhage”!

The second time around, Jon lined up the B-25 on the strip perfectly. The Air Force, Military Police, Customs, . . . everybody who was able to help, had their cars up on each side of the strip with lights on. This helped considerably. Then, at this very moment, all gas gages indicated empty! Although we did not know whether the landing gear would lock in place in time, we had no choice. Jon flipped the gear lever and set the plane down. Fortunately for us, the gear locked just before the wheels touched! The old blacktop strip was wet and with only one engine for control, the plane skidded to a stop at an awkward angle. Normally, Jerry and I would have waited for a ladder to be brought up to the nose cone but he ripped off the hatch cover and jumped approximately 12 feet to the ground, and I followed suit!

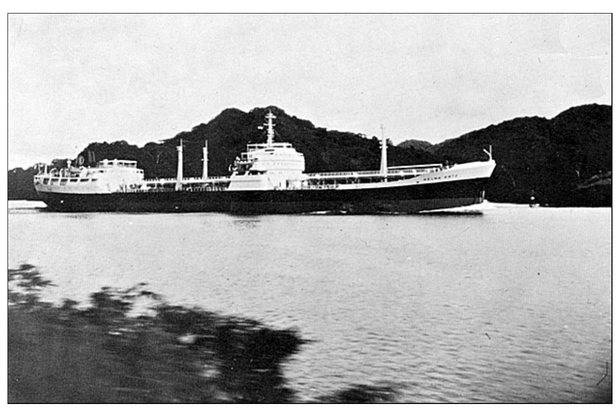
The ancient Hotel Washington in Colon, Panama, where our intrepid expedition stayed the night.
All photos by the author.



Zeke and Win being given some pointers by Sergeant Davidson at the Air Force Survival Training School.

We looked around and saw ambulances, fire engines, and people in all sorts of uniforms and gear. They pressed forward to congratulate us on our narrow escape. "Thought you guys were goners!" was the typical remark. I remember getting quite a bit of dirt in my mouth, kissing the ground that day! The others piled out of the plane and wonder .of wonders, it stopped raining. The whole thing seemed like a nightmare, especially for Jerry and me, but there had been one "amusing" incident. It seems that Win and Zeke, who had been in the tail, slept through most of the excitement! During the last few minutes of violent maneuvering, however, Win woke up and noticed that there was no vibration from the right side of the plane. He then looked through a gap in the left loading hatch and saw waves below, concluding that we were in trouble. At that time, there was no communication setup to the tail, so Win woke Zeke up and confided his fears. The landing at France Field had been very smooth in spite of it all (Jon was complimented highly on his flying by several Air Force Officers) so Win and Zeke actually did not know that we had touched down safely. Jon asked Bill to shut off the left engine after we had stopped but he was so nervous (weren't we all?) that he revved it up instead. Jon just reached over and shut the engine down. But in the tail, Win and Zeke heard the gunning of the engine, and then utter silence. Win, thinking that we had lost the other engine remarked to Zeke, "Now we're really in trouble!" They waited for the plane to crash all the while we were safely on the ground. We tapped on their hatch and told them to come out!

The right engine had been shut down and its props feathered because its oil gage indicated zero pressure. If there had been no oil to the engine and we had continued to run it, it would have torn off its motor mounts within 60 seconds, and probably taken the wing with it. Jon had no choice but to shut it down. However, after we had all quieted down, it was noticed that there was no oil either on the right engine nacelle or on the right rudder. This was puzzling because if an oil line had broken, there should have been oil all over the plane on that side. Leaving Bill and Jon to ponder this, the rest of us were driven by M.P.'s into Colon, the nearest town. The Desk Sergeant told us that we would have been billeted in the local Y.M.C.A. but due to anti-American rioting, this building was burned to the ground a scant two weeks before our arrival. Our luck was holding true to form! After warning us not to walk about Colon unless we were in pairs, one M.P. drove us to the Hotel Washington. This is situated on the Caribbean and some 50 years ago, was one of the most famous hotels in Pa-



A freighter making its way through the Panama Canal.

nama. When we arrived, however, it looked ready for Urban Renewal.

We checked into the hotel, three to a room. It felt good to lie on a bed once again. Also, it helped to quiet our nerves. After a brief rest, we washed up and went down to dinner. There we met Jon and Bill with some good news. There was nothing wrong with the right engine! All that had happened was that the oil pressure indicator line had broken, a 20-minute repair job! Still, I doubt that many of us tasted our food that night.

The next day, Jon and Bill went out to the plane while the rest of us explored our surroundings. Within a few minutes, Jim and Zeke had caught some *Bufo marinus*, a sort of toad, right on the hotel grounds! Jerry, Win, and I explored the shore of the Caribbean, catching marine crabs and other interesting creatures. Right off the sea wall behind the hotel, we found hundreds of gorgeously colored marine tropicals. It hurt deeply that we couldn't bring any back home with us. Then, Win, Zeke, Jerry and I decided to explore Colon. Remembering the warning of the Desk Sergeant, we contrived to speak loudly in German whenever we passed a corner full of young toughs. It worked and we spent some pleasant hours exploring the market, the shops, and the streets.

Returning to the hotel, we found Jon and Bill waiting for us. The Air Force had flown them to their machine shops to fix our instrument line, and then had flown in 200 gallons of gasoline so that we could proceed to Tocumen airport on the Pacific side. It was decided that:

(1) The nose cone was too dangerous and therefore we would shift cargo at Tocumen . . . no one would ride in the nose any more.
(2) Communications would be installed from cockpit to the tail. Jim and Dick volunteered to fly with pilot and copilot to Tocumen and shift the cargo.

The rest of us opted to take the train across the isthmus of the Canal Zone and rendezvous with the others at the airport at 11 p.m. that evening. We proceeded to get rid of our Panamanian money by using the slot machines that were placed in a room at the hotel but it wasn't easy. We kept winning! Finally, we left for the train depot.

The train ride across the isthmus, from one ocean to the other, costs but $1.25 and takes about 2 hours. On the Caribbean side it runs along the Panama Canal and where in Colon we could only see the ships lined up to go through the Canal in the distance, now we saw them close up. Our train accommodations were not exactly first class but then, nothing was first class on this trip so far (more like 5th class!). However, we enjoyed ourselves immensely. I had not realized before how hilly the isthmus really was. It got even more mountainous as we approached the Pacific side. The Canal and the Panamanian jungle were wonderful to behold.

Upon arrival in Balboa Heights, Zeke remarked that he knew the director of the Air Force Survival Training School located there. We had become quite interested in survival recently and seconded the motion that we try to wrangle an invitation to the school. Although Zeke's friend was not in Panama at the time, Sgt. Davidson came down to the station,

One specimen of *Bufo marinus* in hand!

A large tree shading the Survival School Headquarters. The strange objects hanging from branches are birds' nests.

picked us up, and drove us to the school. No classes were in progress at the time but he showed us around for several hours. The survival school has imported all sorts of plants and animals from Asia, South America, and Africa, and they were most interesting to see. They even had an electric eel in their outdoor area! Sgt. Davidson told us that for lunch on the first day of school, each class gets a meal of fried caterpillars! The final exam is also interesting. The student is dropped into the jungles of Panama equipped with nothing more than the clothes on his back. If he doesn't get back within 6 days, he flunks the course!
After supper in Balboa Heights, we rented a cab and took off for the airport.

A Peruvian Adventure – Part IV

[Aquarium Journal, April 1965]

"LITTLE ORPHAN ANDES"

Our luck was running true to form for immediately upon arrival at Tocumen Airport, the ancient cab that brought us broke down! The four of us, Jerry, Win, Zeke, and myself, went out to the plane but found that Panamanian Customs had sealed the aircraft, and the others were nowhere to be found. Thoughts of sacking out in the plane were discarded and we proceeded to the airport lounge. My evaluation of the situation went something like this. We had about two hours before scheduled takeoff and it was clear that a man had to be either crazy or drunk to get back into that airplane. We decided on the latter course and ordered Panamanian beer as a starter. It was obvious that Win was quite concerned (but no more than the rest of us) so Zeke offered him a tranquilizer tablet. The tablet looked like a small basketball but Win swallowed it post haste. "This is going to be interesting," sez Zeke. "Why?" sez Win. "Because that was a pill that we give to elephants at the Cincinnati Zoo to tranquilize them before giving them shots," sez Zeke. "What!" sez Win. "It was the only thing I had," sez Zeke. "Have you ever tried one yourself?" sez Win. "No," sez Zeke. At this point, Win stopped worrying about the B-25 and concentrated on the effect of elephant tranquilizer on Man. As for the rest of us, we concentrated on "Operation Juiced" and we were feeling no pain when Jon, Bill, Felix, Jim, and Dick showed up. Jon was just about to join us in "Operation Juiced" when we remembered that he was flying so it was strictly coffee for him. The next leg of the journey was to Talara, located in the northwestern corner of Peru . . . a trip of some 5% hours flying time. At midnight we refueled, passed through customs and took our positions in the plane. This time, Jerry and I went with Win and Zeke in the tail portion. We closed up the rear hatch and promptly fell fast asleep. I don't know whether Win was tranquilized or just asleep

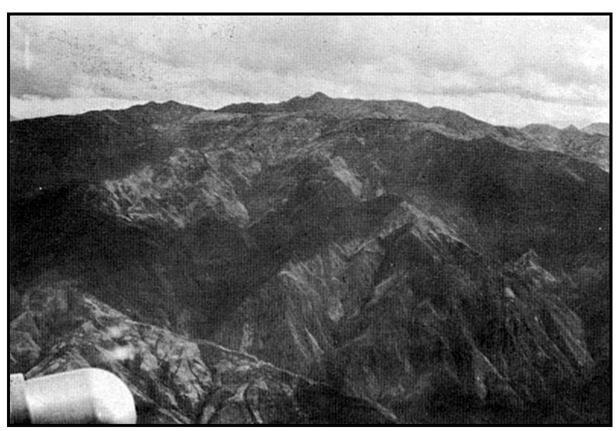
Taking a look at the cockpit while over the Andes.

but in any event, he wasn't making much noise. The next thing we knew, the old B-25 was coming in for a landing at Talara.
Talara is a small town located on the Pacific Ocean that serves as an oil depot in northwestern Peru, not too far from the border with Ecuador. The airport itself is located on a level several hundred feet above the town and without doubt, it is the most desolate spot I have ever visited in my life. The coast of Peru is, surprisingly, nothing but desert … sand, sand and more sand. The wind blows in from the Pacific Ocean and bends the little vegetation that there is until the palms nearly touch the ground. A good many of the smaller windows at the airport terminal building had blown out and had not been replaced, so the wind blew in quantities of sand continuously. No sooner would a Peruvian sweep the sand up in the lobby, and then a fresh layer would take its place! This was ridiculous! Just below the equator and on the Pacific Ocean … and we were in cold, windy desert!

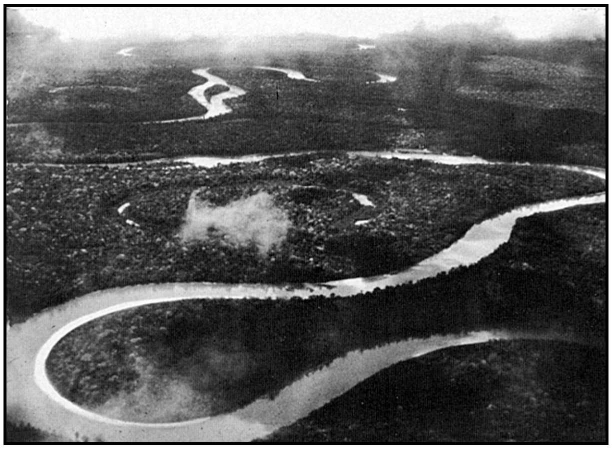
There was no point in going into town. Firstly, it looked as desolate as the sand dunes themselves and secondly, we had no time. A few hundred feet from the airport we found a clapboard shack that housed a sort of restaurant run by a Peruvian farmer. The farmer's pig stys were located right next door but the wind, fortunately, was blowing in the right direction. Breakfast consisted of greasy eggs, stale rolls, and cold coffee. We were to find out later that this was a banquet in comparison to things we would be eating in the jungle! The fanner and his wife were quite nice, however, and I had a chance to listen to some real Peruvian Spanish being spoken. It was obvious that my high school Spanish left much to be desired.

Now we were ready for the most dangerous part of our trip . . . the flight across the Andes Mountains, and then over the jungle. Prior to this, we flew either over the U.S. or over water and if trouble occurred over the former, we could have landed almost anywhere, and if over the latter (as it did over the Caribbean), we had the ocean in which to ditch. If trouble occurred over the Andes, however, we would have had it, for there wasn't a parachute in the plane. If trouble occurred over the jungle, our chances wouldn't be much better … trees are almost as hard as mountains! Furthermore, from now on we had no outside navigational aids, i.e., no radio contact, radar, radio beacon, etc. We were looking for a needle in the haystack, i.e., a tiny settlement in the thick jungles of Peru. After breakfast, we refueled once again and readied for takeoff. The Talara airport is not used for commercial purposes. It serves mainly for the Peruvian Air Force and Peruvian jet fighters were streaking by like mosquitoes. Although we had clearance to take off, evidently the jets didn't hear about it for one nearly landed right into us while we were taxiing! After a 15-minute delay, and looking in all directions, we took off. Our estimated time to Tournavista, our destination, was 3-1/2 hours: 2 hours over the Andes and 1-1/2 hours over the jungle.

This time I took a place immediately behind the pilot for I had some pictures to take! The desert below was impressive but then, the Andes came in sight and we had to gain altitude. There was no bottled oxygen aboard the plane except for one tiny container to be used by pi-



The mighty Andes. The spinner of our propeller can be seen at the lower left.



The Pachitea River, taken from the cockpit of the B-25.

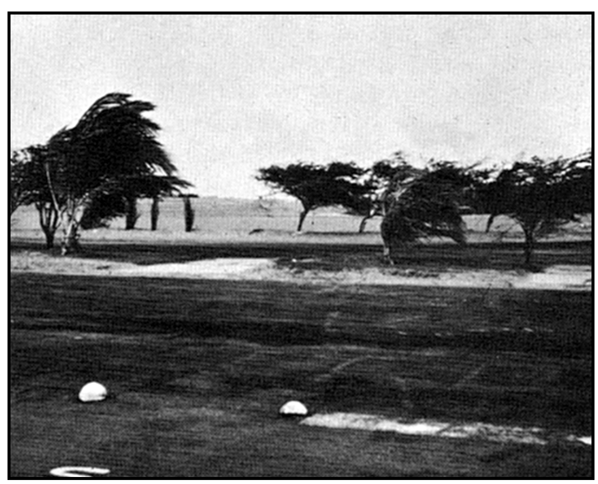
lot and copilot. Consequently, we could fly no higher than 17,000 feet . . . any higher and we would die from lack of oxygen. Unfortunately, the Andes were over 20,000 feet high at the point at which we desired to cross, and a little arithmetic indicates that we had a slight problem! Our strategy was to fly between peaks and it was a jim-dandy strategy except for one thing, i.e., clouds. We never knew exactly what was waiting for us whenever we entered a cloud. Furthermore, once inside a cloud it was a frightening experience not to be able to see what lay ahead of us. All we could do was to trust our maps and to hope that what we saw out of our window was the same thing we were pointing to on our maps.

Later on, we learned that some months previous to our arrival, a Peruvian airliner crashed into a mountain because it was marked on the maps as 5,000 feet, when it really was 10,000 feet!

It was cold in the plane and I nearly froze. However, the Andes were magnificent and my camera clicked away. We flew very close to the mountains … a cameraman's delight! The high altitude gave me a warm, cozy feeling after a while, and if I didn't move around too much, I could breathe although with great difficulty. Win, who suffered from asthma, also rode in the mid-compartment with me so that he could use the pilot's oxygen bottle if needed. However, the oxygen bottle was soon exhausted and Bill, our copilot, nearly passed out a while later. In the rear compartment, Dick Stone was having an especially bad time of it due to the lack of oxygen.

After two hours, we crossed the Andes and came over the jungle. Consequently, we were able to reduce altitude, and the strain of low-oxygen flying was over for the moment. Our problem now was to find the tiny settlement of Tournavista in all that jungle. We did this by flying very low, looking for the telltale Pachitea River on which the settlement is located. The jungle looked dense and among the predominantly green treetops would appear at times, isolated yellow or red trees. It was quite a sight. Then, we found the river. It wound across the jungle like a tremendous hairpin, and it looked as if 10 miles on the river would be equivalent to 1 mile as the crow flies. We were all looking hard for Tournavista, however. To miss it would spell disaster.

Then . . . there it was! A tiny area hacked out of the jungle, its roads exposing raw earth to give it a naked look; it perched on the eastern bank of the Pachitea River, a hundred miles from the mountains. We lost altitude and started our approach. The final turn was right over the river, skimming but 200 feet over it. The old B-25 creaked and groaned as it settled



Winds bending palm trees at Talara, Peru.

A typical Indian village, Tournavista. Note the lack of vehicular traffic.

down on the gravel strip. The wheels and prop stream kicked up large chunks of rock, some of which hit the plane. One rock broke off a piece from one of the left propeller blades, and another cracked the copilot's windshield! But we were safely down in the jungle at last, our destination achieved. We didn't have to worry about flying in our old plane for two more weeks. Deus Miseratur!

The jungle air hit us with a choked feeling but it smelled wonderfully fragrant nevertheless. A reception committee was waiting for us as we got out. It consisted mainly of the wives of the non-Peruvians who lived in Tournavista, but also included Peruvian customs for we had much missionary cargo on board. We each grabbed a small handbag containing personal things and leaving Jon, Bill and Felix to argue with Customs, the rest of us piled into a truck and drove to the communal dining hall. Here we had a good solid lunch consisting mostly of steak and papaya, but we mainly were interested in quaffing large quantities of iced tea and fruit juices! I don't think that we were ever able to quench our thirsts all the time we were in Peru!

After lunch we took a quick tour around the settlement. There were about 20 wooden houses for the non-Peruvian (mostly American) families plus general store, machine shop, and lumber mill. A diesel generator supplied electricity to the settlement. Then there were about 40 or so thatched huts comprising what was known as the "Indian village," and here lived the Campa Indians who worked in Tournavista. Finally, a school rounded out the complement of Tournavista's buildings. Tournavista is the headquarters of the El Tourneau del Peru Company, an American company with a mandate from the Peruvian government to develop 1,000,000 acres of jungle for future settlement. To date, the Company has worked on building a road across the Andes, linking Lima (the Capital of the country) with Pucallpa (the largest port on the Ucayali River, the major river of Peru), the latter some 60 miles from Tournavista. The Company is also working to establish a cattle ranch in the jungle and at present, has a 5,000 head herd. The elevation of Tournavista is 800 feet and the site was selected because of its healthful climate. However, it is isolated as we were soon to find out.

A Peruvian Adventure – Part V

[Aquarium Journal, May 1965]

"ME AQUARIST – YOU JANE?"

The next day at Tournavista found us ready and eager to start our exploration. The first thing on the agenda was a visit to Jon's compound, a 10-minute walk from our dormitory. The compound itself was quite extensive, covering a plot of ground roughly 75 x 200 feet. It

Residential area, Tournavista.

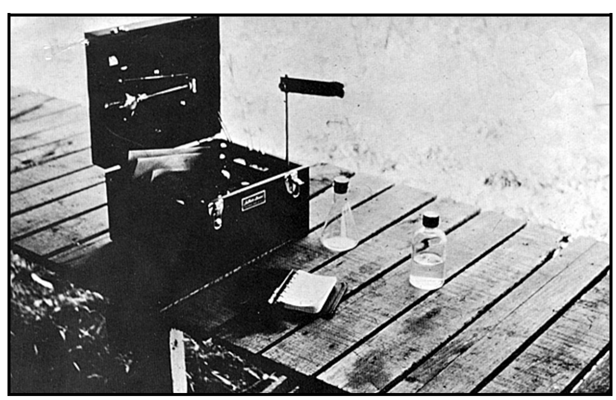
Freezing in the tropics! Left to right: Zeke, Dick, Win, and Jerry.

featured a high, thatched roof and a construction of the pole variety with no nails used whatsoever. All of the poles were lashed together with vines. The holding tanks, about a hundred of them, were simply constructed of flat boards lined with a polyvinyl plastic sheet. They held water and that was all that was required! A few “luxuries” such as planks on the ground to keep mud off the feet and some tables for working space, completed the compound. A sort of “apartment” was built up in the rafters, reached by a rickety ladder. None of us slept there but we did use it to store supplies and equipment.

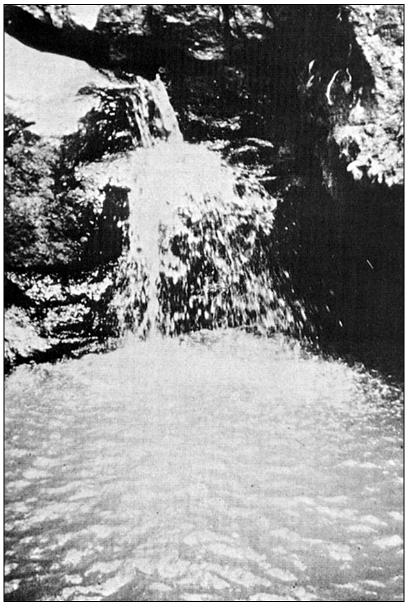
Someone announced that there was a small jungle stream behind the compound, and most of the party elected to try to reach it. This was easier said than done since although the stream was hardly 200 feet away from the compound, the ground leading to the stream dropped sharply and was covered by the thickest sort of jungle imaginable. Most of us were wearing the usual grey work pants and shirts, plus 8-inch leather boots. Our shirts were long-sleeved, an advantage going through the jungle since almost everything (it seems!) that grows in the Peruvian Amazon has a thorn or a spine on it. To go bare-armed is to invite scratches and stings of sundry sorts.

The jungle had a succulent aroma to it and it was dark. All kinds of strange-looking vegetation grew about and we had to take care on two counts, viz., where we placed our hands, and where we placed our feet. The former had to do with accidentally grabbing some thorn-clad vine or tree, or perhaps even some stinging ants, and the latter with stepping into a hole and breaking an ankle or else stepping on a snake. I will remark at this point that every one of the snakes we captured personally were venomous. But more about poisonous snakes later!

We broke up into three groups, each group reaching the stream at different points. The light broke through the jungle here, and the air felt somewhat cooler. The jungle stream itself was perfectly delightful, running over gravel for the most part. It was of a brownish hue but clear, and moderately fast-flowing. This turned out to be the only gravel-bottom body of water we found during our travels. Everywhere else we found strictly mud bottom. The stream averaged perhaps 4 feet wide and 1 foot deep but at places it widened and/or deepened to double these dimensions. We switched to sneakers for wading purposes and started looking for fishes. These were not long in forthcoming and soon we spotted some at the surface in the calmer pools formed by bends in the course of the stream. They were not particularly easy to catch, however. The seines were too big to use so hand nets were employed instead. Although it is true that the stream had practically no



The LaMotte field water testing laboratory in use at Tournavista.



The ole swimming hole in the jungle.

aquatic vegetation (one of the things that really amazed us was the general lack of vegetation in these natural waters. In our jungle stream, the explanation was simple ... the light was insufficient for plant growth! In the darker spots of the jungle, there is no plant growth even on the ground. The vegetation amounts mainly to trees, bushes, and vines.), there was plenty of woody debris that continually snagged our nets. We did catch them, though, and they turned out to be none other than *Rivulus peruanus*, the only species of killifish caught on our trip. This was a significant discovery for the original locality for this fish, "Perim," Peru, cannot be found today. No one knows or has ever heard of "Perim"! You might have expected that the first fish a group of American Killifish Association members might find would turn out to be a killie! *Rivulus peruanus* is a beautiful killifish and we soon discovered that there were two color forms present, viz., a brownish-reddish variety, and one with a pronounced bluish enhancement. These fish were placed into plastic bags we carried for this purpose.

Darting in and around the rocks were isolated specimens of some sort of bottom fish. These were especially prevalent in the more swiftly moving areas of the stream. A few vigorous scoops of the net brought up not only pebbles and stones, but some fish as well! They turned out to be various forms of loricariid fishes such as *Hypostomus, Ancistris, Hemiancistris*, etc. There were so many, many forms, fat and skinny, with and without whiskers, dark and light, etc., that we gave up trying to identify them scientifically then and there. At this point, I got a little careless and banged into a wasp's nest that was attached to a branch span ping the stream some 5 feet above it. One of the wasps stung me on the cheek and I was forced to take off in a mad flight up the stream, pursued by an angry hoard of the insects! That sting in the cheek was no fun and I had to return on land (to avoid the wasps) through the thick jungle that surrounded the stream.

We followed the stream for a distance and observed that it started to run over a solid rock bottom, finally turning into a 10-foot waterfall, a picture right out of a Tarzan serial! Just before the waterfall, however, we discovered a

A nest of termites.

This is what is laughingly known as a "trail" through the jungle.

silvery fish swimming about in a pool formed by the stream. These, being fast, were hard to collect but we were successful and found them to be a species of the characid genus, Prionobrama. Our attention now turned back to the waterfall, which culminated in a pool about 4 feet deep, 20 feet long, and 12 feet wide. The water was cool but not too clear due to its roiling by the fall of the water. For a while, the pool served Win and me as a private "swimmin' hole." The air temperature in the afternoon frequently went to 95° F, so we had real need of a means to cool off.

We had no bathing trunks but since the pool was not exactly situated in the middle of Times Square, we did not have to worry about being interrupted swimming in our "birthday suits." The second time out, however, Win complained that something nipped him. Nothing happened to me so I accused him of having an overactive imagination. He complained again the third time out and as I was laughing at him, something pinched down on the left side of my chest. At this, I jumped four feet straight up out of the water, did a right turn, and wound up on a rock ledge! We discovered that we weren't the only swimmers in that pool and that it was infested with a smallish crab, about two inches overall, that had pincers a full one-half inch long! Since we were swimming in the raw, we were a bit concerned about where the "phantom" would strike next and so, reluctantly gave up our favorite swimming hole.

Before starting on our trip, I had made up my mind to do some serious water testing of these natural habitats. What was needed was a lightweight field-testing laboratory, one which incorporated simple but reliable chemical tests. My first thought was of the LaMotte Chemical Company, a well-known, respected chemical concern which has manufactured water testing equipment for the aquarium hobby for years (they primarily are in the business of making test equipment for professionals). Their testing equipment for aquarists is, in my opinion, the best available. For example, their colormetric test for pH involves a rather precise color matching technique using vials of "standard color" where both control and test samples are viewed behind samples of water to be tested.

Through the courtesy of LaMotte, I was outfitted with a beautifully constructed field kit (e. g., mahogany case, polyfoam cushioned compartments, etc.) weighing but 14 pounds, that enabled me to make 11 different tests of water quality, including such involved analyses as dissolved oxygen. I plan to devote one complete article in this series on what I found since very little information of this nature is available. Far too many aquarists have made trips to South America and returned with the hobby being none the wiser as to the water quality of natural habitats. Let's be quite honest — anyone can travel to South America and discover new fishes. It is even no feat to have a dozen fishes named after you as a consequence of these discoveries. All you have to do is to go down there. South America is virtually unexplored as far as fishes are concerned! It is another thing, however, to make meaningful ob-

A very typical thorn-covered tree trunk.

servations that are really of some value to hobbyists. With this thought in mind, I collected water samples from the jungle stream and returned to the compound to complete my tests.

One may summarize our findings in this, the first body of water we investigated, as follows:

1. No aquatic vegetation of consequence was found. This appeared to be a result of the poor lighting this heavily shaded jungle stream received.
2. The three major types of fishes found (characins, killies, catfishes) occupied three different, general ecological "niches." The catfishes were found on the bottom among the rocks; the characins were found nearer the center of the stream at a small distance below the surface in moderately flowing water; and the killies were found at the surface near the banks of the stream in slowly moving water.
3. The characins and killies were quite obviously nourished by the many insects that fell into the water, especially the latter fishes. The catfishes, on the other hand, definitely grazed on the algae-covered stones that covered a good portion of the streambed. They were found in both slow and swift waters. The catfish referred to are sucker mouth types, previously mentioned.

4. The killies laid their eggs on the vegetative debris (sticks, branches, leaves, etc.) that was found close to the banks of the pools (I actually found some *Rivulus* eggs!). The characins scattered their eggs that fell to the bottom to be concealed by either the mud or the stones. It appeared likely that the catfishes built nests among the stones or in the mud near the banks.

Of course, there was other aquatic life present as well, including various crustacea and aquatic insects. However, the common notion that natural bodies of water in the Peruvian Amazon are just teeming with live food for fishes is ridiculous. It just isn't true! We caught no Rivulus, for example, with the bulging stomachs that indicate recent feasting. Could it be that we overfeed our fishes in the aquarium? A full chemical analysis of this stream will be presented later but we can briefly mention that this was water high in oxygen, low in dissolved minerals and of moderate pH. We placed our *Rivulus, Prionobrama*, and assorted catfishes in the compound and returned to Tournavista for a quick lunch of papaya and steak. The Peruvian idea of steak, however, is two-thirds shoe leather and one-third garlic. By breathing in the general direction of the mosquitoes after eating this steak, we did better than even a can of "Raid"! After lunch, we departed on an exploration that took this writer closer to death than at any other time during our trip.

A Peruvian Adventure – Part VI

[Aquarium Journal, June 1965]

BUSHMASTER BOULEVARD

There were three logging roads that led to the Pachitea River and the next day, we selected the east one for our first serious exploration. Zeke, Jim, Jerry and I, each carrying fishing and/or photographic equipment, started out along the dirt patch. At the outskirts of Tournavista we passed the missionary school and could hear the singing of the children within. Now we were in the jungle. Some of the trees had been rolled down by the tremendous "tree roller" of the Le Tourneau Company, leaving isolated specimens standing naked against the surrounding swamps and jungle brush. We were particularly impressed by their great size and by the extensive vine system that lived in symbiosis with them. Jerry and Zeke could not resist taking a vine and sailing across a clearing, Tarzan-like. The consensus was, however, that neither would ever replace Lex Barker unless the Tarzan role was rewritten to cast him as wearing a beard or weighing about 120 pounds. As for the part of Tarzan's faithful companion, Cheetah, that was another matter but in deference to my companions, I will not comment further.

Much to our surprise, the jungle was not a riot of noise. We had expected to hear the chattering of monkeys and the whistling of tropical birds, but the sounds of the jungle were muted. Of course, I write this as a married man with three young children so perhaps a good deal of the jungle noise was automatically filtered out of my ears. Be that as it may, we discovered several pools of water by the side of the road. At one point a brisk stream was flowing vigorously over the road as a consequence of a previous rain. It was not deep over the road so we were not stopped by it. The pools at both sides looked inviting and we stopped to fish.

All of these pools had thick, mud bottoms but their outstanding characteristic was their color. The water, although clear, was of a strong, tea-color. The largest of the pools was approximately 15' x 20' but much to our surprise it was over our heads in its middle. Consequently, the seine was all but useless. We did manage, however, to bring up some specimens of characins, viz., hatchet fishes and *Pyrrhulina*. The latter had deep-crimson fins . . . a truly beautiful fish. The stream that fed this particular pool led into the jungles and we elected to follow it. This was easier said than done, however, because either the ground was swampy, or more often the case, covered with thick brush that we feared harbored jungle creatures we did not care to step on in just our sneakers. Fortunately we found several downed tree trunks and used them as bridges.

These tree trunks were covered with sharp thorns approximately the length of the thickness of our sneakers. One had to be careful to tread carefully to avoid a genuine Peruvian "hotfoot"!

We followed the tree bridges as far as they could take us, and then Jim, Zeke, and I prepared to enter the water. Again, it was quite deep and we found no accessible area that was not at least up to our shoulders. Combine this with underwater hazards such as submerged logs, trees, and branches . . . most covered with thorns at that … and one can realize that it was not the easiest thing in the world to collect fish under these circumstances. The brush harbored snakes, the water concealed leeches,

The author exploring the natural habitat of hatchet fishes and *Pyrrhulina*.

Zeke handling a vine snake, a rear-fanged, mildly venomous reptile that just "dropped in."

and we weren't about to linger in such surroundings! It was back to the road once again, to explore the pools on the other side. Here, only hand nets could be used but we were delighted with our catch which included *Hoplosternum thoracatum, Hoplias malabaricus, Apistogramma borellii*, a knife fish or two, several small characins and a few specimens of *Erythrinus erythrinus*. The cichlid was of special interest to us. Our *A. borellii* favored the edges of this very small pool, underneath overhanging vegetation. By jamming in a hand net, one or two specimens at a time could be caught. This was hard on the nets, and although they were made of plastic screening, they lasted but a day or two. Fortunately, we had spares. *Apistogramma borellii* is one of two dwarf cichlids known to the hobby for many years as "Apistogramma U-2". Jim and I brought these cichlids back to the States with us and we were both fortunate in being able to spawn them. They are easy breeders, quite prolific and a handsome-looking fish in the bargain.

As mentioned, the *Apistogramma* was found in vegetative debris near the banks (there being no vegetation in the water itself). The hatchet fishes and *Pyrrhulina*, however, were found in the middle of the pool (where it was quite deep) near the surface where the current was negligible. When the pool necked down to form a small stream, it invariably became shallow (1 to 2 feet) but the current increased tremendously. Here no hatchet fish were found but a few hardy *Pyrrhulina* did brave these miniature "rapids." More characteristically present were specimens of *Hoplosternum*. These catfish hugged the muddy bottom of this fast-flowing area and sometimes were accompanied by the predacious characins, *Hoplias* and *Erythrinus*. Actually, *Hoplias* was omnipresent throughout our travels although in isolated specimens only. Near the banks along with *Apistogramma borellii* but in a bit deeper water, were also isolated knife fishes of the genus *Gymnotus*. A complete water analysis will be given in the final installment of this series but generally, the water was very soft, moderately acid and quite low in dissolved oxygen. This last-named characteristic contrasted vividly with the high oxygen analyses found in the fast-flowing stream over gravel that was described previously (i.e., the *Rivulus peruanus* habitat). The reason was obvious . . . the high organic content of the latest find simply consumed a great proportion of the dissolved oxygen.

At the end of the day, we had collected many interesting fishes and were ready for a good

The second most dangerous snake in the world - the legendary Bushmaster.

Zeke with his hand full of bushmaster.

meal back at Tournavista. The fish were placed into a large polyfoam container, and each of us taking a handle, Jerry and I led the way back to camp. Jim and Zeke followed with the collecting equipment. Dusk arrives swiftly in the tropics and the transition from night to day can take but 30 minutes. So it was as we made our way home. Jerry and I were happily discussing the day's activities when suddenly, Jerry stopped! This, of course, pulled me up short since I was attached to the other side of the container we were carrying. "What goes?" I said. "There's a snake!" he shouted. Sure enough, not more than four steps in front of me lay what I thought was a small log across the road. Suddenly, the "log" raised its head and stared right at me. Many years ago, prior to entering the aquarium hobby, I had been interested in snakes. Through the years, my knowledge of reptiles had deserted me considerably but the sight before me recalled to mind the many reference books I had committed to memory in the past. I was utterly astonished! Before me lay the largest specimen of the legendary bushmaster (*Lachesis mutis*) I had ever seen! The bushmaster is a member of the pit-viper family Crotalidae, which includes our copperhead, moccasin, the fer-de-lance and rattlesnakes. It is the largest poisonous snake in the South American continent, and considered by many to be the second most dangerous snake in the world (after the king cobra). This snake becomes very large (to 11 or 12 feet) and extremely venomous. It secretes neurotoxic venom similar to that of the cobra, and coupled with its large fangs and aggressive behavior, is one of the terrors of the snake world.

Jerry and I softly but swiftly put down our container of fishes and retreated a few yards. Since the snake was making no overtures towards us other than just looking, we tried to avoid any motions that would either cause the snake to attack or to retreat. We both knew the risk we were taking but that snake was valuable and we knew it. As carefully as I could, I dashed back to get Zeke, who was carrying the snake equipment. As soon as I cried "bushmaster!" Zeke threw off all of his equipment and grabbing his aluminum snake clamps, ran to the snake. Jerry, Jim, and I then witnessed a fantastic battle. Zeke, who was barefoot (!), clamped the end of the snake stick

A helping hand to Jon Krause by Win Rayburn.

A road inundated by a flash rain— the nearby pond is a habitat of *Apistogramma borellii, Hoplosternum, Erythrinus*, and *Hoplias*.

behind the bushmaster's head (the clamp was quite similar to the old-fashioned grocer's clamp, but much shorter, i.e., about three and a half feet). As soon as this happened, the snake began a violent struggle! It whipped its body around furiously, twisting and turning. Zeke was hard-pressed to keep his bare feet out of the way. Several times the bushmaster twisted out of the clamps and struck, but it missed and Zeke managed to obtain a new hold each time.

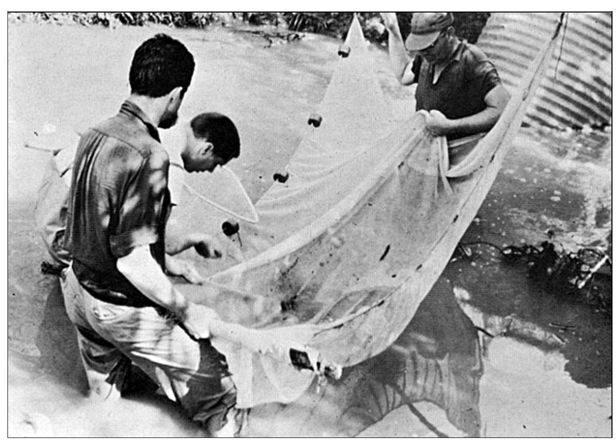
The battle exhausted both Zeke and the snake. Jim ran back to camp to fetch some help, as we carried nothing large enough to contain the snake. In 20 minutes, he arrived back on the scene with a truck and some men. It took this long and longer, to subdue the bushmaster! Using a burlap bag, Zeke managed to cage the animal finally. In triumph, we all returned to Tournavista. Only after dinner when we had time to discuss the incident and to christen the road, "Bushmaster Boulevard," did we realize its full import. Although we carried antitoxin with us (for rattlesnakes, fer-de-lance, etc), there is no known completely successful anti-toxin for bushmaster venom. A few days before, I had asked one of the missionaries about snakebites in the area. He said that bushmasters were rare but upon occasion they did bite somebody. When the snakes were small, say under 3 feet, his experience was that the mortality rate, even if the leg were amputated and anti-toxin used, was about 50%. Looking at our almost 8-foot long specimen, I asked him what he thought the chance would be with one that size. He shrugged his shoulders and made a circle with his thumb and forefinger. I shuddered to think that when Jerry stopped me, I was just four steps from almost certain death. Deo gratias!

A Peruvian Adventure – Part VII

[Aquarium Journal, July 1965]

"UCAYALI ALLEY"

Our next destination was Pucallpa, the major port upstream on Peru's mightiest river, the Rio Ucayali. A dirt road connected Tournavista with Pucallpa, a distance of some 60 miles. If the weather is good, the average travel time is three hours. Our transportation consisted of a bus-like structure mounted on a Ford truck chassis. The driver's nickname was "Lobo" (i.e., "wolf") although Barney Oldfield would have been more appropriate! Jon, Felix, Zeke, Jim, Jerry, Win, and I hopped aboard along with a small contingent of Campa Indians. Our equipment was stowed on top of the truck and considering the cramped quarters within, Jim and I elected to ride on top over the cab. This, as it proved, was a big mistake.

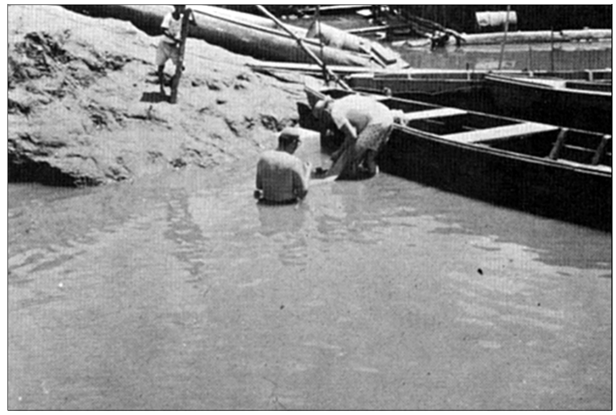


The haunt of the rosy tetra. Collectors Zeke, Win, and Jim deep in the heart of the Peruvian Amazon.

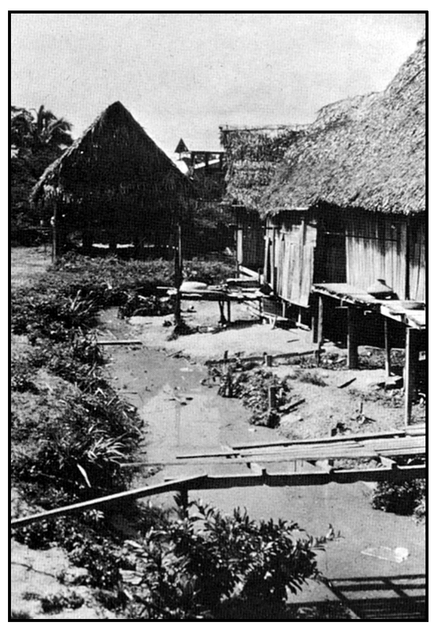
Our driver evidently was devoting his life to rounding off the teeth on the Ford's gears. It was a point of honor with him not to use either first or second gear, or the brakes, if it could possibly be avoided. There was one speed only, and that was "full ahead." The low-hanging branches frequently did not clear the top of the truck, let alone Jim and myself, and every so often a branch would knock me flat. I perfected a ducking procedure but it was not 100 per cent effective. Further, it was cold on top of the truck for as soon as the sun goes down, the jungle becomes quite cool. Fighting both being knocked silly and incipient frost-bite, the perilous journey screeched to a halt in the main street of Pucallpa at 1 a.m. Our next problem was accommodations. Jon, Felix, Zeke and Jim obtained "dormitorios" at a doubtful structure known as the "Hotel Los Angeles," and after pounding on doors for an hour, Jerry, Win and I found sleeping quarters at the Hotel Mercedes, Pucallpa's "best." Later, we really were to appreciate the Hotel Mercedes.

At 2 a.m., we were all tired and thirsty so the Mercedes group found an all-night beanery poste haste. Being the only one with a speaking knowledge of Spanish, I was commissioned to order beers for all. Either it was just too late and I was too tired, or my high school Spanish teacher had steered me wrong, but in either case what arrived was an evil-looking mixture of coffee and sour milk. I really took a ribbing from the crew that night!

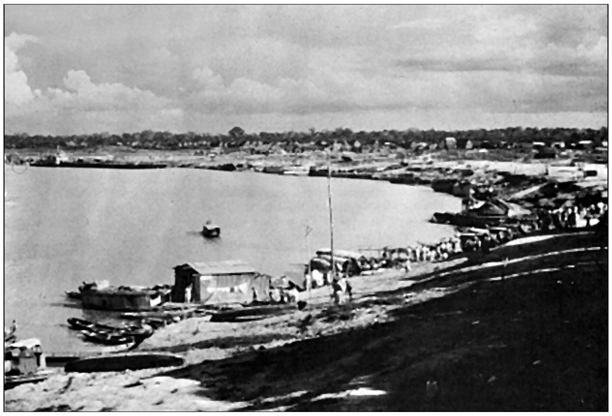
The next morning, the Mercedes group joined the Los Angeles group for breakfast. We discovered 'a newly-opened restaurant that featured a "complete breakfast." It started off with papaya juice but next on the agenda was something called "Quaker." None of us knew the translation for "Quaker" and when the proprietor was questioned, his answer made no sense at all. When it arrived, it turned out to be a thin gruel of Quaker Oats, served up in a chipped porcelain mug! Three-quarters of the way through the "Quaker," Win discovered his to be full of maggots. Sure enough, all of our cups had this unbargained-for extra addition of protein. Since there was no extra charge and in view of the fact that they appeared well cooked, we downed the remainder with stoicism typical of our Peruvian friends. Afterwards, I always ate wearing my sunglasses and with my eyes averted to the ceiling. It was much better for my morale and I didn't want to



Jon Krause and Jim Thomerson fishing along the shoreline of the Ucayali. Catfishes by the thousands were caught here.



Indian houses on the outskirts of Pucallpa.



The shores of the Ucayali River at Pucallpa.

panic my stomach by sending distress signals in advance.

The business of fishing the Ucayali River and its tributaries now began in earnest. We had a small outboard motor so our next stop was to find ‘a boat. While a portion of the group scouted out a “Peki-peki” (the native name for a canoe plus outboard motor ... a consequence of the sound of the motor!), the remainder of us strolled down to the river’s edge. Here, jungle steamers were being loaded for the long (one month) trip down the Ucayali to Iquitos in northern Peru. Groups of Chapeba Indians were present everywhere. One family rode into shore right in front of us, started a fire, upended a live turtle over it, and commenced breakfast. This may not sound appealing, but at the time it looked considerably better than “Quaker.” The women, who were quite colorfully garbed, had with them a baby capybara, the largest rodent in South America (up to 300 pounds?). Zeke wanted it for the zoo in Cincinnati and I acted as interpreter. Remembering the beer-coffee incident the night before, there was some fear that I might inadvertently bargain for one of the women instead, but we did manage to wind up with the capybara for the sum of $2 without causing any international incidents. Besides, the capybara was not only better looking, but also it smelled better!

Not waiting for the canoe, we started to seine right along the shore next to the river steamers. It was like seining in a mud hole, pure and simple, yet, our seine brought up great quantities of catfishes of the *Doras* and *Pimelodus* types. Each one of them would be worth $5 or more as prime show specimens in any aquarium shop. And new species? Whoever started this nonsense about it being hard to find new fishes? One could accidentally drop his hat into this muddy river and spend the rest of the day picking out new and/or fascinating fishes for the aquarium.

Our canoe finally showed up, along with Jerry sporting a new straw hat. The hat was large, giving Jerry an “Evil-eye Fleagle” look but it effectively warded off the burning rays of the sun. Zeke took off his T-shirt and wore it under his hat, and Win arranged a large kerchief over his head and under his chin to effect a “Mother Hubbard” appearance. In a 100° F. climate (on the shores of the Ucayali at noon), everyone to their own devices! I used the simple expedient of staying in the water up to my lower lip, emerging only for air and lunch at stated intervals. Lunch, by the way, consisted of hard bread, canned sardines, and hot beer. Peristalsis is defined as a natural contraction and expansion of the intestines as a consequence of the eating act. My stomach, how-

Felix, Zeke, and Win handling a “Peki-Peki” on the Ucayali. The Houses in the background are built on stilts.

A typical "bee-hive" oven in the yard of a Pucallpan.

ever, gave up peristalsis early in the game.

The fish we were catching were simply fabulous both in quantity and in variety. Brochis coreuleus were captured literally by the thousands and our bag included needlefish, sundry tetras, loricariids, cichlids . . . you name it, we caught it. Especially prevalent were the parasitic catfishes of the family Pygidiidae, those unpleasant little creatures reputed to enter the genital openings of humans upon occasion. I was especially interested in these creatures as I wanted to collect them for the Smithsonian Institution. Some clown in the crowd had suggested that I wear a pair of cast-iron jockey shorts while collecting them but his whimsy disappeared as he and a companion brought up a net full of medium-sized piranhas. We concluded that, if we weren't careful, the whole lot of us might wind up singing second soprano at church services if and when we returned home. This brings to the fore the interesting question of the hazards we faced while fishing. Certainly pygidiid catfishes and piranhas are potentially dangerous to man but the dangers are comparable to those we faced in the typical "complete breakfasts" we ate. A greater practical danger was the terrible, swift current of the Ucayali itself, and had we capsized in the middle, we no doubt would have drowned. Whether or not seining the shores of the Ucayali is as dangerous as seining in Central Park after dark, is a moot question indeed. But to return to the fishes and their water, complete analyses of these habitats studied will be presented in the last article in this series.

Our bill at the Hotel Mercedes came to $2.40 for the night and when we found out that the Hotel Los Angeles was only charging 80 cents a day, Jerry, Win and I moved in with the others. This, it turned out, was a grave tactical error. Win and I elected to share a double and our landlady led the way. After unlocking a rusty padlock that secured the door, we viewed a musty, disheveled room that looked as if the last occupant had left minutes before the police arrived looking for him. Our landlady took the sheets off the beds and simply turned them over (they were in such a condition that they could have turned themselves over!) The mattresses were of straw as were the pillows. It became clear that we were sleeping on top of a rather active colony of sundry animals belonging to other than the vertebrates. The cockroaches were four inches long but they did not wake us up unless they stomped their feet. The iron cots upon which we were sleeping moved about innumerable times during the night, but neither Win nor I cared to investigate too closely who or what was providing the motive power.

A view from the courtyard of the Hotel Los Angeles.

Chapeba Indian women with their baby capybara on the shores of the Ucayali.

The following day we explored Pucallpa, a city of some 50,000 inhabitants. It, except for the presence of many trucks and some electric light poles, resembled an American wild-west town of the 1870's. Pigs roamed the dirt streets at will, and the outdoor market was right out of a picture postcard. Win and I sampled the products of a street vendor (a drink made from red corn called "chicha morada" was our favorite) and afterwards, dubbed them "instant dysentery." We had expected to run around a lot in Peru, but not that way! Meals were cheap, however, and 24 cents would buy a steak dinner (Jerry insisted that it should be spelled "stake"). A bottle of Pisco, the national brandy (and spot remover), cost but 48 cents as fifth. The activity, the heat, the color, the dust, the people, the humidity . . . all blended to form a picture of this jungle town that Was like a storybook to us. It changed our outlook and our way of thinking, and I hope, made us better men for it.

A Peruvian Adventure – Part VIII

[Aquarium Journal, August 1965]

"LEAVE THE DRIVING TO US"

It was rumored that it had rained in Tournavista but we had no idea of the condition of the road between Pucallpa and our home base. Win, Zeke, Jerry and I hopped on our "bus" for the return trip but the authorities would not permit the bus to leave town, fearing that it was too dangerous to at tempt the muddy, slippery roads (and then too, there was some concern for the road itself!). "Lobo," our driver, returned the four of us to the Hotel and informed us that he would be back at 4 a.m. the next morning. True to his word, his arrival in the wee hours was signaled by shouts of "Arriba!" and vigorous blasts of the raucous horn. Ina soporific stupor, we herded into the, vehicle. The next few hours were spent in picking up other passengers, including men, women, children, and chickens. However, we couldn't complain since we ourselves were featuring fish, capybara, and monkey. The passengers didn't mind and I doubt that they would have even effected a glance had we tried to board a hippopotamus!

This time, the authorities let us through. At the fork, which separates the Tournavista road from the Lima road, the constabulary still blocked the latter but we were free to continue. The road was somewhat muddy and it became even more so as we progressed. Soon the road turned into nothing more than 8 inches of mud and our truck-bus slipped and skidded from one side of the road to the other. Every few minutes, we were all obliged to jump out and push, and every 20 minutes, Lobo was forced to stop to let the engine cool off. We had to

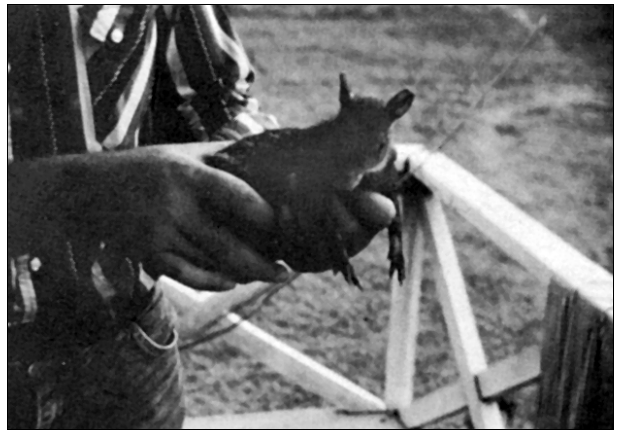
"Fluffy," our three-toed sloth. Note Jerry's wired snake gloves for protection

make frequent trips to nearby creeks for radiator water. At these stops, the Indians on board would exercise their chickens, and we would graze our capybara.

Many times, the truck would almost slide off the road with the prospect of falling into the ravines, which occasionally would line both sides. It started to rain and we were up to our knees in mud, tired and miserable. Further, we had had neither food nor water for hours. Finally, Lobo came to an isolated Campa Indian house by the side of the road and we stopped to bargain for food and water. "Quaker" was number one on the menu but it tasted this time, better than a filet mignon. With the Quaker came a mug full of yucca brew made in the following manner. The Indian wife would collect the roots of the yucca palm, and proceed to chew them fully. When sufficiently softened, she would spit this into a large, cast-iron kettle, continuing until the kettle was full. The kettle was then set aside for a week to 10 days, whereupon the mixture would ferment. It tasted like a sweet, somewhat alcoholic buttermilk, containing lumps of woody rhubarb. I doubt that the beverage will ever replace Pepsi Cola here in the States, however. Again, at the time it was pure ambrosia.

The Campa Indian establishment was a complete family unit consisting of young adults, children, and oldsters alike. The floor was raised about 10 inches off the ground and there were no sides to the thatched structure. Sleeping was via hammocks enclosed in mosquito netting, and for privacy, a cloth was hung between them. Although these people were poor, they nevertheless shared what little they had.

Zeke, Jerry, and Win, with 20 miles remaining to Tournavista, elected to walk the remainder of the way. Dumping their luggage, capybara and monkey into my lap, they waved goodbye and started off. After an hour or two, the rain stopped and we were off again, slipping and



sliding most of the way. Some six hours later, we caught up with Jerry and Win, and they were a pitiful sight indeed. They had been forced to take off their boots because the mud would suck them down, and they were so tired that they could hardly stand. Thirty minutes later we came to a sharp drop in the road that was under about 4 feet of water. Here we found Zeke, surprisingly in pretty fair shape. We marked the road where it went under water and timed the drop of the torrential stream. We calculated that it would be close to midnight before we would be able to get the truck through. Zeke and two of the Indians finally managed to ford the stream and an hour later, Win, Jerry, and I ferried our equipment across (wearing the monkey and capybara as hats)! Win struck out for Tournavista, some 10 miles away still, while Jerry and I guarded our belongings. It turned dark and soon we discov-

Dick holding a pimelodid catfish caught on rod and reel.

ered that our flashlight batteries were exhausted. Our 10-minute spot “bushmaster checks” had to be discontinued and we promptly imagined all sorts of animals harking about. This was not so funny since this was jaguar country and these oversized pussycats were the last things we wanted to see. We were well armed, however, Jerry having a sharpened popsicle stick and I having a safety razor. Help arrived from Tournavista in the form of a 4-wheel drive truck, and soon we were back in camp. In 29 hours, we had traveled but 60 miles!

During our stay in Tournavista it became known that we desired animals of all sorts (for the Cincinnati Zoo). Indians (many of them children) brought us many animals and it wasn’t long before we had quite a collection. Frequently, an Indian would approach us and state that he had such and such an animal and would we be interested? Unfortunately, these collectors knew only the native name for the animal where we knew only the scientific name of American popular name. We would always answer that we were interested and it never ceased to be an adventure to see what finally was delivered!

We had to store these animals somewhere, and the closets in our dormitory served the purpose admirably. Zeke had the crocodile concession in his closet; Win and I had the monkey and marmoset concession; Jerry had the agouti and sloth concession; the poisonous snakes were on the back porch, the boa constrictors on the front porch; the tarantulas were in cans in our living rooms; and so it went. One day our Peruvian maid opened the door to Jerry’s closet to deposit his laundry only to be greeted by Fluffy, our 3-toed sloth. She took off through the house, toppling furniture as she went. Fluffy was later found, hanging upside-down from the rafters in the bathroom. Our maids soon learned to open doors in our dormitory with a broom handle only!

Collecting crocodiles (actually caymans) was quite an operation. Every little dinky pond by the side of the road had its own crocodile population. These would submerge as soon as we approached but would soon put their eyes above the water surface after they calmed down a bit. Zeke, and sometimes Jim, would enter the water while others of us would try to attract the animal’s attention from the shore. Then Zeke would slowly creep up behind the all but submerged crocodile, and at the proper moment, would jump it. At such time, all heck broke loose and lasted until the animal was subdued. Many caymans were caught in this manner, normally at night (it was easier then) until one evening, Zeke crept up on a small croc perched upon a very large (about 10 feet) log. A few feet away from the croc, the “log” submerged and Zeke promptly gave up barehanded crocodile wrestling for the duration!

The time to return home drew near and we all pitched in to box the many fishes caught. This was an all-night operation. First, the cardboard boxes were assembled and then filled with their own plastic bag. The bags were filled with water and the long, hard process of netting, sorting and placing fishes began. This took us until 3 o’clock in the morning and we were plenty tired. After a few hours’ sleep, we returned to the compound and tied off all the bags, closed the boxes and loaded them onto a

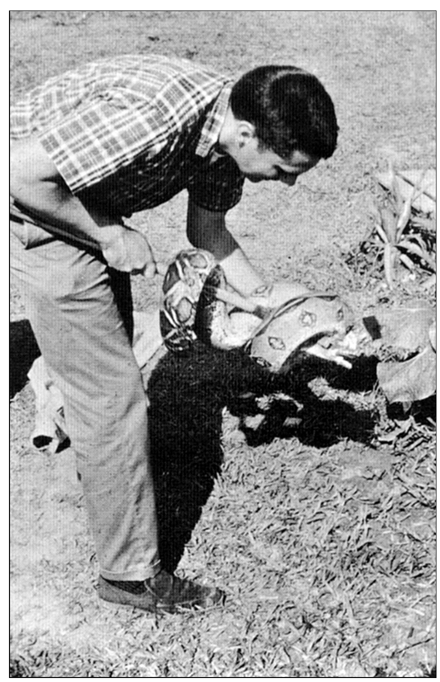
Wading through the mud after pushing the bus for a distance.

Zeke and Jim looking fro crocodiles - or is it vice versa?

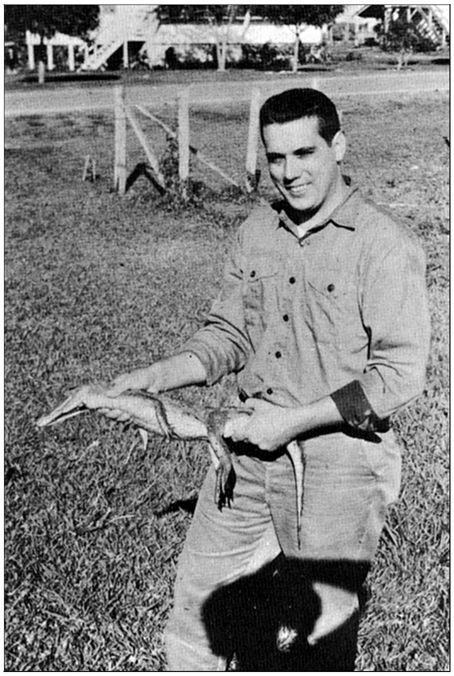
truck. At the plane, cargo, fishes, and other animals were loaded aboard. During loading, we dropped the crate containing Francesca, our baby Tapir. However, Francesca wasn't hurt and we patched the crate and finished loading.
Many of our cages were made on the spot a few days before, of mahogany, a very available wood in Tournavista. I felt criminal using this wood on mere crates! Zeke discovered a convenient way to ship crocodiles, viz., by just slipping a canvas bag over their head and tying it behind their front feet. One large croc, however, simply wandered off, never to be found. If, by chance, you should happen to find a crocodile in Peru with a bag over its head some day, it's ours!

There was one incident during loading. Zeke temporarily stored two large trots in the bathroom, neglecting to pass this information to the rest of us. Win strolled in to use the facilities and was promptly attacked by one of the reptiles. Win did not break the 4-minute mile, but then Roger Bannister didn't have his trousers down when he did it either!

Our plane was heavily loaded and it had sat, unused, for over 17 days in the jungle. The strip was 4900 feet long and we calculated that we would need 4300 feet for take-off. We started our roll but old Betsy balked at leaving the ground. I could hear Bill, our co-pilot, yelling into the headset, "Rise, Baby, rise!" We were only 12% off on our take-off calculation (12% of 4300 feet is 516 feet, add that to 4300 and you get 4816 feet) and so had a comfortable 84 feet to spare. The trip back home was uneventful except for two things. Number one was that we cracked an exhaust manifold over the Caribbean. By the sheerest of luck, we landed at Kingston, Jamaica, without catching fire. A B-25 two months before us had similar trouble but was not so lucky. It caught fire and had to land at Kingston, a total loss. The airport invited us to salvage a replacement manifold from the burned-out hulk, and in five hours, Bill successfully made the switch. The second item was that the left engine, which alone sustained us for so long on the trip down over the Caribbean, leaked oil like a sieve. Every time we touched down, Bill had to check the oil level and refill. The plane was a pile of junk when we returned.



Win Rayburn unraveling himself from a boa constrictor.



Win holding his favorite "varmint" - A Peruvian caiman.

Our arrival at Miami International Airport on Labor Day caused quite a commotion. When the animal inspector learned about the crocodiles lying around loose in the plane, the bushmaster, the boa constrictors, tarantulas, etc., they looked at each other and just stamped the plane, "PASSED"! For some reason, they were not anxious to make a personal inspection, especially when we couldn't remember which container the bushmaster was in. We arrived home in Columbus (Dick and Jim left us in Miami) to be greeted by wives and children, friends and relatives. Fish, equipment, souvenirs, animals, and personal belongings were unloaded and transferred to our personal automobiles. We took Jerry, loaded with fish, spears, crockery, bow and arrows, etc., over to the commercial side of the airport where he caught a plane home. I don't think that the ticket agent has recovered from that sight yet!

Without doubt, our trip was the experience of our lives, and for my part it couldn't have been made with a grander bunch of fellows. A lot of people have asked me if I would do it all over again if the opportunity presented itself. The answer is that I wouldn't have missed the trip for anything in the world but as for repeating it, I quote Jerry's favorite expression, "Lots o' luck fella!"

A Peruvian Adventure - Part IX

[Aquarium Journal, September 1965]

WATER ANALYSES FROM THE PERUVIAN AMAZON

INTRODUCTION

The effects of different substances upon fish life vary with species, size, age, and physiological condition of the individuals. It has long been known by aquarists that water favorable for some species may not necessarily be adequate for others that have been adapted to somewhat different conditions. Further, the question of aquarium water quality is complicated by the fact that the effects of deleterious substances upon fish vary with the physical and chemical composition of the water. For example, in soft water the damaging effects of poisons are generally greater than in hard water. Decreased oxygen concentrations and increased temperatures tend to increase the susceptibility of fish to toxicants. Interrelationships between the dissolved constituents of water are also important. By synergistic action, the combined influence of several substances simultaneously may result in greater damage to fish life than the sum of the individual effects taken independently. On the other hand, certain combinations of salts act antagonistically to reduce the injurious effects of each. We need not, however, speak of water quality in such drastic terms as "toxicity" or "lethality." Our fish might be quite healthy in a given water, the problem being rather that of breeding. At times aquarists have overemphasized water quality in the aquarium and at other times, underemphasized it. There is insufficient space here to discuss these pros and cons, the author's objective being merely a report on the water conditions found during his recent expedition to central Peru. This represents data, from which the reader may draw his own conclusions.

EQUIPMENT

Through the courtesy of the LaMotte Chemical Products Company, I was provided with a special water test outfit that contained all of the required standards, reagents, glassware and equipment for the following chemical determinations on natural waters:

pH value
iron
total hardness
copper
total alkalinity
color
chlorides
turbidity dissolved
oxygen

The pH equipment was of the highest quality featuring an octet comparator and a bicolor reader. Briefly, an indicator solution was added to the water sample, the two then being mixed. The octet comparator is a plastic comparator that contains eight hermetically - sealed color standards mounted adjacent to the viewing windows. If the water sample is turbid or cloudy, it is necessary to compensate for the effect of this color or turbidity. This is done by means of a three test tube reading procedure using the bicolor reader. This exacting system permits readings to an accuracy of 0.1 of a pH unit.

Total hardness was measured by an approximate titration procedure as was alkalinity and chloride. The iron test was colormetric in nature, with hermetically sealed comparator standards. The copper test used was qualitative only. Color was measured by means of an optical comparator, supplied with standards representing A.P.H.A. cobalt-platinum color values of 10 and 20. Turbidity was also by comparison. The dissolved oxygen was measured by a precise titrametric procedure, a modified version of the Winkler test. This involved solutions of manganese sulfate, alkaline potassium iodide, concentrated sulfuric acid, starch solution, and sodium thiosulfate. All of this equipment was neatly protected by Styrofoam and enclosed in a mahogany box.

With the exception of alkalinity, all of these tests are either already well known to aquarists or else self-explanatory. Alkalinity is not a specific polluting substance but rather represents a combined effect of several substances and conditions. It is a measure of the power of a solution to neutralize hydrogen ions and is caused by the presence of carbonates, bicarbonates, hydroxides, and to a lesser extent, by borates, silicates, phosphates, and organic substances. The significance of alkalinity, as well as all of the other measurements previously mentioned, will be discussed after each water analysis. Finally, after my return, I measured the conductivity of various water samples using a Chrystalab Ionimeter.

HABITAT NUMBER ONE

This water sample was obtained on the outskirts of Tournavista, Peru, behind the Krause compound situated there.

Analysis
Date: August 20, 1964
Time: 8:52 a.m.
Bottom: Mostly gravel, some mud
Appearance: Clear to slightly amber, under 10 A.P.H.A.

Water temperature:	73°F
pH:	7.2
Hardness:	34 ppm
Alkalinity:	45 ppm
Chloride:	trace
Iron:	trace
Copper:	none
Oxygen:	7.1 ppm
Conductivity:	240 micromhos

This stream, flowing moderately over a gravel bottom, contained *Rivulus peruanus, Astyanax bimaculatus, Hypostomus plecostomus,* and an *Ancistris* species. What may we conclude from this water analysis? The answer is simply that it really contains no surprises. This is clear, clean, cool, moving water containing little or no vegetation. It is very soft, well oxygenated, and contains little in the way of dissolved materials. It is common in the hobby to recommend, generally speaking, that water favorable for a good mixed aquarium fish fauna (excluding common aquarium livebearers) falls within the following limits:

1. Temperature	70-76°F
2. pH approximately	6.7 to 7.7
3. Hardness	25 to 125 ppm
4. Chloride less than	50 ppm
5. Dissolved oxygen	not less than 5 ppm
6. Conductivity	150 to 500 micromhos

This habitat, then, satisfies these guidelines. That the guidelines do not properly reflect the true state of nature, however, will be shown shortly.

HABITAT NUMBER TWO

These water samples were obtained from a pool situated alongside of a logging road connecting the Pachitea River and Tournavista. The second analysis was taken five days later, after a short but heavy rain raised the level of the pool and flooded the road to a depth of ten inches.

	Analysis I	**Analysis II**
Date:	August 20, 1964	August 25,1964
Time:	9:00 a.m.	9:00 a.m.
Bottom:	Mud and plant debris	mud and plant debris
Appearance:	Clear, slightly very dark brown (like tea)	Clear but yellow
Temperature:	76°F*	77°F
pH:	6.8	6.5
Hardness:	51 ppm	51 ppm
Alkalinity:	90 ppm	50 ppm
Chloride:	trace	trace
Iron:	2.0 ppm	2.5 ppm
Copper:	none	none
Oxygen:	3.5 ppm	0.5 ppm
Conductivity:	-	525 micromhos

***The sun had quickly warmed this relatively small pool (no larger than a bathtub) for forty-five minutes earlier this temperature was 75 degrees F.**

The water in this pool flowed moderately fast but after the rain, its flow was swift indeed. Fishes caught here, both before and after the rain, included *Hoplosternum thoracatum, Erythrinus erythrinus, Hoplias malabaricus, Apistogramma borelli, Pyrrhulina melanostoma, Carnegiella strigata, Hyphessobrycon peruvianus*, and *Pimelodella peruana*.

Prior to the rain, this habitat differed from Habitat No. 1 chiefly in its higher hardness, alkalinity and iron readings, and lower oxygen and pH readings. This is quite understandable since the high organic material content of this water would naturally decrease pH because of organic acids, increase hardness and iron because of the additional materials leached out of the soil (the soil in this area of Peru is reddish, containing much iron) and decrease dissolved oxygen because of the oxydizable organic material carried in the water. The alkalinity rose as a consequence of both increased bicarbonate and organic matter. We may characterize this habitat as one, which is soft, acid, poorly oxygenated, and with a significant iron content. The two most pertinent measurements are oxygen and iron. In North America, it has been reported that 3.5 ppm of oxygen will kill all kinds of fish although in winter, a few have been reported to tolerate 1.0 to 2.0 ppm for short periods. Also in North America, it has been found that 95% of waters supporting a good fish fauna have less than 0.7 ppm of iron.

Except for the hatchet fishes and tetras, which were found just at the surface of the water

This is a typical habitat for *Rivulus peruanus* in the Amazon jungle. All photos by Albert J. Klee.

where oxygen was plentiful, the remainder of the fishes were in water generally considered unfit for fish with respect to dissolved oxygen. Granted, fishes such as Hoplosternum, Hoplias, Erythrinus, etc., are not great consumers of oxygen; nevertheless, we must review our ideas on oxygen requirements for fishes at least of these types. Contrary to what one might expect, the oxygen content decreased after the rain, decreasing in fact to an almost ridiculous level. I feared that my reagents had become contaminated but additional checks on Pachitea river water (which contains around 7 ppm oxygen) measured previously, showed this not to be the case. Furthermore, my oxygen analyses were reproducible to within 0.1 ppm (everything was run in duplicate except for this pool water which was run four times!). Although one might have expected the rain to oxygenate the water, the additional great quantities of oxydizable organic material (also indicated by the pH drop) absorbed almost all of the dissolved oxygen. Still, the fish survived, even at 0.5 ppm oxygen! Fewer surface characins were now caught but the bottom or middle strata fishes were still found, all in excellent condition. It was obvious that in addition to being low consumers of oxygen in the first place, these fishes were assisted in respiration by virtue of the swiftness of the current. There may not have been much oxygen in the water, but it was being replenished very fast. At the same time, waste products were being removed just as quickly. Some fish then, can successfully cope with low oxygen environments. This is probably why many fishes survive in overcrowded aquaria. Finally, one should remember that what holds for trout or bass need not necessarily hold for Hoplosternum or Apistogramma. The factor of acclimatization should also not be overlooked. It may be mentioned in passing that the rain caused dilution, decreasing the alkalinity due to decreased bicarbonate content of the water. The effect of the increase in organic material upon alkalinity is small in comparison to the bicarbonate effect. Thus, although opposing effects were present, the alkalinity decreased after the rain.

It is interesting to note that throughout tropical portions of Asia, Africa, and South America, iron is often present in natural waters. This is a consequence of the easy leaching of the surrounding soil. Since many of our “problem fishes” come from such waters, this may have a bearing on the breeding of some fishes.

HABITAT NUMBER THREE

This water sample was obtained from the Pachitea River in the vicinity of Tournavista.

Analysis

Date:	August 1964
Appearance:	Slightly turbid, some silt present
Temperature:	79°F
pH:	7.7
Hardness:	102 ppm
Alkalinity:	95 ppm
Chloride:	45 ppm
Iron:	0.5 ppm
Copper:	none
Oxygen:	6.7 ppm

Fishes caught or observed here included mostly very large specimens of *Chalceus elongatus, Pimelodus pictus, Hemicetopsis* *candiru, Leporinus trifasciatus*, and *Anostomus trimaculatus*. The water is more alkaline, harder and with more dissolved minerals than the smaller habitats already discussed. I could always identify river water from its chloride content alone. This river water was, as might be expected, well oxygenated.

HABITAT NUMBER FOUR

This water sample was obtained from a swampy, muddy area alongside the road leading from Tournavista to Pucallpa, some 25 miles from the former.

Analysis

Date:	August 1964
Bottom:	Mud
Appearance:	Very muddy
Temperature:	78°F
pH:	7.2
Hardness:	68 ppm
Alkalinity:	80 ppm
Chloride:	trace
Iron:	1.5 ppm
Copper:	none
Oxygen:	3.2 ppm

Fishes found here included *Hoplias malabaricus, Prochilodus nigricans, Geophagus jurupari, Aequidens dorsigerus*, and *Hyphessobrycon peruvianus*. Vegetation consisted of flooded grasses. The flow was almost nonexistent and there were a few water scorpions visible on the surface. A conductivity check showed the water sample to far exceed the range of my instrument (i.e., 600 micromhos). The muddiness (a good part organic in nature) of this water contributed to its high alkalinity and low oxygen content.

HABITAT NUMBER FIVE

This water sample was obtained from a tributary (of the Ucayali river) that forms over a third of the boundary of the town of Pucallpa.

Analysis

Date:	August 1964
Bottom:	Mud
Appearance:	Muddy, grayish in color
Temperature:	86°F
pH:	6.8
Hardness:	51 ppm
Alkalinity:	65 ppm
Chloride:	trace
Iron:	4.0 ppm
Copper:	none
Oxygen:	4.2 ppm
Conductivity:	350 micromhos

No vegetation was present. Fishes collected included *Brochis coeruleus, Hoplias malabaricus, Amblydoras hancocki, Gasteropelecus sternicla, Farlowella amazone, Loricaria ucavalensis, Apteronotus albifrons, Cichlasoma festivum, Geophagus jurupari, Otocinclus vestitus, Apistogrammoides pucallpaensis, Pseudostegophilus nemurus, Leporinus friderici, Trachycorystes coracoideus, Bunocephalus bicolor*, and *Hoplosternum thoracatum*.

The quantity and diversity of the fishes were remarkable. This water was decidedly warm, low in oxygen, and relatively high in iron and other dissolved materials.

HABITAT NUMBER SIX

This water sample was obtained from the Ucayali River, near the dock area of Pucallpa.

Analysis

Date:	August 1964
Bottom:	Mud
Appearance:	Muddy
Temperature:	84°F
pH:	7.6
Hardness:	102 ppm
Alkalinity:	90 ppm
Chloride:	30 ppm
Iron:	1.5 ppm
Copper:	none
Oxygen:	6.3 ppm

No vegetation was present and fishes captured included *Sorubim lima, Colomesus psittacus, Aphyocharax alburnus, Pimelodella peruana, Anodus latior, Hemicetopsis candiru, Pseudostegophilus nemurus, Vandellia plazai, Otocinclus macrospilus*, and *Hypostomus emarginatus*.

In short, this river differed from its tributary in that it contained (with the exception of iron) more dissolved materials, a greater oxygen concentration and was more alkaline.

DISCUSSION

The rivers investigated generally differed from the surrounding ancillary waters in the following ways:

	Ancillary Waters	**Rivers**
pH	higher	lower
iron	lower	higher
hardness	higher	lower
alkalinity	higher	lower
chloride	higher	lower
oxygen	higher	lower

The "higher" figures for the rivers mostly reflect the increased amounts of dissolved materials carried in them. The higher oxygen content is due to the swiftness of the main river currents, which are powerful indeed! Iron, on the other hand, is lower for the rivers since there is less leaching likely to occur.

The most significant observations about all of the water analyses may be summarized briefly as follows:

I. No real extremes of pH were encountered.

2. A wide range of temperatures (73 to 86° F!) was observed.

3. Iron content was significant, especially in the smaller bodies of water.

4. In general, in comparison with North American waters, all waters were soft and low in dissolved minerals.

5. In a number of habitats, the dissolved oxygen content was extremely low.

6. The most productive fish waters were extremely muddy. Very little aquatic vegetation was found.

The implications of these findings are fairly obvious. For one thing, it may be that the ability of a fish to adapt to aquarium conditions merely reflects the wide range in water quality of its natural habitat. Our fishes then, survive in spite of us! If one were to ask me how to duplicate the natural habitat of a fish, I would be severely tempted to answer, "Take a 10-gallon aquarium, fill it two-thirds with water, add a bucket of mud, stir, and then introduce your fish." It may not win any aquarium beautiful contests, but it is "natural" and typical! As for the lack of aquatic vegetation, the explanation is simple. Either the water was too muddy, or too shaded by terrestrial jungle plants to admit light needed for plant growth. The real locations for aquatic plants are in the swamps and marshes, not in rivers, pools, or streams.

One must be careful, of course, not to take this one report as representing every thing there is to the water conditions of South America. There are places in which fish live on that continent, with waters of pH ranging down to 5.0! River waters are not always muddy. Some are clear, others are blackish.

For my own part, I will remember better perhaps some of the smaller, more poignant things about these waters such as my friend Dick Stone baiting a hook with *Rivulus peruanus* to catch pimelodids in the Pachitea, or the time the Rio Pachitea literally boiled with fish seeking to escape some unseen (to us) enemy, or the way the size of the parasitic catfishes matched the size of the fishes with whom they were caught (big pygidiids were caught with the big Doras species, little pygidiids were caught with the much smaller Brochis). It is best summed up by the following (Alexander Pope's *Essay on Man*): **"All nature is but art, unknown to thee; All chance, direction, which thou canst not see ..."**

ACKNOWLEDGMENTS

The author would like to thank the LaMotte Chemical Products Company and Mr. William Kenny of their staff, for supplying the very accurate and sturdy equipment used during my expedition, and for their invaluable assistance on matters involving water analyses in general.

The Bivittatum Group – Part I

[Aquarium Journal, February 1965]

INTRODUCTION

The bivittatum group of killifishes has been defined by aquarists to contain the following species: *Aphyosemion bivittatum* (both subspecies, *A. bivittatum* and *A. bivittatum hollyi), A. bitaeniatum, A. loennbergii, A. splendopleuris* and *A. multicolor.* Perhaps the unifying characteristic of these fishes is the presence of two, black longitudinal lines on the body of the females. Indeed, even an expert killifish fancier cannot distinguish the females of these forms from one another readily, if at all. The question arises then, "Are these distinct and valid species?" It is to this question that the following discussion is devoted.

A HISTORY OF THE BIVITTATUM GROUP

Aphyosemion bivittatum was described by Lönnberg in 1895 and Boulenger's *Catalogue of the Freshwater Fishes of Africa* lists a distribution of this fish from Old Calabar in Nigeria, down through Douala and the Kribi River in the Camerouns. Thus, it has a very wide distribution. This fish, which we will refer to as *Aphyosemion bivittatum bivittatum,* was imported into Germany as an aquarium fish in 1908 with a second, larger importation being made in 1929. The second member of the group is *A. loennbergii,* described by Boulenger in 1903. This is a southern Cameroun form, also from the vicinity of the Kribi River and consequently, *loennbergii* overlaps in this area with *bivittaum bivittatum* (see Figure 1). It was imported at the same time (1908) and by the same firm with *bivittatum bivittatum,* and at that time was readily distinguishable from the other. The next importation into Germany was made in 1928. In 1924, Ahl described A. *bitaeniatum* although it was not imported as an aquarium fish until 1934. However, it never did become a really established aquarium fish even then. It was described as coming from the Niger (where it, also, overlapped with *bivittatum bivittatum).*

The year 1930 proved to be a busy year for the description of members of the bivittatum group. *Aphyosemion multicolor* and *A. splendopleuris* were described at the same time by Hermann Meinken, the former as originating from Lagos in Western Nigeria, and the latter from Tiko in the northern Cameroun area. Thus, *multicolor* extended the range of the group farther west, while *splendopleuris* overlapped the range of *bivittatum bivittatum.* Both fishes were imported in the previous year (1929) as aquarium fishes but Arnold and Ahl claim that *multicolor* was imported as far back as 1912, also. This I find hard to believe. Later in 1930, Meinken de scribed *"Aphyosemion*

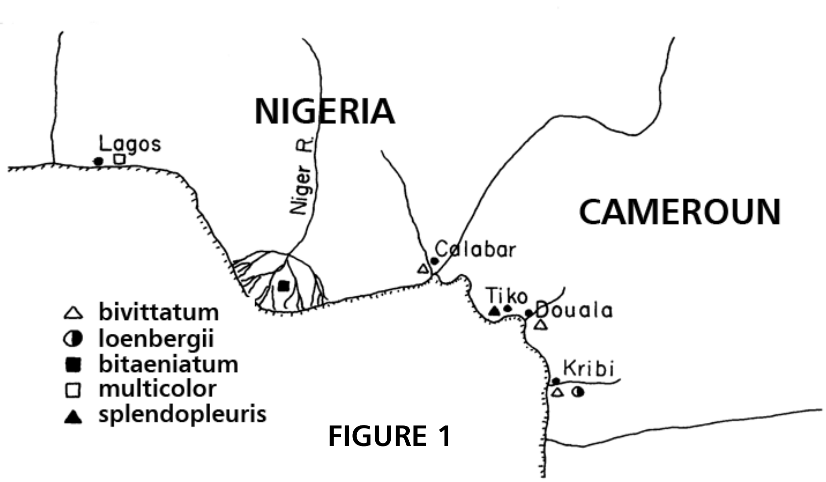


FIGURE 1

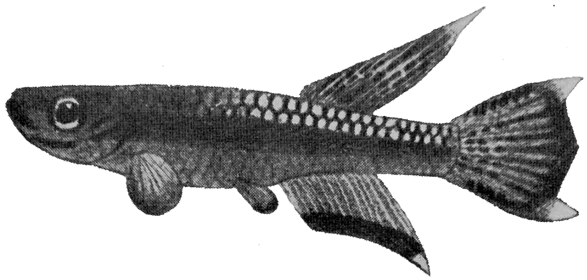


FIGURE 2: *Aphyosemion loenbergii*

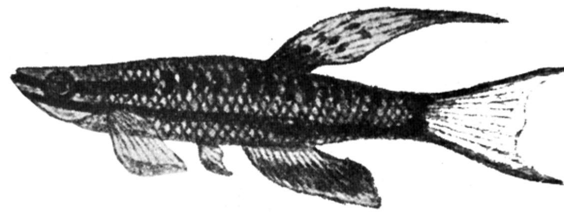


FIGURE 3: *Aphyosemion bitaeniatum.*

bivittatum variety *coerulea,"* but because *coerulea* was preempted (preoccupied) by *Aphyosemion coeruleum,* Dr. George S. Myers renamed the fish as *A. bivittatum hollyi* in 1933. It was imported in 1929 from West Africa but its exact locality was (and remains) unknown. Unlike *multicolor* and *splendopleuris, bivittatum hollyi* became quite rare and disappeared from the aquarium scene.

SOME DESCRIPTIONS

When *A. loennbergii* was imported, aquarists had no difficulty in distinguishing it from *bivittatum bivittatum.* The former had such a brilliant sheen to its body that it was called the "Glanzfundulus" (= "glazed *Fundulus"*). Although both fishes had each scale edged in red, there was an underlying color of green-to-blue on *loennbergii* (this was yellowish-brown to reddish-brown in *bivittatum bivittatum).* The crisp, blackish longitudinal lines were absent in the males of *loennbergii* (there was a suggestion of these lines but they were formed by different patterns of iridiocytes rather than melanophores (as in *bivittatum bivittatum)* but the dorsal, anal and caudal (both lobes) were tipped in a lemon or sulphur color (see Figure 2). However, *bivittatum bivittatum* did have the longitudinal lines, and its unpaired fins were considerably more elongated.

Next on the scene was A. *bitaeniatum.* Although this fish was very similar to *bivittatum*

TABLE I
COUNTS AND MEASUREMENTS ON BIVITTATUM FORMS

Form	Length, mm	Dorsal rays	Anal rays	Lateral scales	Depth in length
bitaeniatum	60	9-10	12	27-28	4-1/2 to 5
bivittatum bivittatum	65	11-13	13-14	26-29	3-2/3 to 4-1/3
bivittatum hollyi	55	12	14	28-29	4 to 4-3/4
loennbergii	50	11-12	12-13	26-28	4 to 4-1/2
multicolor	60	10	13	26	4 to 4-1/2
splendopleuris	55	11	13	26-27	4 to 4-1/2

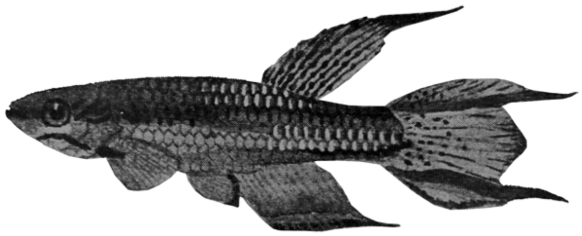


FIGURE 4: *Aphyosemion multicolor.*

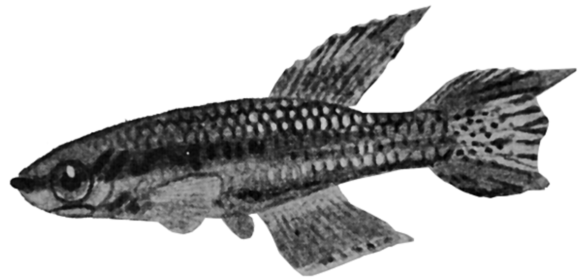


FIGURE 5: *Aphyosemion splendopleuris.*

bivittatum, it was distinguished by its more slender body shape, a brownish-green body (sides) and a very elongated dorsal fin, more so than in *bivitttatum bivittatum* (see Figure 3). Furthermore, although the lower longitudinal line was present, the upper one broke into short vertical slashes not too far after the pectoral fins. In truth, A. *bitaeniatum* was much closer to the *"bivittatum"* of today than the *bivittatum bivittatum* of early German aquarium history.

Chronologically, *multicolor* and *splendopleuris* (see Figures 4 and 5) were imported next and were immediately recognized as being very close to *bitaeniatum* and *loennbergii. Aphyosemion multicolor* was easily differentiated from all the others in that the fish showed all the colors of the spectrum, hence the name. The longitudinal stripes, although present, were not intense and depended upon the light source to a great extent. Furthermore, there was a good deal of yellow or yellow-orange in the anal and tailfins. *A. splendopleuris,* on the other hand, was really a yellowish fish both in body and in finnage. Unlike *bivittatum bivittatum,* its fins were relatively short and it did not have much in the way of red-edged scales on its body (these were mostly found along the upper longitudinal line). The longitudinal lines were stronger than in multicolor. Furthermore, the tip of the dorsal fin was yellow, resembling that of A. *loennbergii.*

TABLE II

COMPARISON OF BIVITTATUM-SPLENDOPLEURIS FORMS (after Bozkurt)

Item	bivittatum male	F1 male	splendopleuris male
1. Body color	chocolate brown	brownish-olive	olive
2. Ventrum	brownish	orange	yellow
3. Tip of dorsal and caudal	red; lobes on tail same length	yellow; upper lobe longer than lower	yellow; upper lobe longer than lower
4. Middle of dorsal	dark red: black dots	orange-red; black dots	yellow-red
5. Pectorals	colorless; blue-edged	greenish-yellow	yellow
6. Ventrals and anal	light yellow; faint border	yellow; bordeaux-red bordered	bordeaux-red border
7. Tail fin border	outer margin	outer margin	outer margin
	bordeaux-red, inner margin red	inner orange	bordeaux-red, inner yellow

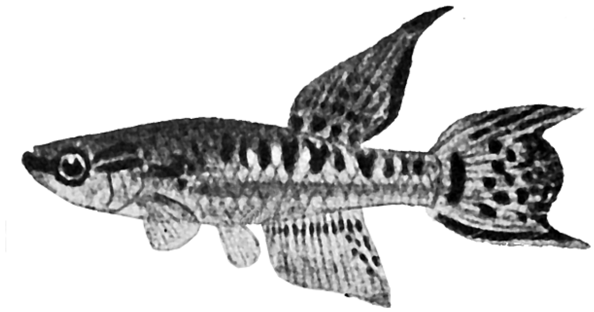


FIGURE 6: ***Aphyosemion bivittatum hollyi.***

Finally, A. *bivittatum hollyi* made its appearance (see Figure 6). This was immediately distinguished by its bluish sides (greenish-blue to dark-blue). Also, the upper longitudinal line tended to break up into short, vertical strokes as in *bitaeniatum.* Its dorsal fin was elongated as in *bivittatum bivittatum.* It more closely resembled present-day *"bivittatum"* in body coloration than does the original importation. I have been calling *bivittatum bivittatum.* However, it must be remembered that *bivittatum hollyi* also possessed a bluish anal and tail fin, a coloration not present in the ordinary, aquarium forms of *bivittatum* seen today. It is important to stress that the mere presence of a bluish body does not fulfill the requirements for a *hollyi* form. If one were to sum up briefly, the important features of these forms, they would appear as follows:

A. bitaeniatum - slender body, elongated dorsal fin, upper longitudinal stripe broken into slashes
A. bivittatum bivittatum - basically reddish-brown on its sides
A. bivittatum hollyi - bluish in body and fins
A. loennbergii - gleaming green with yellow-tipped fins
A. multicolor - colors of the spectrum with much yellow in tail and anal fins
A. splendopleuris - yellowish in body and fins.

Finally, to complete this section we should present certain key technical measurements of all of these forms, if only to show how difficult it is to distinguish among them by these criteria alone. For this purpose I present Table I.

One cannot leave this discussion of the description of *bivittatum* forms without referring to Fowler's discovery of the variability of pattern in *bivittatum bivittatum* that were collected in the vicinity of Kribe in the Camerouns. His sketches are shown in Figure 7 (these are all male specimens but the caudal extensions were knocked off in transit). These alone suggest the tremendous variability of even one local wild population!

PREVIOUS GENETIC RESEARCH

In the year 1930, the first cross within the group was made, i.e., A. *loennbergii* x A. *multicolor* (we follow the usual procedure of listing the male first, female second, in all crosses noted by an "x" separating them … if a "-" is used, this signifies the cross both ways). No difficulty was encountered in producing the F_3 hybrid. Unfortunately, the information was never published and consequently, details are lacking. The work of Bozkurt in 1945 is quite detailed, however. Bozkurt had no difficulty in obtaining fully fertile hybrids from *splendopleuris - loennbergii* crosses. These hybrids stood in-between the parent forms morphologically. Under no circumstances, however, was it found possible to produce *a bivittatum-loennbergii* hybrid.

Bozkurt did produce *bivittatum-splendopleuris* hybrids. The F_3 generation males fell right in between *bivittatum* and *splendopleuris* males, appearance-wise (see Table II). However, the F_3 generation proved sterile. A male was available of ancestry *multicolor* mother and *splendopleuris* father. This male hybridized readily with *a bivittatum* female but again, the F_3 were sterile. Furthermore, the hybrids never attained the finnage and coloration of the straight *splendopleuris-bivittatum* cross.

The Bivittatum Group – Part II

[Aquarium Journal, March 1965]

CURRENT GENETICAL RESEARCH

John Gonzales, of Philadelphia, has extended Bozhurt's work by experimenting with *bivittatum - multicolor* crosses. No difficulty was encountered in either *bivittatum x multicolor* or *multicolor x bivittatum* hybridization (see Figures 8 and 9. Although the F3 generations were fertile, it was difficult to raise any of the F2 generation (only a few fry were produced). A number of interesting observations were made, however. As a generalization, *bivittatum* boasts extended finnage while *multicolor* boasts the lighter (yellow and yellow-orange) coloration and the more iridescent sheen. By themselves, these fishes are pretty but when hybridized they are simply fabulous. The finest show guppy in the word would look drab next to this cross. They would surpass the guppy in the following areas:

a. Finnage - It would be "no contest."
b. Spectrum of color - as an example, the multicolor x bivittatum cross is as follows: Dorsum brilliant orange mixed with red; reddish sides and yellow ventrum; crimson and green markings about gills; anal yellow, orange-green and dark red successive bands; dorsal orange and green successive bands; tail lemon-yellow, orange lobes, lower lobe margined in dark red; pectorals greenish; ventrals bright orange, tipped in green; dark-red or reddish-brown spots on al-most all fins.
c. Glaze or brilliance - all of these colors are influenced by an iridescent sheen not present in the guppy.

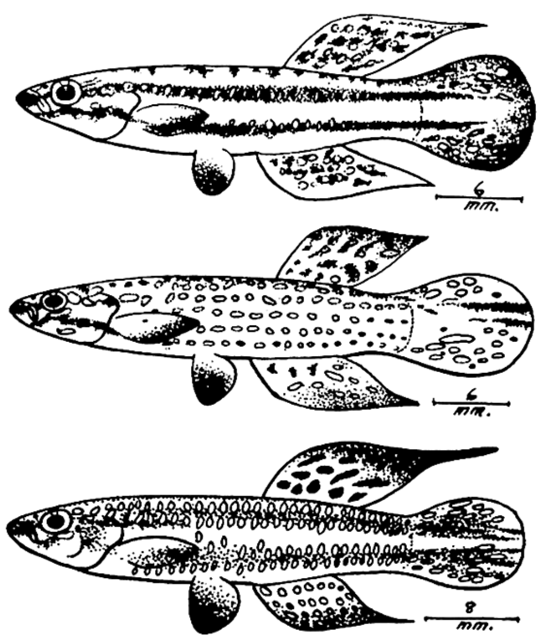


FIGURE 7: Variation in natural populations of *Aphyosemion bivittatum* (after Fowler).

The contrast between the hybrids and the parent forms is brought out by comparing Figure 8 with the ordinary aquarium *bivittatum* of Figure 9.

Another interesting note is that in the F3 generation, the opposite sex from the *bivittatum* used in the cross is huge. For example, if the cross was *multicolor x bivittatum,* the male F3 was exceedingly large. Furthermore, the color of the hybrid tended to follow the male parent. These observations suggest that the gene for color is linked to the Y-chromosome, while the gene for size is linked to the X-chromosome. However, because of the well-known "hybrid vigor" effect, these are but surmises.

ELECTROPHORESIS

In 1961-62, the American Killifish Association pioneered in the development of electrophoretic techniques for use in the identification of aquarium fishes. Since then, these techniques have been used by Col. J. J. Scheel in his study of African killifishes. I quote from KILLIE NOTES, an AKA publication:

"Electrophoresis is a technique whereby high voltages are applied to, for example, a strip of filter paper containing some usually highly complicated organic extracts such as muscle protein. As a consequence of the high voltages, the different components of the extract migrate at different velocities, producing a se-

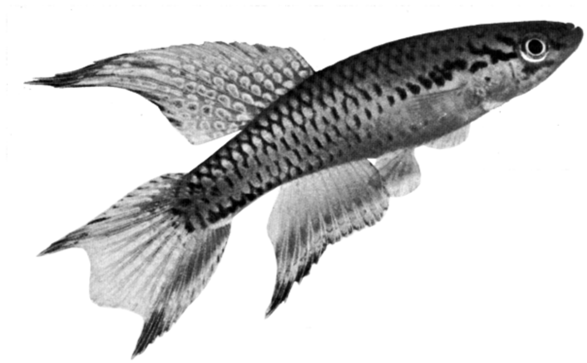


FIGURE 8:
Aphyosemion bivittatum x multicolor
cross by John Gonzales. Photograph by Albert J. Klee.

ries of bands. These bands are then brought out strikingly when stained with a dye specific only to protein. Evidence has been presented to suggest that such bands from groups of muscle proteins may `fingerprint' the species in question."

Through the kindness of Dr. Richard Hewitt of the Carnegie Institution, Dick Lugenbeel of Washington, D.C., was able to obtain electrophoretic analyses of *Aphyosemion multicolor, a bivittatum* strain used in the crosses mentioned (No. 1), a *bivittatum* strain not used in these crosses (No. 2), *bivittatum x multicolor, multicolor x bivittatum, A. australe* and *Aplocheilus lineatus* (the last two for another species identification study). Furthermore, analy-

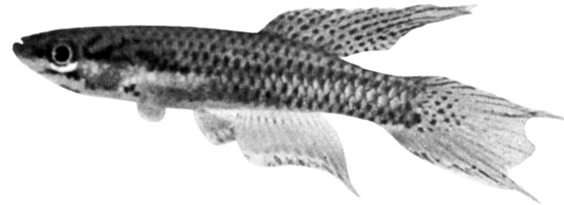


FIGURE 9:
***Aphyosemion bivittatum* . Photograph by Albert J. Klee.**

ses were done first using a protein stain and then using an aromatic esterase to bring out the bands (see Figures 10 11 12 and 13). The four species are nicely "fingerprinted" by the method and the conclusions are as follows:

(a) *Aplocheilus lineatus* differs markedly from the others (as was expected) in both strains.

(b) *A. multicolor* is very nicely separated from *A. bivittatum* in aromatic esterase stain. They are also separable in protein stain but to a less dramatic extent.

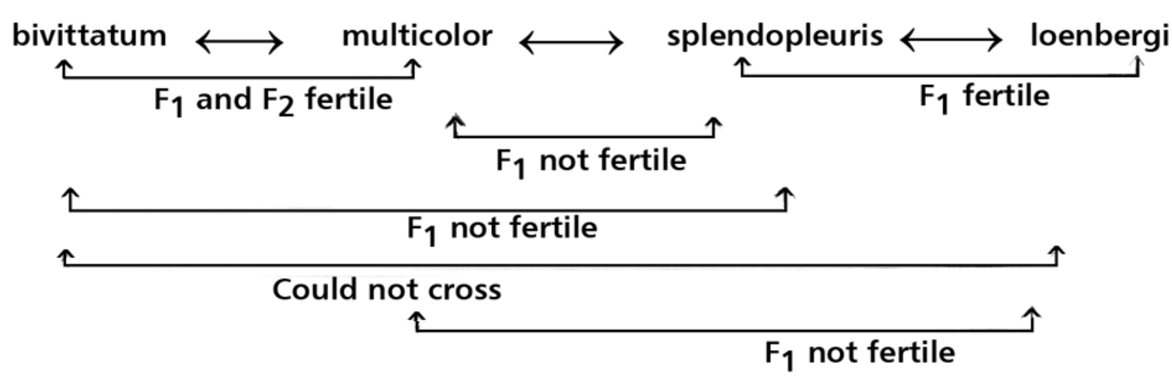
(c) *A. australe* is distinguished easily from *bivittatum* and *multicolor* in both stains, via distance from one band to the next, band intensities, and number of bands.

(d) There are no significant differences between *bivittatum x multicolor* and *multicolor x bivittatum* in either stain.

(e) Sex differences as well as strain differences (the latter referring to *bivittatum*) are picked

FIGURE 14

Hybridization Summary



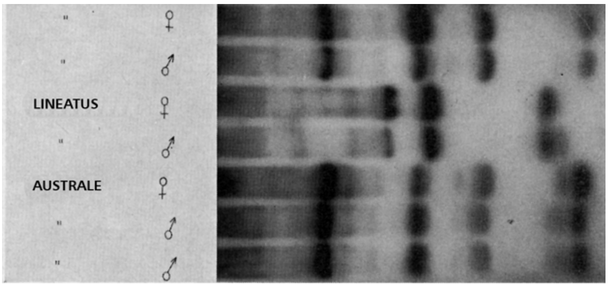


FIGURE 10

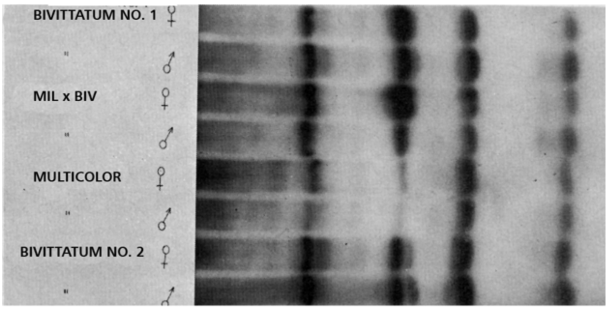


FIGURE 11

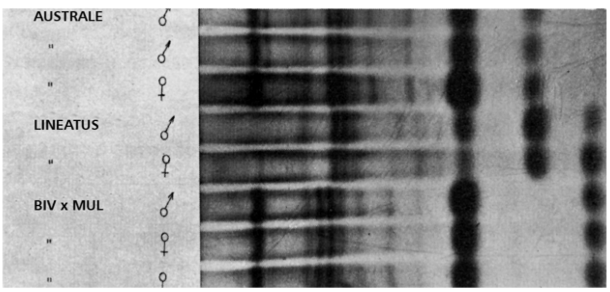


FIGURE 12

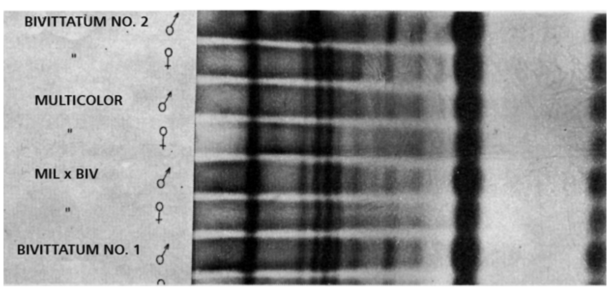


FIGURE 13

Figures 10 & 11: Electrophoretic traces in esterase stain.
FIGURES 12 & 13: Electrophoretic traces in protein stain.
Photos by Dr. R. Hewitt.

up by this technique and they are about the same order of magnitude. Neither, however, is of the order of magnitude of the species differences.

(f) The hybrids have intermediate characteristics in protein stain but are more like *bivittatum* in esterase stain.
(g) Replications using different specimens were done on male australe and female *bivittatum x multicolor*. The agreement among replications was excellent, proving the power of the method as far as precision is concerned.

DISCUSSION

The results of these experiments and those of the other investigators mentioned are summarized in Figure 14.

In zoology, a "circle of races" (sometimes referred to as a "Rassenkreis," although this is not accepted by all scientists) is a genetical species with a series of intergrading but distinguishable local populations, occasionally so different that two terminal populations cannot interbreed directly even though still exchanging genes through intermediate populations. We appear (see Figure 14) to be quite close to this state of affairs with our *bivittatum* group fishes. Although I have used the term *"bivittatum"* for common aquarium *bivittatum* stock, there is little doubt that this is not the *bivittatum* of the early days of our hobby. It is rather a form quite close to *multicolor* genetically. The concept of subspecies nowadays is intimately linked with ideas of geographical distribution about which we unfortunately know the least regarding members of the group. This then, even precludes solving our problem by the simple expedient of treating all forms as subspecies with rather definite names such as *Aphyosemion bivittatum loennbergii.*

Nor is there one iota of doubt that there are genetical differences among these forms. Furthermore, aquarists do have means for distinguishing one form from another, provided that they have not been careless in mixing the females. In view of the very questionable geo graphical information that we have, I believe that it serves no useful purpose at this time to revert to subspecific terminology. However, I realize that the *bivittatum* group represents an extremely closely-knit complex of species or near-species, and that in this instance, the classical definition of species leaves much to be desired.

REFERENCES

Bozkurt, B., "Cyprinodontilerde Aphyosemion genesundan elde edilen tur melezlerinin kisirligi hakkinden," ISTANBUL UNIVERSITESI FEN FALCULTESI MACMUASI. SERI B, CILT X, pp. 143-163. 1945.

Fowler, H. W., "Zoological results of the George Vanderbilt African Expedition of 1934: Part III, The freshwater fishes," PROC. PHIL. ACAD. NAT. SOL.. Vol. LXXXVIII, pp. 318-320 1936.

Klee, Albert J., " The Christyi-Cognatum Problem revisited," AKA KILLIE NOTES. Vol. II, No. 1, pp. 8-12 1963.

Villwock, W., "Eierlegende Zahnkarpfen," Kleine DATZ BUCHER Nr. 10, Stuttgart 1960.

ACKNOWLEDGMENTS

My appreciation is hereby extended to John Gonzales of Philadelphia, Pa., who undertook the painstaking breeding experiments described; Richard Lugenbeel, of Washington, D. C. who arranged for the electrophoretic work; and to Dr. Richard Hewitt of the Carnegie Institution of Washington, who did the actual electrophoretic analyses.

Snails vs. Beef Heart

[Aquarium Journal, June 1965. Note: This article was co-authored with Clarence Knepper, AJK being the Senior Author.]

One of the things that has always fascinated us is the stress placed by certain ecologists upon the fact that snail-feeding animals are bigger than related species. To verify this experimentally, two Rumanian zoologists fed tadpoles for 20 days with minced snail food. The control tadpoles of the same generation were kept under identical conditions but fed meat. After 20 days, the snail-fed tadpoles were 60% larger than the controls. Indeed, some of them were "giants" in comparison. Examination of their pituitary glands showed that the snail-fed tadpoles had a greater number of "blue" '(basophile) cells, which denotes a greater activity, than did the meat-fed controls. Apparently the snail food has some component, which excites the pituitary, provoking accelerated growth.

The question occurred to us, does the effect of snail-feeding carry over to fishes? To help answer this question, we selected a number of bettas *(Betta splendens)* of age 8 weeks, matched them in size as best we could by eye, and divided them into two groups. Our prior probability then, that the average weights of the two groups were not significantly different exceeded 50% (had the fish been selected at random, this prior probability would have exactly equaled 50%). Each group was housed in a 3-gallon, bare-bottomed tank equipped with an inside filter.

The fish were fed once a day for 5 weeks. One group was fed unshelled, minced red ramshorn snails *(Planorbis corneus),* the other minced beef heart. Due to the quantity of minced snail required, it was necessary to raise a quantity of them prior to the experiment. The total amount of food added to each tank was approximately the same. Both groups consumed their respective diets greedily and their bellies all bulged after each feeding. No food was uneaten.
After 5 weeks, the fish were killed in rubbing alcohol. The fish remained in the alcohol for one day. Then, each fish was removed, the alcohol allowed to evaporate to surface dryness (this took but a minute or two), and the fish weighed on an accurate chemical balance. The results are shown in Table I.

The beef heart group exceeded the snail group in weight by about 77%. A statistical test shows the difference between the averages to be highly significant, i.e., the probability that they are not different is less than 0.05%. Even prior to weighing, it was quite obvious to the eye that the fish in the snail group were considerably smaller. The difference was quite marked.

We conclude, therefore, that as far as *Betta splendens is* concerned, beef heart is far superior to snails as a constant diet, and the ecological "law" as previously discussed is not valid in this instance.

TABLE I	
WEIGHTS OBTAINED (in grams)	
Beef Heart Group	Snail Group
0.3910	0.1907
0.2488	0.1006
0.3273	0.3649
0.4044	0.1969
0.3267	0.1296
0.3190	0.2042
0.2773	0.1731
0.4399	0.1608
0.2823	0.1814
0.2305	0.1362
average = 0.3247	average = 0.1838

The *Corydoras* Myth

[Aquarium Journal, September 1965. Note: This article was co-authored with Clarence Knepper, AJK being the Senior Author.]

Admittedly, some myths die hard … and so it goes with a number of aquarium myths. The longer they go unchallenged, the more they take on the stance of aquarium "laws" to be copied dutifully from one author to the next, perhaps with embellishments along the way. The "Corydoras Myth" is a case in point. A number of years ago, so many that the authors frankly were still in their swaddling clothes, some purported "experiments" were made to determine how much salt treatment different species could stand, and it was observed that the *Corydoras* died first. We place "experiment" in quotations simply because the authors feel rather strongly that, with few exceptions, the word has been prostituted again and again in the hobby. Be that as it may, the myth has been carried down to the present.

In an excellent article in the Australian aquarium magazine, FIN CHAT ("Catfish can't stand salt?"), Fred Parkes, its erudite editor remarks:

"It is surprising how many statements we read and assume are correct. This is partly due to not having the time or resources to check them all, and to a feeling that if you can't believe the experts who can you believe? The fact is that in such an unscientific subject as tropical fish keeping where proper scientific experimentation and controls are practically impossible, even the experts have much to learn, and the field is so vast that we read statements from one expert and assume that, because he is a recognized authority, he must be right. In this manner erroneous theories are accelerated with every new book that is written."

We heartily agree with Mr. Parkes.

Some of his observations are quite pertinent here. At one time he noticed that a tank of pearl gouramies had, as he put it, "developed mysterious shimmies." He then dosed them with salt to a fairly dangerous strength but the fish began to die, one by one. Puzzled, he brought this to the attention of his assistant (Mr. Parkes owns an aquarium shop in Australia). It turned out that the assistant had also dosed the tank with salt. To quote Fred again, "With that I tasted the water and it tasted strongly saline; in fact I have never tasted such salty water containing freshwater fish." The point is, however, that 8 half-grown *Corydoras aeneus* in the tank were still swimming around, active and healthy! Afterwards, he kept every species of *Corydoras* he could lay his hands on in tanks with brackish water fishes with salt added to the extent of one ounce of salt per gallon. After months, everything was well. In fact, *Corydoras arcuatus* lived wonderfully in his tank of scats!

Now it is not claimed that salt will not kill fish. There is practically nothing that we can add to tank water that will not kill fish at some critical concentration. Ellis, in his *Water Quality Criteria* (SWPCB PUBLICATION No. 3, pgs. 209-210, State of California), supplies the information that among U.S. waters supporting a good fish fauna, ordinarily the concentration of chlorides is below 3 ppm in 5%, below 9 ppm in 50%; and below 170 ppm in 95% of such waters. He reports that the following concentrations of chloride have been found to be harmful to fish:

ppm	Type of fish	Reference
400	"trout"	Adams, 1940
2000	"some fish"	Brenecke, 1945
4000	"bass, pike, perch"	Adams, 1940

Marine water typically contains 30,000 ppm chloride; brackish water 2800 ppm and tap water 50 ppm. Roughly speaking, each level teaspoon of salt per gallon increases the chloride content of an aquarium by 1000 ppm. Emmons ("Measuring and Adjusting the Quality of Aquarium Water," AQUALIFE, pg. 3, June 1956) has stated: **"Aquarium water often builds up a salt content of 500 ppm or more, particularly when salt is purposely added. Beyond 1000 ppm plants are likely to suffer ... some do not like more than 300 or 400 ppm."**

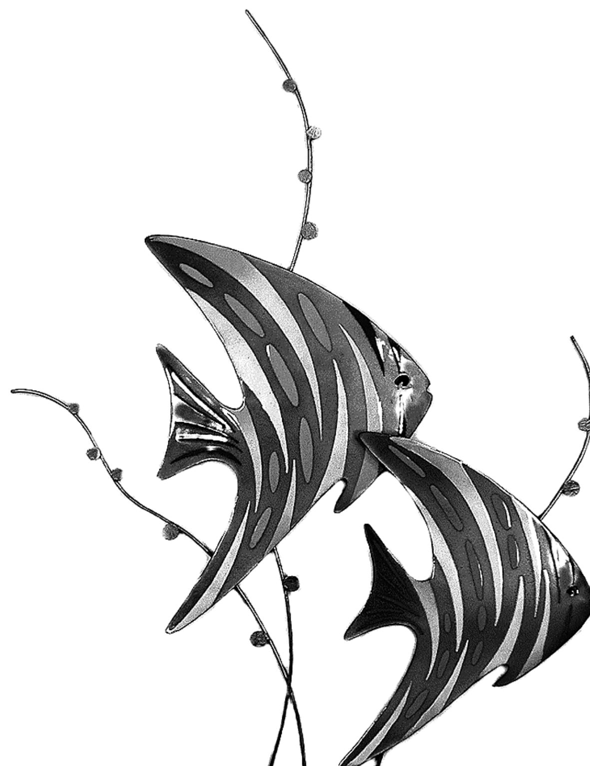
By way of our own contribution, the authors conducted the following designed experiments. Three, 3-gallon aquariums, each containing 10 *Corydoras aeneus* were set up. The thirty catfish involved were 2 months old, all from the same brood. The tanks were bare-bottomed, equipped only with inside filters. Feeding consisted of dry shrimp pellets, brine shrimp, and shredded beef heart. Care was taken to insure that no food was uneaten and that each tank received the same amount of food daily. Tank No. 1 was the control tank … it received no salt other than the amount originally present in the water, and that added through feeding. Chloride, hardness, and pH measurements were made using LaMotte Chemical Company equipment (the first two tests were via titration, the last-named via color comparison). Tank No. 2 was brought up to a chloride concentration of 2400 ppm over a 4-day period (using regular, non-iodized salt); Tank No. 3 was brought up to a chloride concentration of 3600 ppm over a 14-day period. One month after initial salt addition, all thirty fish were in excellent condition. All were eating well and the size distribution of these young catfish appeared random, with no correlation with the amount of salt present in the tank. The water analyses after 30 days produced the following data:

	Chloride, ppm	Hardness, ppm	pH
Tank No. I (control)	330	140	6.4
Tank No. II	2400	155	7.2
Tank No. III	3600	160	7.6

The increase in hardness and pH of salt tanks II and III over the control tank is attributed to the small amounts of hard, alkaline salts present in ordinary table salt to prevent "bridging" in damp weather. The relatively high chloride concentration is attributed to the feeding of brine shrimp pellets and brine shrimp. The tanks used were small, and the natural increase of chloride content observed due to feeding probably cannot be taken as typical for the ordinary aquarium.

Finally, desiring to observe what happens when the chloride addition is sudden, a strong salt solution was dumped into the control tank, to bring it up to a concentration of chloride of 3600 ppm, i.e., that of Tank No. III. No extraordinary immediate response was noted and. after two weeks, the catfish were active and in excellent health! All experiments were terminated when it became clear that salt or no salt, our 30 experimental animals appeared capable of living out their ordinary life spans.

Undoubtedly, it is possible to kill *Corydoras* with salt. But then it is even possible to kill scats. What we have demonstrated is that the danger to *Corydoras* from the use of salt in reasonable and normal disease-treatment amounts is virtually non-existent in waters of normal aquarium quality. The effect of chloride on fish is osmotic in nature for there is no convincing evidence that chloride ions have any specific toxicity ("Aquatic Life Water Quality Criteria," SECOND PROGRESS REPORT, SEWAGE AND INDUSTRIAL WASTES, Vol. 28, No. 5, pp. 684-685, May 1956). It is clear that the osmotic resistance of *Corydoras* is far greater than formerly believed. This discussion should properly lay to rest one of our oldest aquarium myths. Certainly apropos is a quotation from Robert Herrick's "Seek and Find":
**"Attempt the end, and never stand to doubt;
Nothing's so hard but search will find it out."**



The Graceful Cats

[All-Pets Magazine, May, 1956]

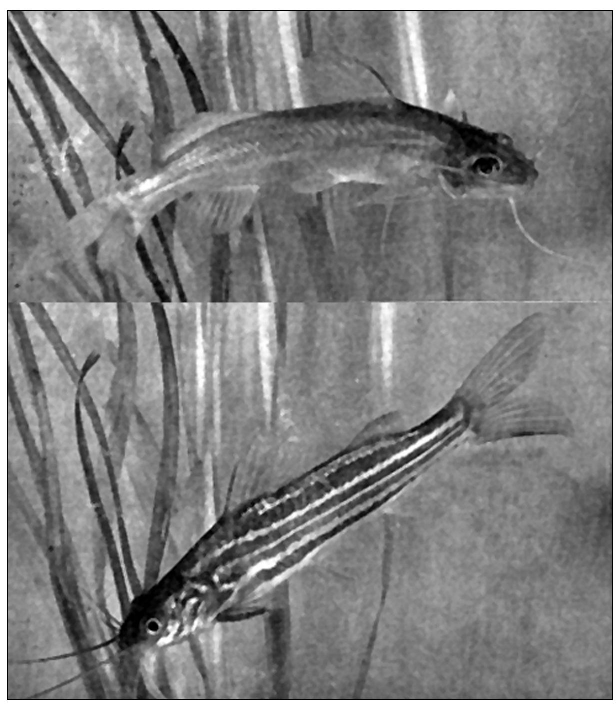
It would not be difficult to show that the vast majority of our aquarium catfishes are oddities in one way or another, perhaps most strikingly in shape or form. By way of contrast, fishes of genera *Pimelodella* and *Sperata* possess a streamlined, graceful form coupled with a liveliness that would do credit to our swiftest tetras.

There are black and white fishes with extravagantly long barbels. Superficially, the two types appear quite similar but differences do exist. Both groups are quite devoid of scales but pimelodellas do not have the rough, granulated skin about the head that characterizes the genus *Sperata*. Another external difference is reflected in the eight barbels of *Sperata* species as against only six in *Pimelodella* species. Other differences are mostly internal and minor.

The first importation of pimelodellas was made to Germany in 1895. They are found only in South America and their range includes the basin of the Orinoco, the Amazon, and La Plata rivers. The genus is a large one; however, aquarists seldom see but one species, *P. gracilis*. This fish, which does not exceed six inches, is of a light tan, almost a pale-yellow color with thin black edging on the fins. Occasionally, specimens of *P. lateristriga* and *P. chagresi* appear in shipments.

In 1903, two species of Sperata were exported to Germany from North India and the Punjab. Subsequently, these fish were also found in Burma and Siam. In general, they are silvery fishes with well-defined horizontal black lines and black fin edging. The two species, *S. tengara* and *S. vittata*, are identical with the exception of a proportionally larger mouth in *S. tengara.*

Keeping the graceful cats is no problem as they are extremely hardy and make excellent scavengers. Seemingly nocturnal fish at first, they soon adjust to daytime life and compete actively with other fish in foraging for food. Due to their size, these fishes are best kept with larger fishes like cichlids. They are quite capable of swallowing earthworms whole and will readily take canned shrimp and horsemeat. The author once lost over 1500 three-week-old *Aequidens portalegrensis* overnight as a result of removing the cichlid parents and overlooking the presence of a six-inch *P. gracilis.* Most incidents like this can be



UPPER: ***Pimelodella gracilis*.**
LOWER: ***Sperata vittata***

avoided by following the simple rule of placing large' fish with large fish and small fish with small fish.

None of the graceful cats have been bred to date. There have been reports that, in nature, *Pimelodella gracilis* lays adhesive eggs upon plants. This action is catalyzed by the advent of the rainy season, as is the breeding of many of our aquarium fishes in nature. Until breeding can be accomplished in the aquarium, aquarists will have to depend upon importations for a supply of these fishes.

There is a possibility of risk in handling pimelodellas improperly. Like our own native "Mad Toms," they are capable of inflicting a severe, irritating wound with their fin spines. The renowned American ichthyologist, Dr. Samuel F. Hildebrand, was once stung by a specimen of *P. chagresi* in Panama. He felt excruciating pain for over half an hour after the incident. The probability of such an occurrence with *P. gracilis* is small but this is no reason to neglect common sense precautions.

As efficient scavengers for aquariums housing the larger aquarium fishes and as interesting tank occupants in their own right, the graceful cats provide a welcome change from the usual.

Knife Fishes - Part I

[All-Pets Magazine, August, 1956]

If I were to attempt to define a "knife fish" I would be doomed to certain difficulties from the start, as the term is not a scientific one but rather an aquarist's impression of these strange creatures. As a result, popular use has applied the name to two totally unrelated groups of fishes in different scientific orders and coming from different continents.

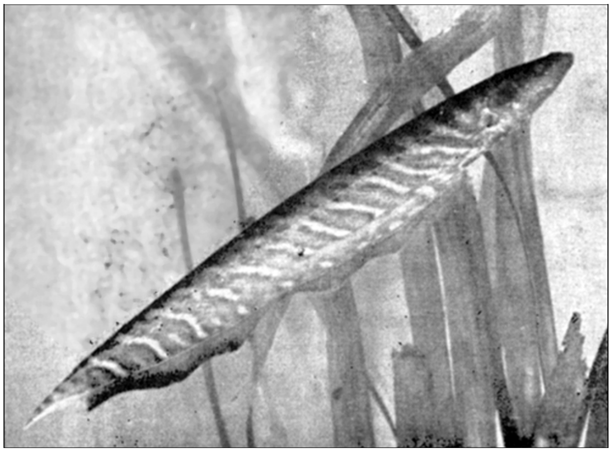
To the casual observer, the knife fishes have in common a long tapering body propelled by the motion of a very long anal fin. They are capable of darting forward or backward at great speeds. Even while moving backwards they can pass through small holes without touching their sides.

But even though you may find the knife fishes unusual as to their shape and manner of swimming, they are even more peculiar scientifically. Recent tests have indicated that all of the South American knife fishes may be electric fishes. There is a knife fish with a strange worm-like organ under its chin, to date mystifying researchers. And to add to an already strange picture, the South American knife fishes have their vents in their throats!

The African knife fishes present fewer scientific surprises. The small number of species brought to us from Africa are all members of the order Isosprondyloidei and represent but two genera. These fishes have the vent in the normal position and have a very compressed appearance. They are at home in either fresh or brackish waters and in their native waters they prefer side streams and pools to the main streams. Some of them even flock together in underwater caves. All are predatory creatures in nature and in the aquarium you can feed them earthworms, small fishes, meat and canned shrimp. Unlike many of their South American counterparts, they are comparatively peaceful with fishes they cannot swallow. I have noted many of them living in harmony with mollies, barbs and other medium-to-large sized tropicals. I find, also, that being shy, all of them prefer well-planted tanks and are most active at night.

The following key may help you in identifying the two genera of African knife fishes:

(1) Dorsal fin present; habitat Africa, East Indies,
Malay Peninsula and India, (*Notopterus*).
(2) No dorsal fin; habitat restricted to Africa, (*Xenomystus*).



A South American knife fish, Gymnotus carapo.

Among the aquarium specimens that have reached our country are *Notopterus afar*, a gray-black fish with a fairly distinct marbled pattern and growing to a length of two feet; *Notopterus notopterus* which grows to more than a foot, and *Notopterus chitala*. The lone representative of *Xenomystus* is *Xenomystus nigri*, a deeper bodied fish than the others that attains a length of eight inches. This fish is native to the Liberia, Niger, Gabon, and Congo rivers. The first *Notopterus* was imported into Germany in 1912 and the first *Xenomystus* in 1902. As you can see, these fishes have been known to the aquarium world for quite some time. However, *Xenomystus* is by far the more common.

It is the South American knife fishes that give us the bulk of our aquarium specimens. They are members of the order Ostariophysoidei, an order characterized by having the swim bladder connected to the inner ear. In the order to which the African knife fishes belong, the swim bladder is connected to the gullet. Aside from these internal differences, both groups present similar external shapes.

The following is the key to the subfamilies of the family Gymnotidae, representing all of the South American knife fishes:

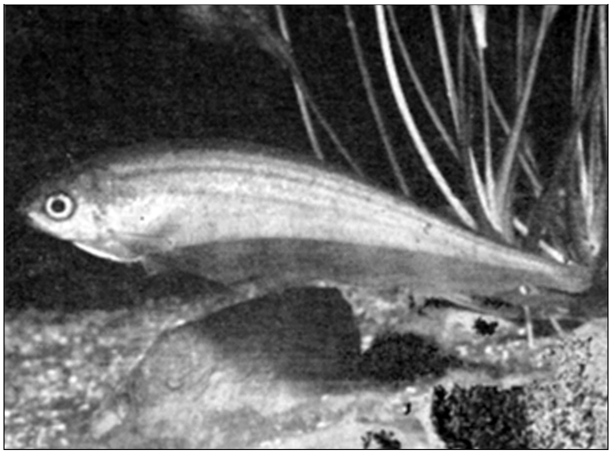
A. Head not depressed, lower jaw not prolonged:
(1) No caudal fin and no dorsal filament:
a. Snout short and not tubular, (Sternopyginae).
b. Snout tubular, (Rhamphichthyinae).
(2) With caudal fin and with dorsal filament present, (Apteronotinae).
B. Head more or less depressed, lower jaw protruding:
(1) Body not scaled, (Electrophorinae).
(2) Body scale, (Gymnotinae)

The single member of the subfamily Electrophorinae is better known as our old friend, the electric eel. With this single exception, the remainder of the family are usually known as knife fishes. The first subfamily, Sternopyginae, has provided us with quite a few aquarium fishes. One of these, *Steatogenys elegans*, is a pretty yellowish-brown fish with a mottled pattern. The popular name, Amazonian mottled knife fish, seems to fit very well. It is quite common in the lowland rivers of the Guianas, South Venezuela, and the Amazon basin. I have kept many of these fishes in aquaria and always found them to be peaceful and shy. They reach a length of seven or eight inches. *Steatogenys* possess a longitudinal groove on each side under the “chin.” Each groove contains a segmented worm-like organ similar to a thick barbel. The purpose of this organ is not known but the most popular theories suggest that it is used in feeding, breeding and as an electric organ.

Knife Fishes - Part II

[All-Pets Magazine, September, 1956]

The South American knife fishes are among the most peculiar fishes that you can keep. Last month, we discussed the Amazonian mottled knife fish, a member of the subfamily Sternopyginae. Another fine member of this subfamily is the glass knife fish, *Eigenmannia virescens*. This is an almost transparent fish much like the glass catfish. You will receive



An African Knife Fish, *Notopterus*.
Photograph by Lawrence E. Perkins.

only small specimens for aquarium fishes, however, since their ultimate size is well over 18 inches. The smaller ones are shy and peaceful with other fishes. The stomachs of wild fishes have been examined and found to contain mainly insect remains, but in the aquarium, daphnia, tubifex, and frozen brine shrimp are all excellent foods. Their natural range covers southern Panama to the River Plata.

The last member of this subfamily that appears often in aquaria is *Hypopomus artedii*. It has a gray-green appearance with black dots. The eyes seem very small. A four-inch specimen of mine lived peacefully in a community tank but kept itself well hidden during the day. This fish is found in the Guianas and does not exceed seven inches.

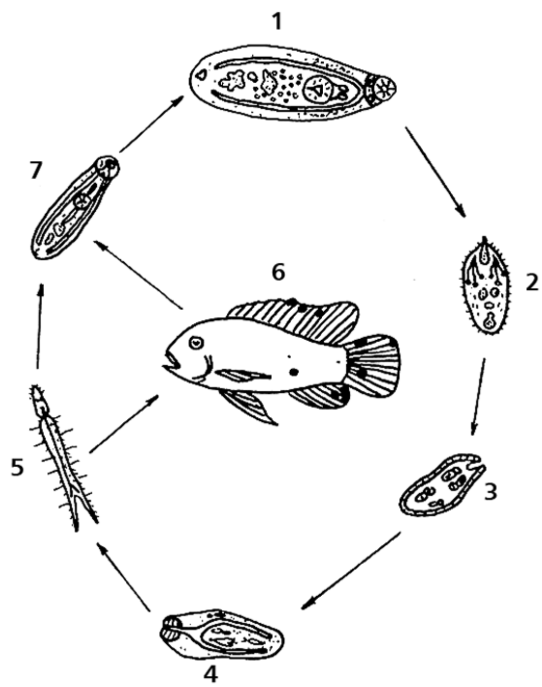
The subfamily Rhamphichthyinae has not provided us with too many aquarium-sized fishes. Both *Rhamphichthys rostratus* and *Rhamphichthys marmoratus* grow well over 20 inches. The New York Aquarium did keep an 18-inch specimen of *Gymnorhamphichthys hypostomus* for research purposes and although a large fish, its mottled or patched pattern gave a pleasing appearance. All three of these fishes are greatly elongated and compressed and, in addition, have a long, tubular snout resembling that of a pipefish.

One of our most expensive knife fishes is a member of the third subfamily, Apteronotinae. This is the Brazilian ghost fish, *Apteronotus* (formerly *Sternarchus*) *albifrons*. The ghost fish gives us an eerie appearance with its velvet-black skin and striking white stripe on the back from the head to the middle of the body. There are also two bands of white near the tail. This is a large (about 18 inches) fish with a large mouth. Unlike most other knife fishes, the ghost fish has a small caudal fin and a dorsal filament. It spends most of its time resting among aquarium plants. The name "ghost fish" is reportedly derived from the natives of Brazil who hold the fish in awe as the abode of a spirit.

Sternarchella schottii is another member of this subfamily. Here, the dorsal filament is pronounced, appearing as a thread from the middle of the back. For a 10 inch fish, it is comparatively friendly with fishes its own size. The coloration is brownish-yellow and it is native to central Brazil.

Our last subfamily, Gymnotinae, boasts of a well-known fish. This is *Gymnotus carapo*, the most common of our knife fishes. The front part of its body is covered with minute scales and is cylindrical. The rear body is compressed and the head is flattened. Coloration is pale-yellow to brownish with sloping bars of gray to gray-black. The brightest specimens are taken from swift, rocky streams of the mountain regions of Guatemala to the La Plata and West Indies. The coloration of this species is the brightest of the family and Was the first to attract the attention of European naturalists among the five species of knife fishes first described by Linnaeus, the father of modern biology. *Gymnotus* is not a good community tank fish. It is amazingly hardy and will eat fish, meat, worms, and canned shrimp. It grows to a length of two feet!

The electric properties of the South American knife fishes have not been well publicized. Experiments by the New York Aquarium have indicated that at least three of these fishes possess electric organs: *Gymnotus carapo, Eigenmannia virescens* and *Gymnorhamphichthys hypostomus*. The rates of electrical discharges per second by these fishes respectively are 65, 300 and 100. None of the impulses exceed three-tenths of a volt, but they are emitted with great regularity and rapidity. Several theories have been advanced to explain the presence of these electric organs. One centers around the thought that the electrical discharges may be used as range finders to locate objects. Another suggests the use of these organs for communication purposes, possibly during breeding. Although the first theory would conveniently explain the dexterity of the knife fishes in their acrobatic swimming, no proof is as yet available. The South American knife fishes have attracted much attention, however, and are now the subjects of much experimentation. Through this research it is hoped that the answers to our many questions will be forthcoming.



The Life Cycle of Clinostomum complanatum (Yellow Grub)

A Case Of The Yellow Grub

[All-Pets Magazine, April, 1957]

Although there is a host of possible afflictions that may, at one time or another, victimize our aquarium fishes, the majority of aquarists have witnessed but a small number of them. Recently, I had the opportunity of studying one of the rarer infections of tropical fishes commonly known as the yellow grub.

Due to its remarkable life cycle, hobbyists will not encounter the yellow grub often, fortunately for our fishes. My introduction to this parasite started when I received a call from Page Gardner of the Dixie Hatcheries in Covington, Ky. Page is one of those dealers who started out as a hobbyist and continues as a keen student of tropical fishes. Briefly, Page outlined to me that he had received a shipment of *Aequidens portalegrensis* from Florida that were suffering from a strange ailment. I wasted no time in getting to the Hatchery and viewing the fishes. The cichlids, which were infected, were about three inches long and in perfect condition except for the appearance of a dozen or so grayish lumps on fins and body. At first glance, the growths resembled a fungus, but closer examination showed them to be of a firmer consistency and having more definite outlines than the true fungus condition. The fish were behaving normally and did not appear to be bothered by the growths.

After some research in aquarium literature, we discovered that the "ports" were infected with Yellow Grub or, scientifically, *Clinostomum complanatum*. These are flatworms and belong to the same group that contains the human blood fluke or *Schistosoma*. Dr. Ross Nigrelli of the New York Zoological Society has noted these grubs on the following tropical fishes: bluefins (*Chriopeops goodei*), *Mollienesia velifera*, *Piabucana* species, swordtail characin

(*Corynopoma riisei*), pencilfish (*Nannostomus trifasciatus*), guppy, South American knife fish (*Hypopomus artedi*) and *Sternopygus macrurus*. To this list of susceptible fishes we now add *Aequidens portalegrensis*.

Clinostomum starts its life, strangely enough, as a bird parasite. The adult parasite lives in the throat and mouth of fish-eating birds (bitterns and. herons) attached by means of a powerful sucker. This adult worm is illustrated as No. 1 in the life-cycle diagram. The eggs, which are produced by the adult worm, are discharged either from the bird's mouth or via its excreta. Immediately after reaching the water, the eggs hatch producing the first larval stage or miracidium (No. 2). The miracidium (which means "little boy") swims about until it finds the right species of snail. The swimming is accomplished by a waving motion of the fine hairs or cilia, which cover its body. If the correct genus of snail (Helisoma) is found, the miracidium burrows into the liver, changes shape, loses its cilia and becomes a sporocyst (No. 3).

If the miracidia cannot find a snail of the genus *Helisoma*, they die within a few hours. The sporocysts produce the third larval stage called rediae. After reproducing and forming daughter rediae (No. 4), the fifth larval form are evil-looking tailed flukes called cercariae (No. 5). After leaving the snail, the cercariae either swim about or hang down from the surface of the water. When they contact a fish, the cercariae burrow into its skin, dropping their tails before the penetration is completed. The fish reacts against this irritating infection by building a cyst around the intruder. This encysted stage is called metacercariae (No. 6). The whole cycle is started anew if the infected fish is eaten by a bird. The metacercariae are liberated from the cysts by the digestive juices of the bird. Once free, they migrate to the mouth and throat of the bird where they attach themselves.

Since it was known that our fishes were pond-raised specimens, it was apparent that they had been exposed to the described cycle. No other fish kept with the infected specimens developed the grubs. From knowledge of the life cycle of the yellow grub, it is evident that the affliction cannot be passed from one fish to another. Two possible sources of affection that may trouble aquarists, however, are pond water in which cercaria stages are present and infected snails.

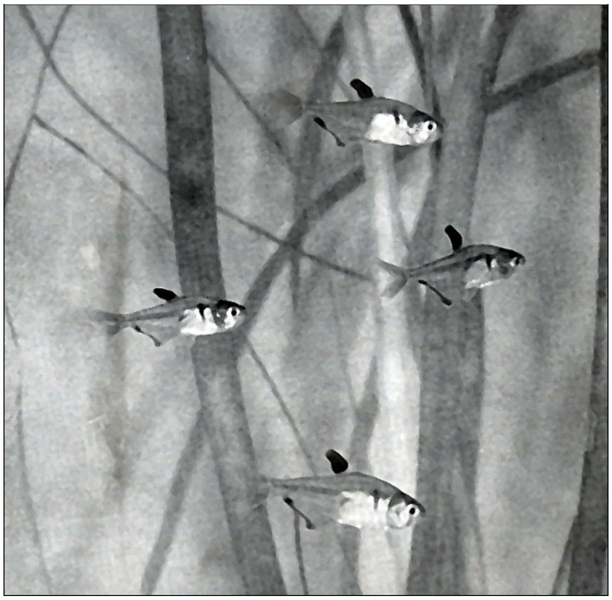
Since most of the infected areas on our fishes centered about the fins, these areas were cut off and the remaining fin parts were swabbed with mercurochrome to ward off bacterial infection. The body cysts proved a bit more troublesome since they had to be cut open with a small lancet and the grubs picked out with a pair of tweezers. This was not easy with a husky, three-inch cichlid thrashing about wildly in a net! In time, the removal process was completed, the wounds healed and the fins grew back. With smaller fishes, such as Tetras, the prognosis may not be as favorable since such treatment would be more of a shock to their delicate systems. With care, even these smaller tropical fishes will respond to this treatment.

Tetras

[All-Pets Magazine, May, 1957]

A word that covers a considerable area of the tropical fish hobby is tetra. The history of the aquarist's use of this word started with an attempt to shorten what would otherwise be a lengthy scientific term, Tetragonopterus. It became the popular name for the series of small fishes coming under this classification.

Today, however, scientists have abandoned the name Tetragonopterus almost entirely, except for a very few fishes. Aquarists, on the other hand, steadfastly apply the shortened version,



Photograph by Albert J. Klee

not only to older tropical fishes, but to newly discovered ones as well.

Although all of the aquarist's tetras belong to the same family, the group is extremely diversified. Here, the hobbyist can find a multitude of sizes, shapes, colors, dispositions, and behaviors. Most aquarists think of tetras as small fishes, much along the size of the Neon tetra or about an inch and a half. A few grow much larger than this; the four-inch tetra from Buenos Aires (*Hemigrammus caudovittatus*) is one example. They would not make very compatible tank mates, for the number of neon tetras would certainly decrease!

For the hobbyist who prides himself on his aquatic plants, a word of warning about thinking of all tetras as living in harmony with plants. The most infamous culprit among these fishes is the silver tetra, *Ctenobrycon spilurus*. *Vallisneria, Hygrophila*, etc., are to this fish as filet mignon is to a famished aquarist. It is fortunate for us that the vast majority of tetras prefer other fare. Of course, when this fare tends to include its neighbors, the relations with its keeper also become strained.

All of the tetras are supplied by nature with a fine set of teeth and a few are known to be fin-nippers at one time or another. The beautiful serpae tetra (*Hyphessobrycon callistus serpae*), unfortunately, has been caught in the act more than once. This also applies to the blind cave tetra, *Anoptichthys jordani*.

Color and shape also are variables in the tetra group. The red-nosed tetra (Hemigrammus rhodostomus) is a slim fish while the familiar black tetra (*Gymnocorymbus ternetzi*) is a disc-like creature. Several, like the swordtail tetra, are plain silvery fishes; others, the *rosaceus* tetra for example, are a rainbow of color.

In general, the tetras are not easy fishes to breed. Very few aquarists breed the neon tetra or Ulrey's tetra. On the other hand, the black line tetra (*Hyphessobrycon scholzei*) is comparatively easy to breed.

Differences can also be found in feeding habits among the tetras. Most of them are sight feeders and avidly snap up their food as it hits the surface or falls to the bottom. The blind cave tetra, however, must depend upon its sense of smell to detect food, and because it usually eats near the bottom of the aquarium, makes a fine scavenger.

The tetras generally are about average in their resistance to diseases. The neon tetra, it is true, is susceptible to a disease almost all its own (a few other unfortunate fishes share the possibility of getting it) known as the neon tetra disease. Now and then, a tetra appears that is extremely sensitive to one disease or another. The blue tetra, for example, *Mimagoniates microlepis*, is especially apt to get white spot. To a lesser degree, the head and taillight tetra, *Hyphessobrycon ocellifer*, is affected similarly, so much so that it is sometimes used as an "ick" indicator in a shipment of new fishes. The head and taillights are sure to be among the first to exhibit the familiar white spots if the disease is present.

Perhaps the most positive statement that can be made about the tetras is that generalizations about them are hard to make. They always seem to come up with that single exception! Maybe it is because of this that they are always among the most popular of our tropical fishes.

Scale-Eating Fish of Africa

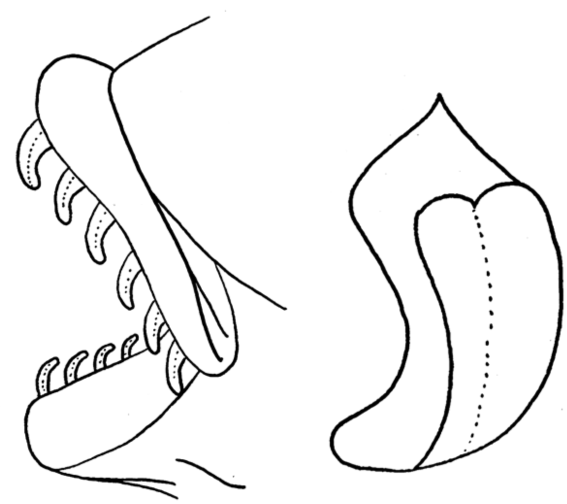
[All-Pets Magazine, August, 1957]

Lake Tanganyika in Africa is a most unusual body of water. This would be true even if its marked degree of thermal stability and unique chemical composition were its only peculiarities. But the great abundance of its species of fauna, many of which are found nowhere else, adds to the interest in what is probably the world's oldest lake.

Perhaps the most curious inhabitants of Lake Tanganyika are the scale-eating cichlids of the genus *Plecodus*. When the stomachs of dead specimens were examined and often found to contain fish scales, it was not known if this represented the usual diet or even if such scales came from living or dead specimens. These questions were answered when live fishes in aquaria were observed feeding on the scales of other live fish. Some fishes were able to elude the scale-eaters but others were left with denuded areas after a Plecodus had pushed its mouth against it for a while. The action was much like that of a kissing gourami eating algae from the side of an aquarium. An examination of the peculiar dentition of *Plecodus* revealed a series of band-like teeth, bent backwards, and well adapted for scale eating.

Other African cichlids have been shown to savor a similar diet. From Lake Nyassa, species of the cichlid genera *Corematodus* and *Genyochromis* were also found to be scale-eating fishes. *Corematodus* has been observed feeding on the caudal fin of a *Tilapia*, grasping it by its upper and lower file-like teeth. When the fin is pulled free, the *Tilapia* inevitably loses some scales as its payment for freedom.

The stomachs of the three genera described have all yielded relatively enormous amounts of scales from an assortment of fishes. *Barbus*, *Labeo,* and cichlid scales, ctenoid scales from primitive-type fishes, some fin rays and a small amount of filamentous algae have all been a part of these stomach contents. The presence of algae is interesting for it suggests an evolutionary relationship between the scale-eaters and the algae-eaters. *Tilapia natalensis*, an algae-eater, has been observed eating algae by a process of pressing against a rock with its mouth and closing it while still pressing, a method employed by the scale-eaters when feeding on live fish. A species of *Labeo*, also an algae-eater, was seen feeding on the permanently attached rotifers on a *Polypterus*. If the teeth of the *Labeo* had been like the scale-eaters, the *Polypterus* surely would have lost some of its scales.



LEFT: Dentition of *Plecodus paradoxus* (after Boulenger).
RIGHT: An individual tooth of *Plecodus paradoxus* .

I have watched similar feeding by *Labeo cyclorhynchus* on members of its own species and other fishes. Such observations have also been made by many aquarists in the case of the kissing gourami. Since it would seem that a special dental apparatus is necessary to deliberately remove scales, it is my opinion that these fishes are employed in feeding on small animals that are so frequently embedded in the skin of many fishes or on skin secretions. If scales are removed in the process, it is probably accidental. However, recent observations both in" Great Britain and the United States with discus (pompadour fish) have indicated that the fry actually subsist on mucus obtained from the parent's skin. The production of this mucus is increased during the breeding cycle, thus providing the young fish with food when it is most needed.

None of the scale-eating cichlids have appeared as aquarium fishes to date. The only member of this group frequently kept in experimental aquaria, *Plecodus paradoxus*, has balked at feeding on anything but scales from living fish. Earthworms, meat, and insects were ignored. If any of these fishes are imported as aquarium specimens, the aquarist will experience a decidedly different feeding problem in the care of tropical fishes!

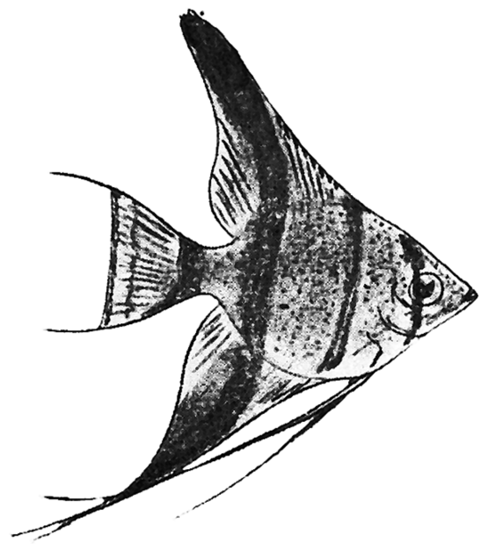
Why Keep Fish?

[All-Pets Magazine, March, 1958]

There are very few persons who can say, "I do this, or I do that for this reason." In most cases it is done for a number of reasons. Perhaps with the accompanying pictures, you can see the most important answers to our question, "Why keep aquarium fishes?"

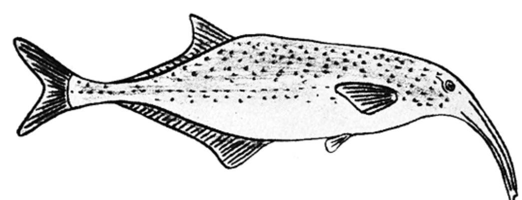
1. FOR BEAUTY AND DECORATION.

The Angelfish is an example of a beautiful and decorative fish. There are many other beautiful fishes and there is every color of the rainbow to be had in them.



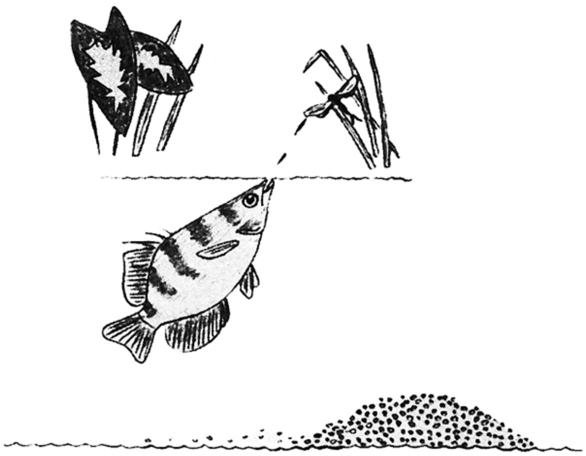
2. FOR STRANGE AND UNUSUAL APPEARANCE.

The Elephant Fish pictured uses his long nose to root for food in the muddy waters in which he lives. Some fish look like snakes while others may look like plates or balls. There is a never unending variety of shapes in fishes.



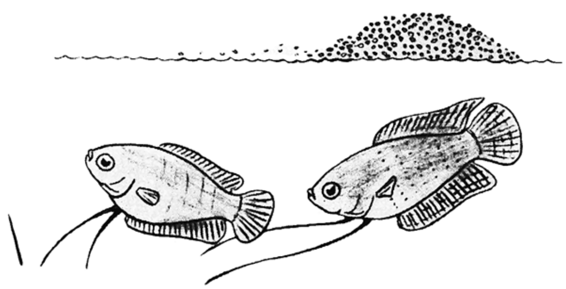
3. FOR INTERESTING BEHAVIOR.

The Archer Fish that comes from Siam, shoots insects with jets of water. The insect then falls into the water and provides the Archer Fish with a meal! There are other fishes with interesting habits such as Fighting Fish, Upside-Down Catfish, and Puffers, all of which can be kept in aquariums.



4. FOR BREEDING.

The pair of Dwarf Gouramies shown is building a bubblenest. This is made out of bubbles and bits of plants. After the eggs are laid in the nest, the male stands guard under them. Some fishes bear live young and some even hatch the eggs in their mouths! Breeding fishes can be the best fun of all and, with many fishes, is not very hard to do.

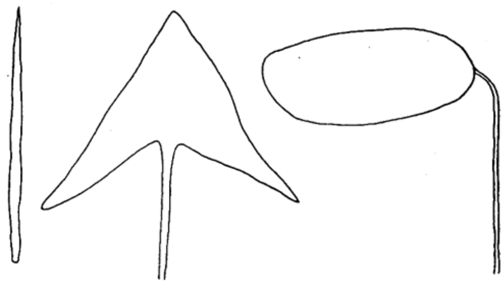


Aquatic Plants – Part I

[All-Pets Magazine, March, 1958]

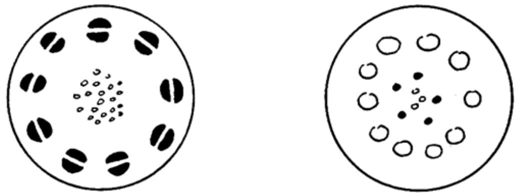
Although there are decided differences between land and aquatic plants, these differences do not serve as any basis for classification. This is to say that aquatic plants do not fall into any special or definite niche. As a result, the aquarist roams the plant kingdom touching upon one plant here and another there until his collection of aquarium plants assumes a most cosmopolitan appearance. Perhaps the wonderful nature of aquatic plants can best be appreciated by a comparison with something we are more familiar with, the land plants themselves.

To an aquarist, the most distinctive part of a water plant is its leaf. Aquatic plants seldom possess the broad, flat leaf of the land plant. There are exceptions, of course, and these exceptions provide aquarists with our center plants. But for the most part they are thread-like (*Ambulia*) or narrow (*Vallisneria*). It is not difficult to imagine the increased buffeting a broad leaf would receive compared to a narrow leaf as a result of the strong currents, which are present in rivers and streams. In a strong current, the former would be torn to pieces while the latter, by virtue of its smaller resistance or surface area, would remain intact. The center plant exceptions serve to strengthen this idea, for such plants are inhabitants of ponds or streams whose water motion is negligible. Thus, the variations in the shape of the leaf of the sagittarias are easily explained. *Sagittaria* is a genus of plants that possesses three leaf forms: a submerged leaf, a floating leaf and an emersed (growing out of the water) leaf. Figure 1 illustrates the general shapes of these three leaves. Non-aquarists know the sagittarias as Arrowheads and the logic of this popular name is easily perceived by an examination of the out-of-water or emersed form*. The floating leaf is broad, characteristic of most floating leaves. This form provides the buoyancy necessary to, keep the leaf on the water's surface. It is important to note that many aquarium plants possess two or three leaf forms which, at one time or another, may be seen by the hobbyist. Water sprite, for example, will show both the submerged and floating forms in the aquarium. The cryptocorynes, under certain conditions, may be induced to grow out of the water and exhibit an emersed form of the leaf, which differs considerably from the underwater shape we usually see.



SUBMERGED EMERSED FLOATING

FIGURE 1: LEAVES OF SAGITTARIA



LAND PLANT STEM (SUNFLOWER) AQUATIC PLANT STEM (MYRIOPHYLLUM)

FIGURE 2: CROSS SECTION OF STEMS

The stems of aquarium plants present an interesting contrast with landforms. Since the leaves of terrestrial plants usually receive no support other than from the stems to which they are attached, the stems must be reinforced. This reinforcement takes the form of woody tissues arranged in vertical rods around the periphery of the stem. As can be seen from figure 2, the structure formed is reminiscent of reinforcement steel rods in concrete. The aquatic leaf, on the other hand, receives considerable support from the buoyant force of the water. It needs a stem that will prevent it from being torn away by the pulling action of the water. As a result, less woody reinforcement is needed, and that which does occur finds itself at the center of the stem where it is better placed to resist these pulling forces.

One further development in stem construction remains to be explained. It is clear that the land leaf has easy access to the air it requires for its respiration. However, air is not as plentiful in water. To ensure an adequate supply of air, aquatic stems are hollow to a considerable extent. The hollows (figure 2) serve as a reservoir for various gases and, in so doing, solve the problem, which their land cousins do not have.

There are other differences between land and aquatic plants, which may be considered. The roots, for example, of aquatic plants are not as hairy as those of land plants. The latter receive more nourishment from the soil than do the former and root hairs assist in obtaining nourishment for the plant. Reproduction of the two plant forms may differ also. Many land plants rely upon the wind or insects for pollination; this would be impossible for aquatic plants. Those water plants that do produce a flower push it above the water's surface in order to take advantage of these methods of pollination. These then are some of the major differences between aquatic and terrestrial plants.

Part of our article next month will describe the general types of aquarium plants and fit them into their proper places in the plant kingdom.

***The name Sagittaria means, "Archer," again referring to the emersed form of the leaf.**

Aquatic Plants – Part II

[All-Pets Magazine, April, 1958]

Last month we compared aquatic plants with their land counterparts emphasizing the specialization that has developed to enable our aquarium plants to thrive in a watery environment. To complete the story we now will explore the plant kingdom with an eye towards explaining the differences among the aquatic plants themselves.

It has been customary to consider the plant kingdom in four main divisions*. These divisions, their representatives, and characteristics are shown in Table I.

Aquarium plants are represented in all divisions and in most, but not all, members. The members of the fungi encountered in the

TABLE I
THE DIVISIONS OF THE PLANT KINGDOM

DIVISION	MEMBERS	CHARACTERISTICS
I	Algae and Fungi	Simple plants without roots, stem or leaves
II	Liverworts and Mosses	Small green plants mostly with simple stems and leaves but without true roots
III	Ferns, Club Mosses and Horsetails	Highly developed roots, stems and leaves but without seeds
IV	Seed plants	Plants bearing seeds

aquarium are mainly the bacteria and *Saprolegnia* (the fungus so often found on bruised fishes). These are plants without chlorophyll but are usually considered under the topic of diseases and so will be overlooked here.

ALGAE: The four main algae groups of algae receive their popular names from the pigments that they contain. Two groups, the red and the brown, are predominantly saltwater forms and aren't usually encountered by the freshwater aquarist. An important group to the aquarist is the blue-green algae. These microscopic plants contain both a blue pigment and chlorophyll (a green pigment vital in photosynthesis).

They are found over a wide variety of conditions, and in fresh, brackish, or saltwater. In spite of their name, the blue-green algae may appear blackish, blue-green, green-olive, green-blue, yellow-green, brownish, violet, or red but in any case, they never have the appearance of a pure green chlorophyll coloring. They are both free-swimming and non-motile kinds, the latter appearing on glass, rocks, wood, and plants.

The green algae form another important group. Since the pigments present in this group consist mainly of chlorophyll plus the usual yellow pigments, there is no great color range as is found in the blue-green algae. Only a few forms are marine and like the preceding group, are represented by both free-swimming and non-motile types. With few exceptions, all aquaria contain green algae in one form or another.

There is a minor group among the algae that aquarists don't often think of as being algae. These are the stoneworts of which *Nitella* is an example. Most stoneworts are freshwater plants, but a few are found in brackish and saltwater. Unlike thread algae (a green alga), *Nitella* will not endanger other plants.

LIVERWORTS: These plants are regarded as a group in the process of becoming adapted to a land environment, transitional between the green algae and the higher plants. Very few aquarium plants are counted in this group, *Riccia* being the most important example. Reproduction among the liverworts is via a spore-forming process.

MOSSES: The mosses are more highly developed than the liverworts; all of them are conspicuously leafy. Unlike most of the liverworts, their leaves all have a mid-rib. In any event, they are not particularly important to the aquarist. The one exception is the well-known *Fontinalis* used both as a decorative plant and for spawning fishes.

TABLE II
THE SEED PLANTS

NAKED SEED SUB-DIVISION
Woody plants like conifers,
very little value to aquarists.

FLOWERING PLANTS

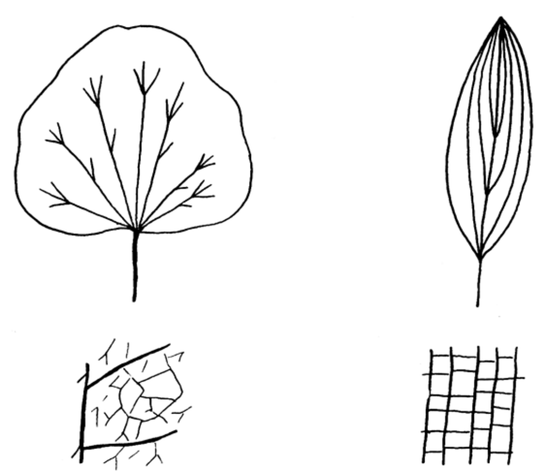
Group 1	Group 2
(Parallel-veined leaves	(Net-veined
leaves	
forming a closed	forming an
open	
system) system)	
Aponogetons	*Ludwigia*
Cryptocorynes	*Bacopa*
Sword plants	*Cabomba*
*Sag*ittarias	*Ceratophyllum*
Vallisneria	*Cardamine*
Anacharis	*Ambulia*
Hair Grass	Bladderwort
Duckweed	*Hygrophila*

FERNS: There are no popular aquarium plants among the club mosses or the horsetails. The ferns, however, do contribute the pretty little floating plant, *Azolla*. Most other Ferns are plants growing in moist, shady places and bearing large leaves, few in number.

SEED PLANTS: By far the most important division in the plant kingdom to aquarists is the seed plants. This is a large division and it is necessary to break it down further via Table II. The flowering plants include most of our aquarium plants. The two groups that make up this subdivision have several points of difference, the table showing only one, viz., the venation of the leaves. The terms, "parallel-veined" and "net-veined" are easily demonstrated by the figure. The ends of the veins in a net-veined leaf do not form a closed system. The upper illustration of the figure does not show the transverse smaller veins, but a magnification of a portion of each leaf type is shown below.

Practically all of the aquarist's center plants are members of the parallel-veined leaf group. It is interesting to note some of the family relationships the aquatic plants have with the land plants. The cryptocorynes share the same family with the skunk cabbage; and, similarly, *Bacopa* is in the same family as the snapdragons. Cardamine and watercress are both in the mustard family, surprisingly enough!

Perhaps it would be well to leave this business of classification with some remarks upon the identification of aquatic plants. For other than a botanist, the exact identification of the lower plants such as the various algae and the stoneworts is practically impossible. Indeed, they give botanists no end of trouble. The flowering plants present fewer difficulties relatively, but it remains no easy task. Consider the cryptocorynes, for example. We have seen how these plants may possess two entirely different leaves, submersed and emersed. In many cases, there is insufficient evidence to



NET-VEINED LEAF PARALLEL-VEINED LEAF

VENATION OF LEAVES (Figure 3)

classify a *Cryptocoryne* if only one form of the leaf is available. Furthermore, there are instances when even observations of both leaf forms is not enough to properly classify them. What is needed, in addition, is the flower. Understandably then, a botanist may have to secure a specimen of a new *Cryptocoryne*, grow it both under water and out of water, and wait for the flower to appear. When, added to this, it is remembered that the botanist's references are scattered among the literature of about 300,000 known plants, we can appreciate the amount of work involved in classification.

This, then, has been a brief glance at the world of aquatic plants. Perhaps it may act as a guide to a deeper appreciation and understanding of these important members of the aquarium for, without aquatic plants, the aquarium would be a desolate setting for tropical fishes indeed.

*** Current thought has been to combine the last two, making then, three divisions. For our purposes, the older method is more suitable.**

The First Principle Of Fish Keeping—Part I

[All-Pets Magazine, April, 1958]

Have you ever noticed how stuffy a. small roomful of people can be? To a fish, its room is the aquarium in which it lives. Unlike a human who can leave the room when he becomes uncomfortable, the fish must remain in its aquarium. When too many fish are placed in an aquarium, they may not only be uncomfortable but even in danger. In short, many fish die from overcrowding.

One of the danger signs of overcrowding is shown in figure 1. The fish are all at the water's surface gulping air. Although there is a possibility that something else may be wrong, fish hanging at the surface is a good indication of overcrowding. For many years, aquarists controlled the number of fish they placed into an aquarium by a simple rule of thumb: Place

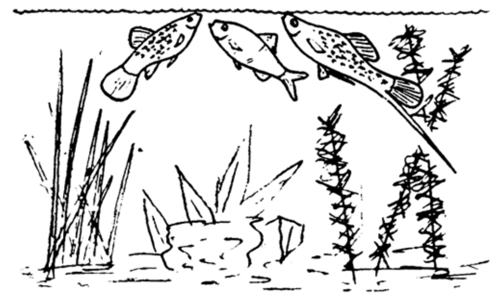


FIGURE 1

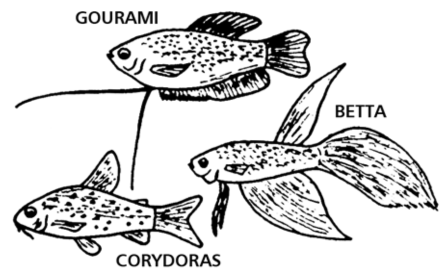


FIGURE 2

no more than two inches of fish in a gallon of water. In other words, a 10-gallon aquarium could support 20 inches of fish that may be made up of 20 one-inch fish, 10 two-inch fish, etc.

Recently, however, this rule of thumb has been replaced by a better guide, the graph shown here. The basis for the number of fish permitted in an aquarium in this graph is not the number of gallons the tank holds but rather the surface area of the tank. A 15-gallon aquarium, for instance, is two-feet long and one-foot wide. This aquarium has a water surface area of two square feet. The graph then tells us that, for a two-inch fish, 12 of them may be placed in an aquarium for every square foot of water surface, a total of 24 two-inch fish for the 15-gallon tank with two square feet of water surface.

Some air breathing fishes such as bettas, gouramies, and *Corydoras* (figure 2) do not need as much space as other fishes. For these, double the number of fishes indicated by the graph is safe in an aquarium. On the other hand, coldwater fishes such as goldfish need twice as much space as indicated by the graph.

For the best results in keeping aquarium fishes, always remember the First Principle: Provide the proper amount of living space for your fishes.

The Principles Of Fish Keeping – Part II

[All-Pets Magazine, May, 1958]

Did you ever turn on the cold-water faucet in the shower by mistake? I think we would all agree that it would be quite a shock! Sudden changes in temperature always cause us to react quickly, usually by jumping away from the too hot or too cold object. However, if a fish's environment, that is, the water all around it, changes temperature suddenly, there is nothing the poor fish can do about it. Usually, he will become sick; sometimes, the change will be so great a shock that death results.

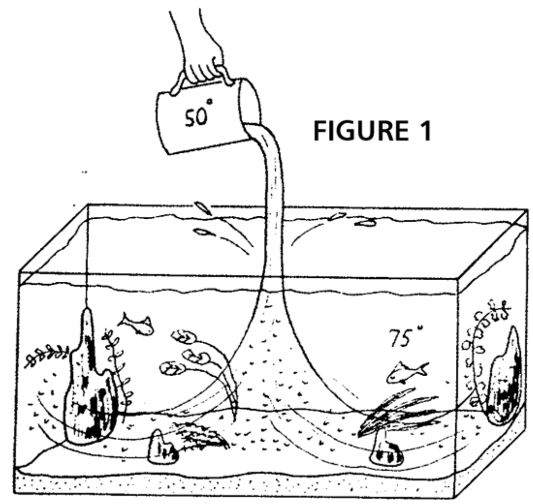
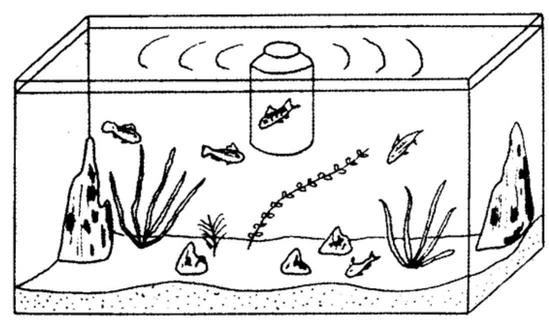
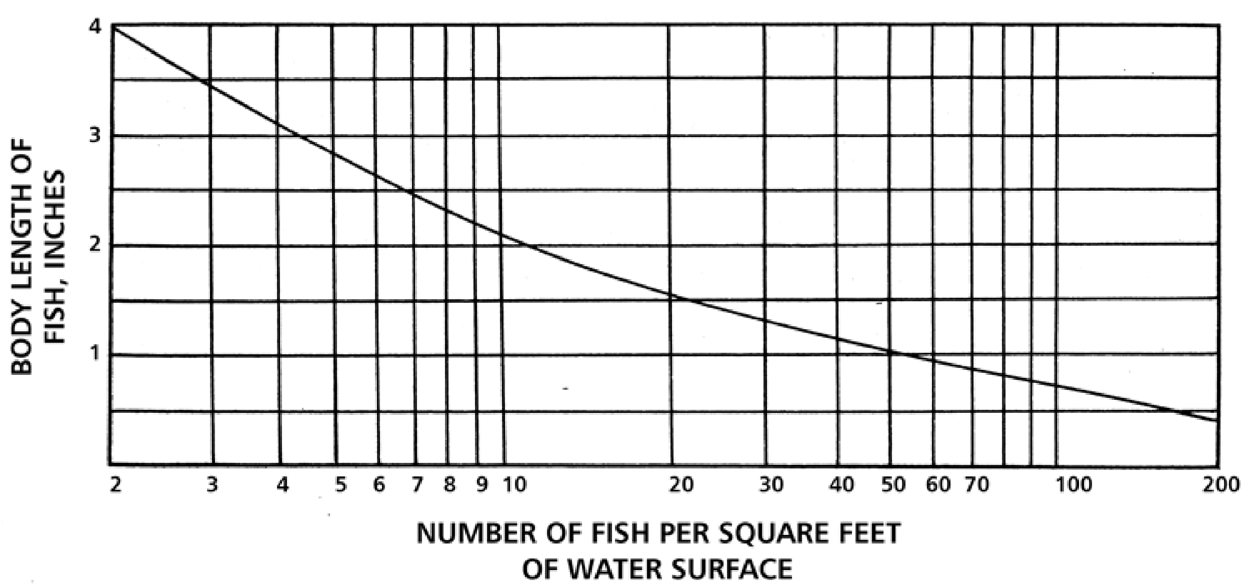


FIGURE 1

FIGURE 2



You will probably have guessed by now that the person adding cold water to the warm water aquarium in figure 1 is making a very big mistake. There should never be more than two degrees F difference between the tank water and the newly added water. That is why a good thermometer is one of the most important items a fish keeper can own. With it, you can



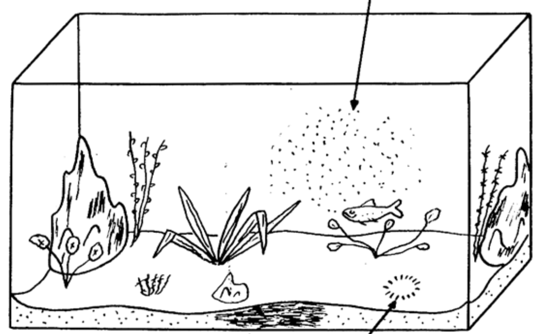
tell when a mixture of hot and cold water is at the right temperature to be added to the aquarium.

Very often, fish just brought home from the store will be in water of a different temperature than that which is in your aquarium. The solution is shown in figure 2. Simply float the container containing the new fish, in the aquarium. Slowly and gradually the temperature in the container will become the same as that in the aquarium. This is usually a matter of 20 or 30 minutes. When the temperatures are the same, tip the container and the new fish will swim safely into his new home.

Always remember the Second Principle of Fish Keeping: Never change the water temperature suddenly.

For the best results in keeping aquarium fishes, always remember the First Principle: Provide the proper amount of living space for your fishes.

FIGURE 1



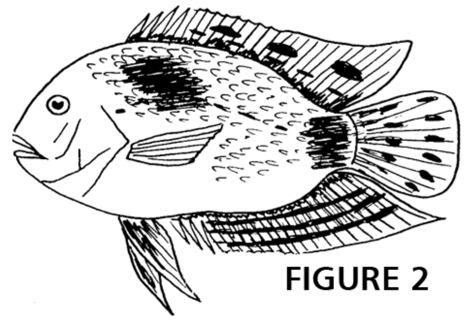


FIGURE 2

Overfeeding

[All-Pets Magazine, June, 1958]

As a newcomer to the hobby, probably the greatest source of trouble in managing your new aquarium will be overfeeding. Most uneaten food in an aquarium will pollute the water sooner or later. It is very important to feed only the correct amount of food and to recognize the danger signals when too much food is being given.

The best way to learn how much to feed your fish is to watch an experienced aquarist or dealer feed his own fish. This will give you a good idea of how much fish eat. If this is not possible, then feed only a small pinch of food at a time and watch your fish carefully. If they finish this food quickly, then feed more. All food should be eaten within 10 or 15 minutes. Some aquarists feed a little extra food just before turning off the tank light at night in order that ally catfishes present might enjoy a midnight snack. Be sure to check in the morning to see that this food, also, is eaten. Catfishes, by the way, are excellent scavengers and will help you to keep your aquarium clean. But even a catfish in an aquarium is no excuse for being careless in feeding.

Some of the danger signals in overfeeding are shown in figure 1. They are: (a) cloudy water, (b) fungused food and (c) black sand or gravel. Of course, any unpleasant odors from an aquarium are also a sign that something is wrong and should be investigated immediately. There are some aquarists who do not overfeed but rather feed food that is too large for their fish to eat. This is just as bad as overfeeding. A good rule of thumb is, feed food no larger than the eye of the fish (figure 2).

Always remember the Third Principle of Fishkeeping: Never overfeed your fish.

FIGURE 1

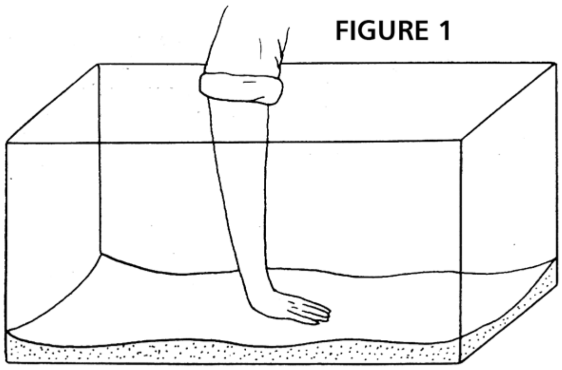
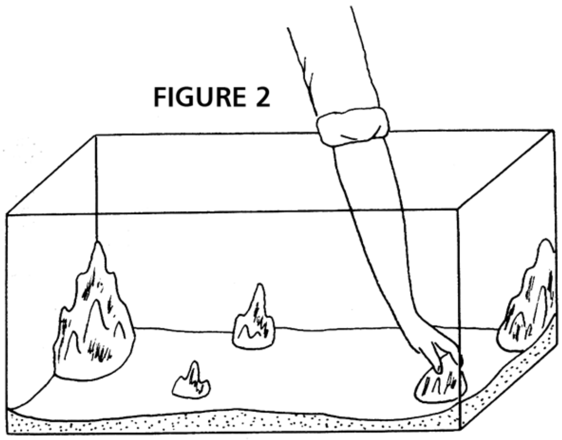


FIGURE 2



Looking Before You Leap

[All-Pets Magazine, July, 1958]

"Looking before you leap" is a time tested proverb which is very applicable in setting up your first aquarium. A 15-gallon aquarium, fully planted and equipped, weighs about 140 pounds and, like all tanks, it can only be moved safely when it is empty. Decide beforehand on the permanent location for your aquarium. Think about those small but important details such as distance from the nearest electrical outlet, possibility of water damage to books or other items if the tank should leak, and proximity to drafts.

After the location is carefully chosen, the next step is to place the aquarium on a firm base or stand. This support should not wobble. All tanks should be supported around all the bottom edges. When the aquarium has been placed upon the stand, coarse sand or gravel may be added. Slope the gravel from front to rear with the hands (figure I). The depth of gravel may rise from one inch in the front to two inches in the rear. This slope will cause any accumulation of dirt to drift toward the front of the aquarium where it can be removed easily.

Now, decorative rockwork can be added to the aquarium (figure 2). Press the rocks or stones into the gravel and then smooth the gravel around the base of the rock so that it looks natural. Now you are ready to add some water to the aquarium. Fill the tank to within about four inches of the top with tap water. To avoid disturbing the gravel, break the flow of water by placing the palm of the hand or a saucer under the stream of water just above the gravel. Allow the aquarium to sit undisturbed for a few days. This will permit you time to check for leaks and also allow the water to release any harmful gases it may contain.

Next month, we shall describe how to plant the tank and complete the preparation of your first aquarium.

Planting Your Aquarium

[All-Pets Magazine, August, 1958]

Last month, we completed one half the work necessary in setting up an aquarium. We are now ready to plant the aquarium.

Since the movements of the hands in the water will tend to splash some water about, we must take the precaution of filling the tank to within four inches from the top.

Some plants are rather tall and narrow. These should be planted at the back of the aquarium. Shorter, and bushier plants can be placed along the sides. Larger, single plants (often called

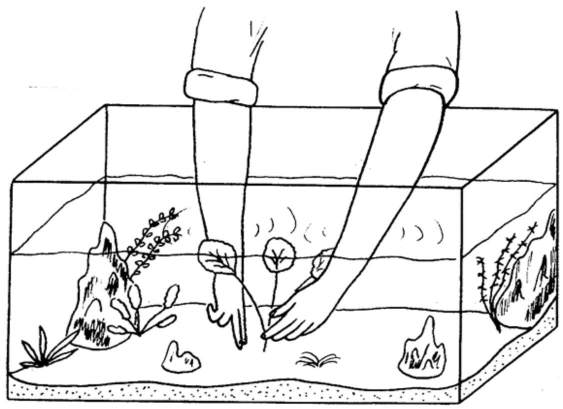


FIGURE 1

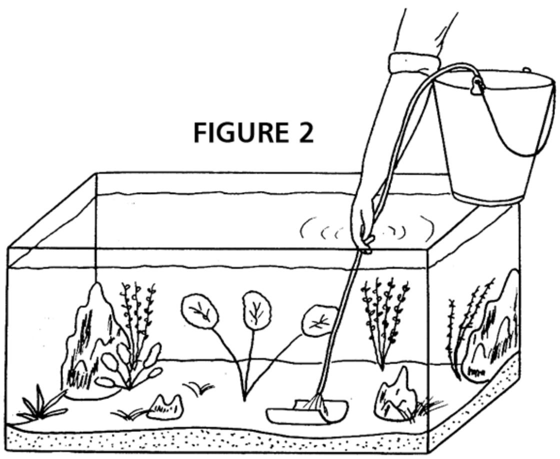


FIGURE 2

"center plants") are used to highlight the planting arrangement and are planted toward one side of the aquarium (figure 1). Do not use too many different kinds of plants because the result will be a cluttered appearance. Most persons who set up a tank for the first time make the mistake of not planting enough in the back and along the sides. Instead, they skimp on these and put in too many center plants. For the best results limit yourself to a single center plant or, at the most, two in any one aquarium.

It is not difficult to plant your aquarium properly; the exception is those plants with "crowns." The crown is the base from which the roots grow. Never bury it completely beneath the gravel; neither should you let it stick up into the water. It should be partially buried so that no roots show above the gravel. Remember to spread the roots in the gravel; do not ball them together. With plants that do not have crowns, simply stick them into the gravel. In time, they will develop a healthy root system.

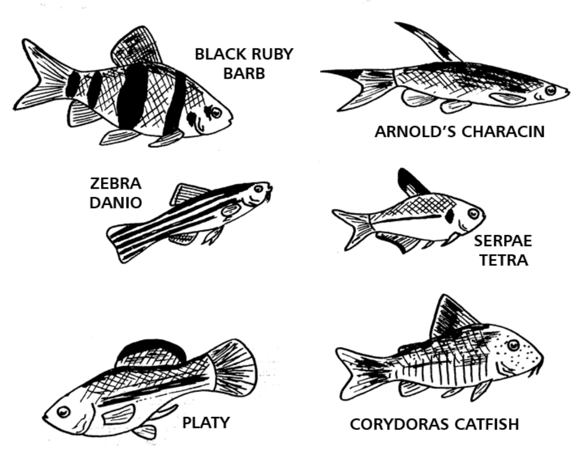
When your planting is finished, add the remainder of the water needed to fill the aquarium (figure 2). Do this carefully so as not to disturb the plants. In a few days it will be safe to add fish to the tank, thus completing setting up your first aquarium.

Fishes For The Community Tank

[All-Pets Magazine, October, 1958]

Although there are hundreds of different kinds of fishes available from time to time to the fish keeper, this does not mean that they can all be kept together in a community aquarium. A community aquarium is a peaceful collection of fishes that live well together. The most obvious question that must first be asked about any fish intended for such an aquarium is, "Is this fish too large or too small for my community tank?" An old axiom states, "Big fish eat little fish." There are some large fish that will not molest smaller fishes, to be sure, but generally speaking, smaller fishes quite often form a major part of the natural food supply of larger fishes.

There are some fishes that, although small or



immature in size, are just naturally nasty. Paradise fish, for example, will rip the fins of other fishes. Quite often, large specimens of Tiger Barbs will become fin-nippers and, bit by bit, reduce to shreds the fins of other fishes in the aquarium. In other words, there are a whole host of fishes that, due to their unpleasant disposition, must be kept by themselves or with similar fishes.

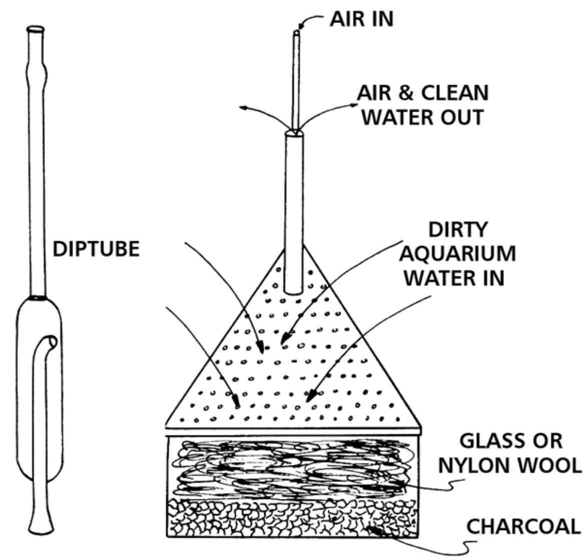
There are some fishes that will get along together very well, but because they require different conditions, will not prosper together in the same aquarium. Livebearers, for instance, require hard, alkaline water while the delicate lyretail of Africa needs soft, acid water. Archerfishes will only eat food found at the surface of the water while catfishes on the other hand will eat mostly from the bottom. Fishes kept together in a community aquarium should always be those who do well under similar conditions, or if this is not possible, then provision should be made for special treatment. As an example of special treatment, consider the catfishes. Often they do not get enough food to eat as other fishes beat them to it. An extra feeding just before the lights are turned off at night will provide them with food, since the catfishes eat at night when other fishes are inactive.

The drawings show some fishes that are good members of a community aquarium. Your dealer will be handy to tell you about the many others that can be added also to increase the numbers of beautiful and interesting fishes in your aquarium.

Care Of The Aquarium

[All-Pets Magazine, December, 1958]

If you have followed the aquarium principles that we have discussed in past articles then you should have little trouble with your fishkeeping. It is necessary, however, to clean the aquarium occasionally. In time fish wastes and plant debris collect on the bottom forming a

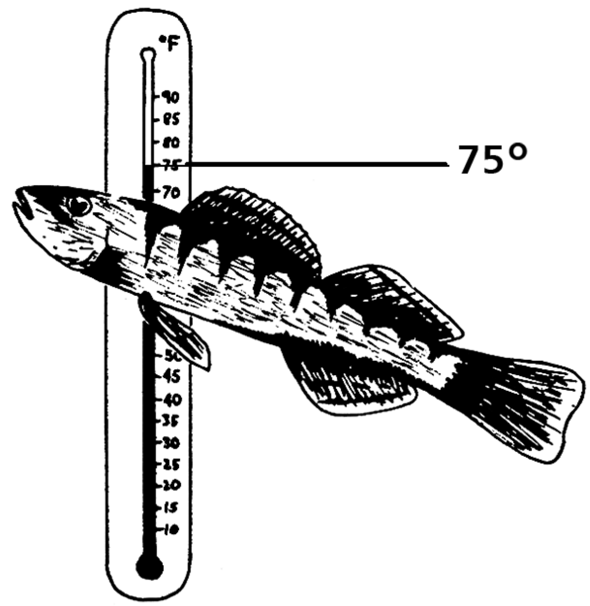


harmless but untidy accumulation called “mulm” or sediment. A good deal of this sediment can be removed automatically by an air-powered filtration arrangement. This consists of a small air pump, a filter and assorted tubing and valves. These vary in price from complete pump-filtration outfits under $10 to over $25 for a pump alone.

Some filters are made to hang on the outside of the tank (outside filters), others hang inside the aquarium in a corner (inside filters), and some are placed under the aquarium gravel (undergravel filters). A typical inside filter is shown in the illustration. The nylon or glass wool serves to remove sediment from the water while the charcoal removes harmful gases as well as some sediment. The wool can be re-used indefinitely while the charcoal is usually replaced several times during the year. By using a pump-filter combination, there should be very little extra cleaning needed for the aquarium.

For tanks without filtration (and occasionally even for aquariums with filtration), sediment must be removed by other means. A common device used is the dip tube (illustrated). This is a sort of suction device which works by placing a finger over the narrow stem and lowering it so the bulb is over the dirt. Releasing the finger causes the dirt plus some water to rush into the bulb where it is trapped. The dip tube can then be withdrawn and the dirty water can be released merely by turning the dip tube over and allowing the water to run out of the narrow stem. This device is very inexpensive and effectively removes large pieces of decayed plants and other debris.

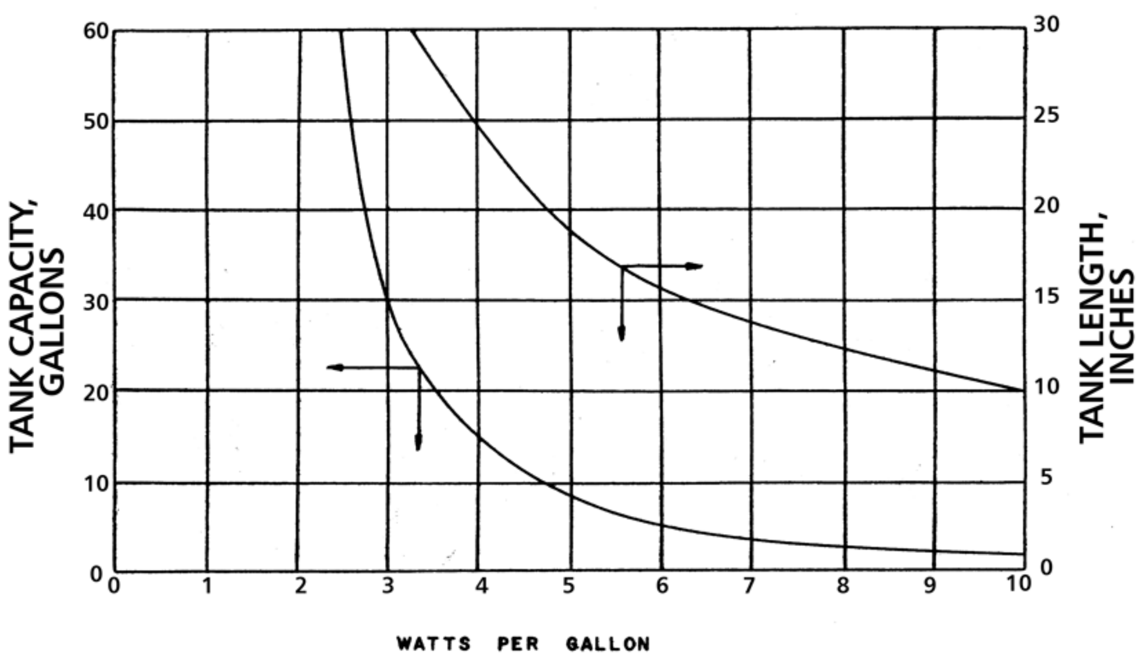
Even less expensive is the siphon tube. This can be of rubber or plastic. Care must be taken that not too much gravel is sucked into the siphon hose while using it. In addition, larger amounts of water are removed during cleaning with a siphon than with the dip tube and this water must be replaced with clean water of the same temperature.



Heating Your Aquarium

[All-Pets Magazine, January, 1959]

It is very important to keep your aquarium at its proper temperature. Since our aquarium fishes are commonly called "tropical fishes," many aquarists feel that their fishes must be kept in water at high temperatures. Although it is true that the tropics are hot as compared to our climate, tropical temperatures and especially water temperatures are much lower than most people think. A good, general tempera-



ture for your fishes (see sketch) is 75 degrees Fahrenheit. A few degrees one way or the other will not make too much difference, but it is important that the water temperature does not drop below 75 degrees.

To keep an aquarium at the right temperature, automatically controlled, electric heaters are used. They are available in many different sizes. If the temperature in the room in which the aquarium is to be kept will not fall below 55 degrees, the graph will tell you how many watts per gallon you will need. For example, if you have a 15-gallon aquarium, the graph shows that four watts per gallon are needed. This is a total of 60 watts. Choose the heater that is closest to this figure. Since a standard 15-gallon aquarium is 24 inches long, the right hand side of the graph could have been used to obtain the four-watts-per-gallon figure. If there is any difference between the two results, use the highest figure.

Always read the directions packed with each heater. It is easy to overlook an important instruction. Although it is possible to buy heaters separately and the controls (called thermostats) separately, it is far simpler to purchase the combination. These combination devices are simply called "thermostatic heaters." They require nothing more than a yearly checkup to provide a safety margin for your fishes should the temperature in the room drop to dangerous levels.

Feeding Tropical Fishes

[All-Pets Magazine, February, 1959]

The fish keeper probably has more freedom in feeding his pets than any other type of pet owner. Many fishes are carnivorous in nature; this is to say, they eat mainly animal matter. Fishes that eat mostly vegetable matter are called "herbivorous." Need-less to say, there are some fishes that just can't make up their minds and will eat either animal or vegetable foods equally well and so are called "omnivorous" feeders. Most aquarium fishes fall into this last category.

An easy way to feed your fishes is with the dry food that is available at your dealer. This should be fed a little at a time but often. Watch what happens to the food. If it sinks to the bottom, uneaten, then the next feeding time, feed a little less. Although feeding two or three times a day has its benefits, don't worry if you can only feed once a day. There are other ways to make up for it.

One of these ways is by giving a variety of foods to your fishes. In addition to dry foods, try bits of canned shrimp or some of the baby foods such as chopped beef. Your fishes will enjoy this. Any food not used can be frozen, and the following day, bits of the frozen food can be broken off and dropped into the aquarium where it will thaw and be eaten by your fish. Canned shrimp or other large foods must be cut into smaller pieces.

TUBIFEX WORM

MIDGE LARVA

MOSQUITO LARVA

DAPHNIA

Many dealers carry live foods in stock during certain seasons. If not, the fish keeper can often catch his own. Some of the live foods suitable for fishes are illustrated. These include mosquito larvae, daphnia, midge larvae, tubifex worms, and others. Al-most any aquatic insect will serve as a fish food, but you must be careful not to include any fish enemies such as water boatmen or dragon fly larvae. Ignore any insect which has suspiciously large pincers — your fish may suddenly turn into food for them!

Fish Ailments

[All-Pets Magazine, March, 1959]

If the principles of fishkeeping have been carefully followed, it is seldom that your fishes will become sick. Accidents will occur, however, as well as troubles over which the aquarist has little or no control.

An important part of keeping an aquarium healthy is to recognize the various fish ailments during their early stages. If you can, control measures may be taken to prevent more serious conditions. Five very common disorders are illustrated. They are: (1) White Spot or “Ick,” an infection caused by parasites which produces tiny white spots over the fishes’ fins and body; (2) Consumption, a wasting away of the fish which is especially noticeable in the belly area; (3) Folded Fins, a general condition indicating that something more serious is to follow; (4) Fungus, a white fuzzy growth that can occur on any part of a fish’s body or fins and (5) Dropsy, a swelling of the body so great that the scales stand out.

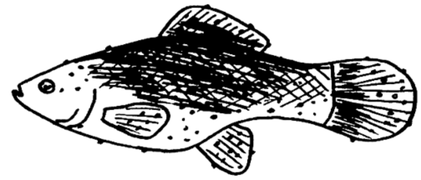


Figure 1

Figure 2

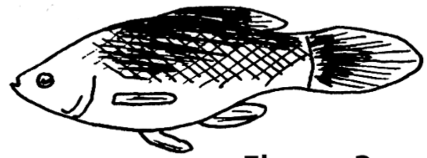


Figure 3

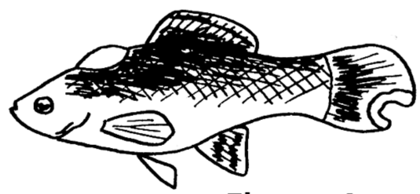


Figure 4

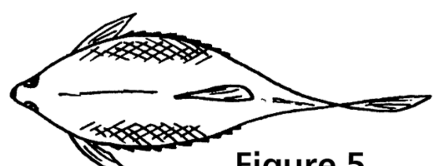


Figure 5

White Spot is a definite disease with a specific treatment. It is usually caused by a sudden drop in water temperatures or by infection from other fishes. There are several commercial remedies on the market (most of them contain either a blue or a greenish-yellow dye), but a useful home treatment is a gradual addition of two tablespoonfuls of table salt to the water plus an increase of temperature to 85 or 90 degrees F.

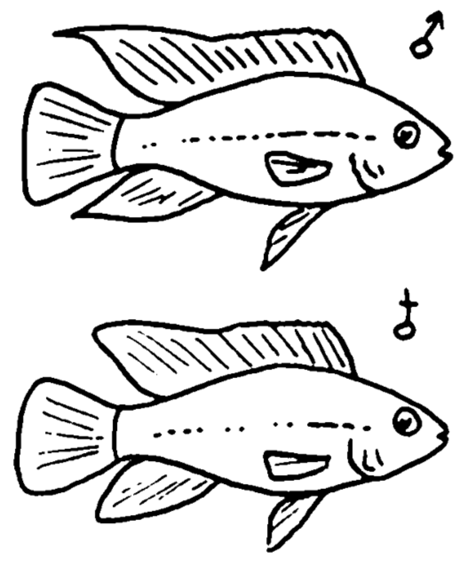
Since salt will damage the plants, they must be removed during the treatment. The salt cure is also affective against certain kinds of fungus. This disorder is usually caused by wounds or bruises. If the fish is large, you may daub it with Mercurochrome on the afflicted area. Of course, the fish must be removed from the tank and held in a net during the swabbing.

For some ailments, there is no cure. This is the case with Dropsy. Like Fungus, it is not contagious (but White Spot is!) Since no cure is available, it is best to destroy the fish. Consumption, also, is an ailment that is difficult to treat. Sometimes feeding with live foods helps, but only if the wasting away has not gone too far.

When an aquarist first notices a fish with folded fins, however, there is still hope. Make a check for a possible cause such as dirty water, black or foul gravel, overfeeding, chilling, etc. A preventive treatment with salt and increased temperature or with commercial remedies often will prove helpful. With tropical fishes it is far easier to prevent a disease by using good methods of care than to cure it.

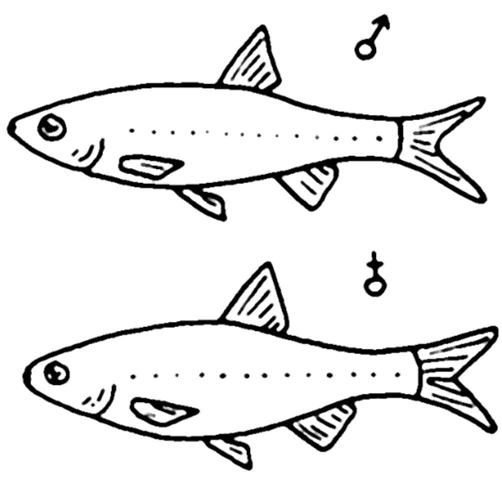
Sexing Fish

[All-Pets Magazine, December, 1959]



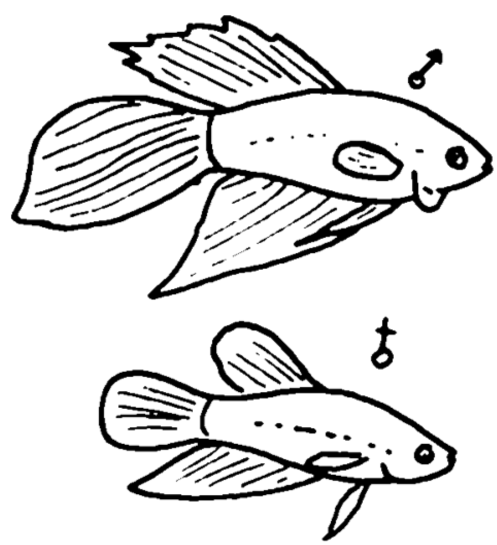
Cichlids

1. Males have longer points on dorsal
2. and anal fins.
3. Important exceptions are discus and angelfish.



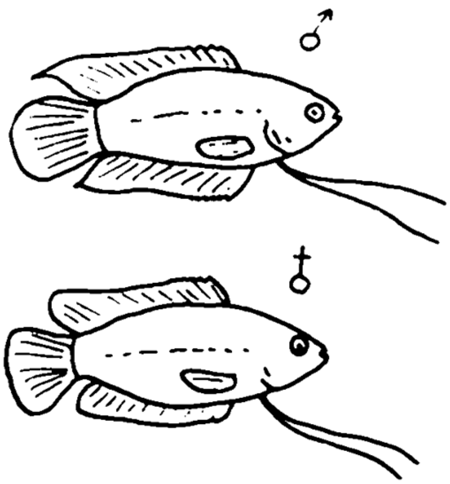
Danios, Rasboras, and Barbs

1. Female has deeper body.
2. Most barb males are more colorful than the females (rosy barb, black ruby barb, *oligolepis* and others).
3. *Rasbora* and *Danio* males are colored about the same as their females.



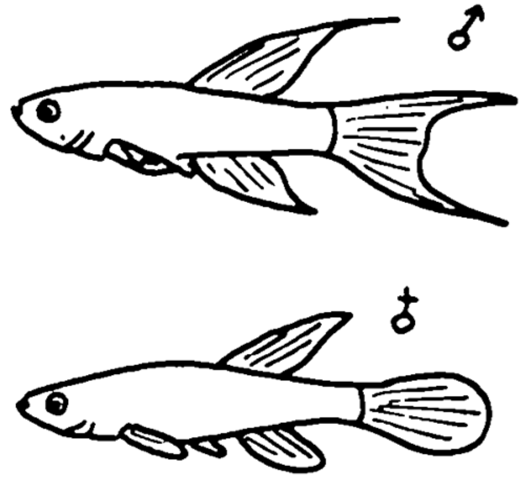
Bettas

1. Male has longer fins.
2. Female is smaller.
3. Male is much more colorful.



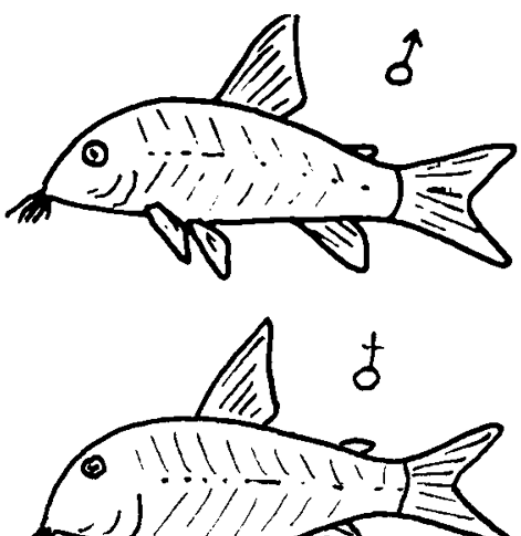
Gouramies

1. Dorsal and anal fins are more pointed in the male.
2: Males are more colorful in the following fishes: dwarf gourami, giant gourami, and thick-lipped gourami.
3. Sexes colored about the same in the following fishes: pearl gourami (out of breeding season), blue gourami, and snake-skin gourami.



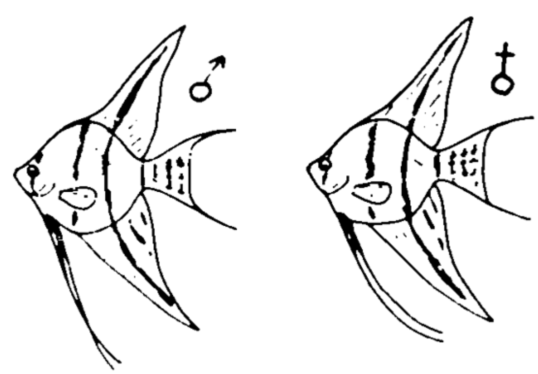
Killifish

1. Males have longer fins.
2. Males are much more colorful.
3. In *Rivulus* species, females have a black spot at the base of the dorsal fin.



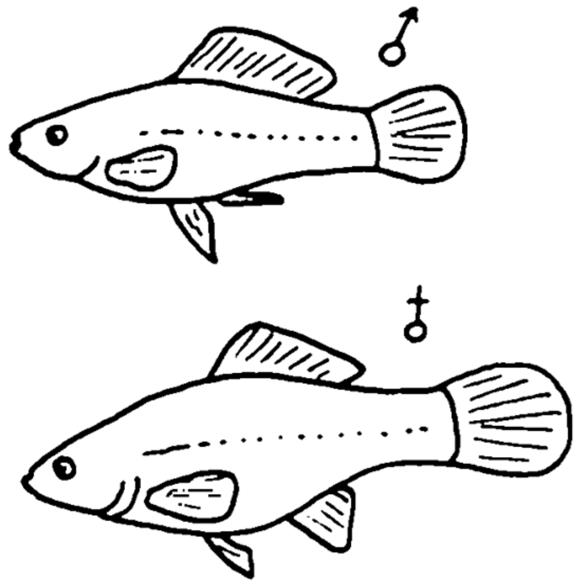
Corydoras Catfish

Difficult to sex. Males generally are slimmer than females.



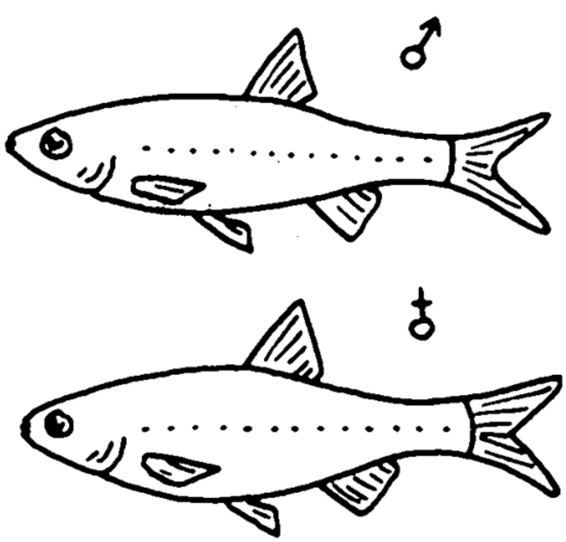
Angelfish

1. Feelers (ventral fins) of the male do not curve much until tips are reached.
2. Line of body between ventral fins and anal fin is steeper in the male.



Livebearers

1. Male has anal fin formed into an elongated gonopodium.
2. Females generally larger.
3. In some livebearers (guppies, for example), the males are more colorful.



Characins or Tetras

1. Females have deeper bodies.
2. Males often have more curved anal fins.
3. In some species (*rosaceus* and others), the males have longer and more colorful dorsal fins.

Composition of Tropical Waters

[All-Pets Magazine, December, 1959]

Editor's Note: The charts below, showing the water composition of tropical fish habitats, mark the first time such complete information has been made available to fish fanciers.

The analyses in Table I represent the waters of South America. The Amazon (by Santerem) is a representative Yellow Water, the Rio Tapajos a representative Clearwater and the Rio Maro, a representative Blackwater. The use of a handbook will tell you what type of South American water any fish has come from.

Since subtle changes in water chemistry initiate spawning, the effect of seasonal variations in water chemistry is important to the aquarist. Table II summarizes these changes for a Clearwater and a Blackwater River:

The Ruzizi River analysis in Table III represents an average African river. Since the outflow from Lake Tanganyika is highly restricted, water is lost mostly by evaporation. This, of course, increases the concentration of mineral matter in the Lake water. The Lake water resembles seawater in some respects. It should be remembered that some African aquarium fishes are found in lagoon pooh which receive an inflow of some seawater. Thus, many species can withstand salt in their water. This is summarized as follows:

1. Lagoons and side waters of the river mouths with variable salinity: *Aplocheilichthys, Epiplatys, Tilapia, Hemichromis,* and *Pelmatochromis* species.
2. Pure freshwater courses (creeks) of the river system: Members of the above genera, tetras such as *Alestes* species, also *Barbus*, *Pantodon* and, *Polycentropsis* species.
3. Small, slowly flowing, very shallow watercourses, also pools and springs, occasionally, some salt water admixing: *Aphyosemion* species and some *Epiplatys* species.

TABLE I: SOUTH AMERICA			
COMPOSITION	AMAZON RIVER (by Santarem)	LOWER RIO TAPAJOS	LOWER RIO MARO
PH	6.5-6.9	6.4-6.65	4.4
Free CO_2, mg/l	3.9-7.2	0.8-3.5	7.4-13.2
Bicarbonate CO_2, mg/l	8.8-17.3	3.14-5.2	0
Total hardness, DH	0.65-1.27	0.31-0.82	0.09-0.45
Total iron, mg/l	0.36-0.38	0-0.12	0.08-0.13
Aluminum, mg/l	0	0	Trace
Manganese, mg/l	0	0	0
Ammonia, mg/l	Trace	0.07-0.18	0.05-0.08
Silicate, mg/l	6.0	3.2-5.6	3.5
Chloride, mg/l	0-0.3	0.1-0.5	0.5
Sulphate, mg/l	0-2	0	0
Phosphate, mg/l	0	0	0
Nitrates, mg/l	0-2.8	Trace-0.3	0
$KmnO_4$ consumption, mg/l (a measure of organic matter in the water)	21.4	12.7-25.1	12.6-28.0

TABLE II							
	RIO TAPAJOS						
COMPOSITION	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
pH	6.6	6.5	6.4	6.3	6.4	6.5	6.6
Hardness, DH	0.39	0.34	0.28	0.90	0.78	0.73	0.67
$KmnO_4$ consumption, mg/l	12	20	25	23	21	19	17
Salt content, mg/l	23.6	20.0	16.7	30.5	28.4	28.1	27.1
	RIO IGARAPE (a Blackwater)						
COMPOSITION	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
pH	4.8	5.0	5.2	5.4	5.5	5.6	5.6
Hardness, DH	0.05	0.22	0.39	0.50	0.67	0.84	1.01
$KmnO_4$ consumption, mg/l	10	16	20	23	26	28	30
Salt content, mg/l	6.2	10.1	14.0	16.2	19.4	22.5	25.5

TABLE III: AFRICA		
WATER COMPOSITION	RUZIZI RIVER	LAKE TANGANYIKA (noted for its high concentration of minerals)
Sodium, ppm	25.0	64.2
Potassium, ppm	9.0	33.5
Calcium, ppm	19.0	15.2
Magnesium, ppm	17.2	43.7
Iron, ppm	Less than 0.1	Less than 0.1
Aluminum, ppm	0.3	0.3
Chloride, ppm	14.0	28.0
Sulphate, ppm	8.2	4.0
Nitrate, ppm	1.5	1.8
Nitrite, ppm	0.003	0.006
Phosphate, ppm	0.06	0.6
Silicate, ppm	26.0	13.5
Carbonate, ppm	100.0	207.6
Totals, ppm	220.6	413.3

TABLE IV: ASIA		
COMPOSITION	MEDAN, MALAYSIA	SINGAPORE JUNGLE
Clarity	Cloudy	Clear, without sediment
Color	Yellowish	Colorless
Odor	Strongly moldy	Odorless
pH	6.15	6.0
Ammonia, mg/l	2.64	0
Nitrate, mg/l	20.0	0
Nitrite, mg/l	Trace	0
Chloride, mg/l	Almost nothing	2
Bound CO_2, mg/l	1.1	0
Iron, mg/l	1.3	0.3
Manganese, mg/l	3.6	0
Total hardness, DH	2.4	1.4

TABLE V: GOBY WATER	
COMPOSITION	MEDAN (streams open to the sea)
Clarity	Cloudy
Color	Yellowish
Odor	Almost odorless
pH	7.3
Ammonia, mg/l	4.3
Nitrate, mg/l	0.3
Nitrite, mg/l	Trace
Chloride, mg/l	1600
Bound CO_2, mg/l	83.6
Iron, mg/l	0.15
Manganese, mg/l	nil
Total hardness, DH	31.6

4. Flowing clear water brook courses, also native water holes: *Aplocheilichthys* species.
5. Papyrus marshes, large African lakes and muddy water courses of West African rivers above the salt water zone: *Calamoichthys, Polypterus, Protopterus*, elephant fishes, Anabantids, *Polypterus*, *Channa* species, catfishes, *Epiplatys* species, knife fishes and *Barbus* species.

Tables IV and V show typical variations in Asian waters. The Table IV waters contain rasboras, barbs, gouramies, and other Asian fishes. However, gobies are found in very different types of water. Table V shows a typical goby water.

Except for goby waters, Asian waters (of the type containing tropical fishes) are relatively low in solids. They are remarkable for their iron and manganese content.

Pronunciation of Fish Names

[All-Pets Magazine, December, 1960]

There is probably no shakier ground for the individual aquarist than the pronunciation of scientific fish names. Combinations of Greek and Latin are not easy for American hobbyists. It would be impossible to treat this subject completely in a short article, but it is possible to present a number of rules, the use of which can assure the aquarist of being right most of the time! The remainder of this article will be divided into two parts: (a) Pronunciation (excluding accent) and (b), Accent. There is little controversy among American aquarists over the first although our British friends would certainly take issue with us in many instances. In view of this, this article is strictly for American ears. In the matter of accent, there is considerable difference of opinion, especially in words containing many syllables. The rules that will be presented are consistent and reflect common (but authoritative) usage.

Part A — Pronunciation (excluding accent)
In general, all vowels are long with the exception of a vowel that is followed by two consonants. For example, brachy is pronounced, **brak'**-ee, since the a is followed by c and h, both consonants. On the other hand *Labeo* is pronounced, **lay'**-bee-o, since the a is followed by a single consonant, b. Other rules in pronouncing vowels follow common English us-

age and often follow automatically if the stresses are placed correctly.

Rule 1: When a fish is named in honor of a person, the name should be pronounced as he or she would pronounce it.
Examples:
(a) *arnoldi*, **ar'**-nold-eye
(b) *dayi*, **day'**-eye
(c) *viehoeveri*, vee-**hoo'**-ver-eye
(d) *riddlei*, **rid'**-del-eye

Comments: Most errors can be traced to this source. Two frequent (and horrible!) errors are found in pronouncing *agassizi* and *ramirezi* in this manner: ag-ga-**see'**-zee and ram-a-**ree'**-zee. They should be pronounced, **ag'**-a-see-eye and ra-**meer'**-iz-eye, in accordance with the French and Spanish, respectively, pronunciation of these words.

Rule 2: In words beginning with CT, PT and PS, the first letter is silent. Examples:
(a) *Ctenobrycon*, ten-o-**bry'**-con
(b) *Pterophyllum*, ter-o-**file'**-lum
(c) *Pseudocorynopoma*, soo-do-ko-ree-no-**poe'**-ma
(d) *Ctenops*, **ten'**-ops

Comments: Although the P may be sounded, the C definitely is not. For most persons, a PT or PS sound is difficult and the P can be correctly dropped.

Rule 3: CH is always pronounced hard. Examples:
(a) *Charax,* **kay'**-rax
(b) *Chela*, **kee'**-la
(c) Characin, **kar'**-a-sin
(d) *Chaetodon*, **keet'**-o-don
Comments: Characin is frequently mispronounced **chair'**-a-sin.

Rule 4: OE and AE in combination take the long sound of E. Examples:
(a) *Poecilia*, pee-**sil'**-ee-a
(b) *Aequidens*, **ee'**-qui-dense
(c) Nandidae, **nan'**-di-dee
(d) *marthae*, **mar'**-thee
Comments: Diphthongs are always difficult for Americans! This rule should help in pronouncing the family names as they end in idae.

Rule 5: G is sounded hard when it comes before A, 0 and U. It is sounded soft when it comes before E, I and Y. Examples:
(a) *Gambusia*, gam-**bew'**-see-a
(b) *gobius*, **go'**-bee-us
(c) *Geophagus*, gee-o-**fay'**-gus
(d) *Gymnotus*, jim-**no'**-tus
Comments: This is usually handled correctly by aquarists as it follows a simple rule that is used in everyday speaking.

Part B — Accent
With few exceptions, two-syllable words are accented on the first syllable. The problem arises in polysyllabic words containing more than two syllables. In the discussion that follows, only the last accent is considered for, if this is correctly placed, the other accents will follow naturally and automatically.

As a general rule, the accent is placed upon the next-to-the-last syllable, called the penultimate. Examples:
(a) *Cichlasoma*, sick-la-**so'**-ma
(b) *semifasciolatus*, sem-ee-fas-see-o-**lay'**-tus
(c) *Hyphessobrycon*, high-fess-oh-**bry'**-con
(d) *oligolepis*, o-lee-go-**lee'**-pis
Comments: Common errors are: o-lee-**gol'**-la-pis and high-phess-**sow'**-bra-con. Other errors are ana-**kar'**-ris and krip-toe-**kor'**-reen for *Anacharis* and *Cryptocoryne*. These should be pronounced an-**ak'**-ah'-ris and krip-toe-ko-**rye'**-nee.

Unfortunately, the general rule is subject to many exceptions. Almost without exception, however, if a word is not accented on the penultimate, it is accented on the antipenultimate (the syllable next to the next to the next-to-the-last!). Here are the more important exceptions:

Exception 1: Words ending in ODON, or ODONT. Examples:
(a) *Pantodon*, **pan'**-to-don
(b) Cyprinodont, see-**prin'**-odont

Exception 2: Words ending in EUS and EUM. Examples:
(a) *Chalceus*, **kal'**-see-us
(c) *Myleus*, **my'**-lee-us
(d) *coeruleum*, see-**roe'**-lee-um

Exception 3: Words ending in IDAE Examples:
(a) Cichlidae, **sick'**-la-dee
(b) Poeciliidae, pee-sill-**eye'**-ah-dee

Exception 4: Words ending in IA or IAS. Examples:
(a) *lalia*, **lal'**-ee-a
(b) *Tilapia*, tee-**lay'**-pee-ah
(c) *Neolebias*, nee-o-**lee'**-bee-as
(d) *Botia*, **boat'**-tee-ah

Exception 5: Words ending in STOMUS. Examples:
(a) *Plecostomus*, plee-**cos'**-toe-muss
(b) *Nannostomus*, nan-**nos'**-toe-muss

Exception 6: Words ending in ION, 1O or EO. Examples:
(a) *Aphyosemion*, aff-ee-oh-**sem'**-ee-on
(b) *terio*, **teer'**-ree-o
(c) *Labeo*, **lay'**-bee-o

Exception 7: Words ending in IUS and IUM. Examples:
(a) Characidium, kar-a-**sid'**-ee-um
(b) conchonius, kon-**ko'**-nee-us

Exception 8: Words ending in a consonant plus S. Examples:
(a) *latifrons*, **lay'**-ta-frons
(b) *acuticeps*, ay-**kew'**-ta-seps

Exception 9: Words ending in PTERUS or PTERA or PTERIS. Examples:
(a) *Notopterus*, no-**top'**-ter-us
(b) *callipterus*, kal-**lip'**-ter-us
(c) *Ceratopteris*, sera-**top'**-ter-is
(d) *dolichoptera*, do-la-**kop'**-ter-a

Exception 10: Words ending in PHALUS or PHALA. Examples:
(a) *microcephalus*, my-krow-**sef'**-a-lus

Exception 11: Words ending in CUS, Examples:
(a) *typicus*, **tip'**-a-cus
(b) *metallicus*, met-**tal'**-a-cus

Above 60% or more of fish names are accented on the penultimate syllable, the remainder on the antepenultimate. Therefore, it does pay to learn the above exceptions to the penultimate rule. If these are learned, others may be discovered by analogy; *Monodactylus* would be pronounced, mo-no-**dak'**-til-us, for example.

Dwarf African Frogs

[All-Pets Magazine, April, 1962]

In recent years, aquarists have been able to purchase, in limited quantities, a quaint animal known to the trade as the "dwarf African frog." These amphibians have been identified at various times as either *Hymenochirus boettgeri* or *Hymenochirus boulengeri*; the former designation being supplied by Messrs. Olsson and Oesterdale of the Zootomical Institute (University of Stockholm, Sweden) and the latter by Pierre Brichard, the well-known African collector. The specimens studied by our Swedish friends were obtained from a German aquarium fish dealer who merely listed them as "afrikanische Kleinfroesche." The first introduction of dwarf African frogs into this country was by Mr. Brichard, via Roosevelt Aquarium, directly from the Congo. In spite of the closeness of the two specific names, it is not a typographical error; these are two separate and distinct scientific names. If Mr. Brichard is correct in his identification, then aquarists have available to them, two species of dwarf frog of this genus. European aquarists have also kept two other genera, *Xenopus* (both *Xenopus laevis* and *Xenopus gilli*, the latter a dwarf species), and *Hyperolius* (*Hyperolius cinctiventris* from Nairobi and *Hyperolius melanoleucus* from the Congo area). However, we will discuss only the *Hymenochirus* species here as only they have received widespread interest in the United States.

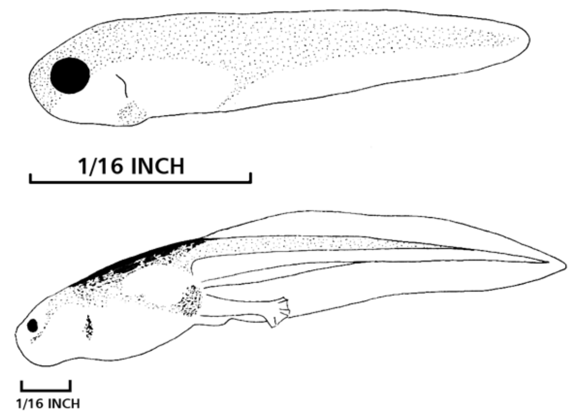
Surprisingly, these dwarf "frogs" are not frogs at all but rather a genus of West African clawed toads closely related to *Xenopus*. As frogs are generally characterized by their aquatic habits, smooth skin, webbed feet and greater agility vis-à-vis toads which are generally thought of as being terrestrial (except during the breeding season when they seek the water), sluggish and having rough skin, an amphibian possessing combinations of these characteristics is an unusual creature! *Hymenochirus* is a true aquatic toad despite the fact that it moves with more ease on land than in the water. Their feet are webbed and display prominent claws on the toes.

Sexing is rather easy as the females are quite broad compared to the male's slimness. The males produce a vibration sound - a period of croaking alternating with periods of silence. In the aquarium, they are little trouble although a close-fitting cover glass should be provided to prevent unscheduled exits. Food is not much of a problem either. Basically carnivorous, they readily take white worms, tubifex worms, raw meat, frozen brine shrimp and even dried foods (especially those high in meat content, such as dried shrimp, daphnia, etc.). Just as with most aquarium fishes, baby guppies and other very small fish are greedily consumed (they locate the prey, by the way, mainly by sight) but the frogs will not bother adult fishes. Needless to say, "froggy" antics provide an interesting variation in aquarium activities.

Dwarf African frogs of this genus are not too difficult to spawn. They have been triggered to spawning activity merely by being placed in a sunny location although the spawning act itself may take place during the evening hours. The "frogs" are not particular about water conditions and have spawned in alkaline water and at temperatures of from 72 to 78 degrees Fahrenheit.

The sex act is very unusual and commences with the female turning upside down with the male clinging to her back. This activity takes place at the surface of the water. In this position, the female keeps her genital tract protruding slightly above the surface of the water while anywhere from two to ten eggs are released. After depositing these eggs, the pair returns to the bottom only to rise again after a few minutes to repeat the act. After about 50 trips, all eggs are laid.

The eggs do not adhere to one another and, in addition, float of their own accord. As with typical amphibian eggs, they are surrounded by a jelly about 1.5 mm thick (the eggs themselves are about 0.9 mm in diameter). After



Larva of *Hymenochirus boettgeri*. Upper figure, newly-hatched; lower figure, 14 days old.

two days, the heavily pigmented tadpoles hatch out.

Feeding starts almost immediately - finely powdered dry food at first, and then newly hatched brine shrimp. Unlike the larva of other frogs and toads, *Hymenochirus* "tads" maintain a horizontal, typical fish-like position. After the fourth day, feeding is no problem and the tadpoles quickly grow to maturity. For the aquarist who desires an interesting change of pace, dwarf African frogs may be the answer.

A Child's First Aquarium

[All-Pets Magazine, April, 1963]

The interest my own children have shown in aquarium fishes has always been a source of great personal satisfaction to me. This interest, by the way, is voluntary with no coaxing on my part needed. I can still remember the day when my oldest son (then age 6) badgered me for almost a week to show him, once again, the beating heart of a fertilized fish embryo under the microscope. He spent the whole week telling his school chums about that event!

From time to time, I have amused myself with friends by calling my four-year old daughter over to a tank and asking her to identify a fish. *Nothobranchius*, she might say to the amazement of my friends, correctly identifying a not-too-common fish and using, in the bargain, a word almost as long as she is! And because of

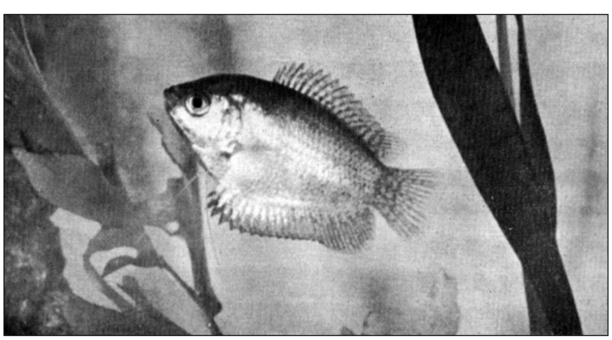


FIGURE 1

FIGURE 2

their questions concerning livebearers, I think my wife and I will have little need for the standard "birds and bees" lecture that most parents little relish. Yes, a child's interest in the aquarium, as with their interest in natural history in general, is a wondrous thing indeed.

Before one can introduce a child to his or her own aquarium, however, certain principles must be considered. In practice, these principles are often ignored. There is a tendency to start a child off with a small tank at first, when the opposite is really needed. It takes quite an expert to successfully manage a one, two or three-gallon aquarium. Why? Because the built-in "safety factors" against the aquarist's mistakes are much smaller in a small tank. A single overfeeding in a two-gallon aquarium, for example, will reduce the aquascape to a cloudy, stinking mess within a day, while overfeeding in a 15-gallon tank can be absorbed with` no ill consequences unless it is repeated over a relatively long period of time. Therefore, it is always better to start with a 10-gallon or 15-gallon tank than with anything smaller. A five-gallon size can be managed, but only under close supervision.

Because a child will naturally take the loss of any animal quite hard, it is really poor economy to try to do without a thermostatic heater combination. Since it materially aids in aquarium housekeeping and increases our “safety factors,” filtration and aeration are also recommended. These mechanical devices are certain to stimulate the child into asking questions, and the answers will introduce him to aspects of geography (“We use a heater because in South America, where our neon tetras come from, the water temperature is higher than in that stream by Grandma’s”), physiology (“Fishes breathe in oxygen and breathe out waste gases such as carbon dioxide. The air bubbles help the fish get oxygen and they also carry off the waste gases”) and bacteriology (“The filter takes out from the water, waste materials, uneaten food and other things which bacteria grow upon. The more the filter removes, the fewer harmful bacteria will be around to make the fish sick”).

The fishes chosen for a child’s aquarium need not be chosen upon esthetic considerations as they might for an adult’s aquarium. Children are interested in each fish individually, rather than the community of fishes as a whole. Thus, the C*orydoras* is interesting because it is the only aquarium fish that “winks;” a dwarf gourami (figure 1) can manipulate its “feelers” (actually its ventral fins) as a sort of pair of “hands;” and the zebra danio looks like its namesake. Yet, the combination of a schooling fish such as the zebra, and a slow-moving, shy, non-schooling type such as the gourami would most likely be passed over in the sophisticated adult’s aquarium.
Yet, the principles of compatibility cannot be overlooked in the child’s tank either. Figure 2 shows a horrible example, including a neon tetra, a black molly, an *Anostomus*, an angelfish, and a Jack Dempsey. The molly does not do well in an aquarium containing soft, acid water as do the others. Furthermore, it does best when vegetable matter is provided in its diet (as does the *Anostomus*).

There is too much difference in size between the cichlid and the neon tetra. If the food size is right for one, it is wrong for the other. Finally, the *Anostomus* will hound the poor angelfish and reduce its feelers to mere stubs in time. Restraint must be shown in the selection of fishes for a child’s community aquarium, and the reasons for vetoing a choice must be made clear. It is a part of the educational process that the tank provides as a whole.

Feeding may be a problem. Most children, I have observed, do better at adding the proverbial standard “pinch” of dry food than do adults. Perhaps it is because the child’s “; inch” is smaller! The bugaboo of overfeeding is always present’, however. My own children delight in field trips, weather permitting, to obtain live fish foods. They dig in with their nets scattering most of the daphnia, mosquito larvae, etc., in the vicinity, but they still manage to bring home some food. They take special pleasure in feeding it to their fishes and many a happy squeal can be heard as a hungry fish snaps up another mosquito larva.

Do not overlook the opportunity to associate each plant and fish with its natural habitat or origin. If the child desires, a sort of game can be played where the child, over a period of time, adds plants and fishes to his tank so that there is a representative from every major portion of the world present. Introduce him to the thermometer and instruct him (or her... the

Suggested Populations of Fishes for a Child's 10-gallon Tank

2 rasboras (*Rasbora heteromorpha*)
2 pearl gouramies
2 small *Corydoras*
1 male betta
4 zebra danios
4 guppies
4 head-and-taillight tetras
4 neon tetras
1 Siamese algae-eater
4 angelfish (body size about that of a half-dollar)

aquarium is a source of pleasure for a girl just as it is for a boy) in its use. Have him mix hot and cold water at the tap to match the temperature of the aquarium water.

While speaking of plants, don't make the mistake of using inexpensive plants more suited to the cold-water tank than to the tropical aquarium. Such plants include the classic *Cabomba, Myriophyllum,* and *Anacharis*. Instead, use fast-growing tropical plants such as *Hygrophila*, banana, and sword plants.

With one fell swoop, the aquarium affords a multitude of educational foci for the child. The principles of fishkeeping are the same for child and adult, but I sometimes wonder if the innocent responses to nature's ways by the former are not infinitely more rewarding.

Seven Spot Live Bearer
Poecilistes pleurospilus

[All-Pets Magazine, July, 1963]

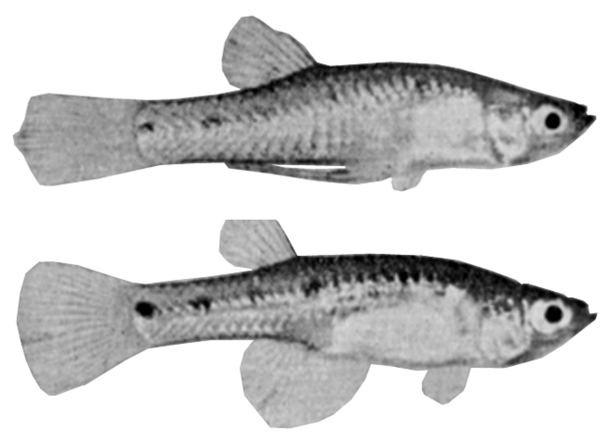
The "seven spot livebearer" would be a good name for our subject if it weren't for one small detail ... the number of its body spots varies with the individual from three on up to ten or eleven! An average count, however, should show six or seven spots present. Nevertheless, no one should feel cheated should his fish have the lesser complement of spots, nor elated with the larger complement for it is just a reflection of the kind of variability for which Mother Nature is well known.

The scientific name, *Poecilistes pleurospilus***,** (pronounced PEE-SILL-**ISS'**-TEES PLURE-OH-**SPY'**-LUS), is longer than the fish itself for males seldom exceed $1^1/_4$ inches and females, 2 inches. It hails from Central America, more specifically the coastal slopes of the Atlantic and Pacific oceans of southern Mexico and of Guatemala.

Because it is not as showy as such livebearers as guppies, swordtails and moons, *Poecilistes* has typically been somewhat neglected by aquarists. However, since its importation as an aquarium fish in 1913, it has appeared regularly in the stores and has attracted those aquarists willing to evaluate a fish solely upon its own merits, and those who have become disillusioned with the unrelenting rat race that goes under the general heading of "breeding better guppies." Since *Poecilistes* is hardly likely to be seriously entered as a candidate for "Best In Show," the aquarist can concentrate on the fish itself and in the process, broaden his knowledge of the aquarium world.

The basic coloration of both sexes is olive-green, although the author has noticed that under oblique lighting, this appears as a light violet. As with many fishes, the belly area is quite silvery. We have, of course, already mentioned the body spots that are dark-colored and arrange themselves along the lateral line of the fish. A few small spots may be present on the dorsal and anal fins. As with other livebearers, the anal fin of the male is modified into an intromittant organ called a "gonopodium."

What makes *Poecilistes* peculiar in this respect is that the rays of the anal fin that produce this tube-like organ, are fused together on the left



***Poecilistes pleurospilus*.**
Male above, female below.

side of the fin, rather than the right side or in the middle (as, for example, in the guppy). Furthermore, the tip of this organ has a characteristic, half-moon shaped structure of skin.

The reproduction of viviparous fishes is most interesting but aquarists should not fall into the trap of thinking that all livebearers breed in the same manner. Unlike the guppy, for example, there is no display behavior in *Poecilistes* (typical of such behavior is the contraction of particular muscles altering body shape, forming the familiar S-curve.

In those livebearers with extremely long gonopodia (and this includes *Poecilistes*), the copulatory act is most probably aided principally by visual cues. Therefore, such fishes are able to contact females while in motion. In forms with shorter gonopodia (guppies, swordtails, mollies, etc.), males rely more on tactile (touch) cues, hence, copulatory contacts are typically made while the female is stationary. If one takes the time to study his fishes, observations like these will teach the aquarist that what at first seems to be "all the same," later turns out to be quite the opposite.

Poecilistes is peaceful, unassuming in tank and food requirements, and easy to breed (breeding really takes care of itself!). It readily takes dry foods although it should be provided a diet varied with frozen foods and some vegetable matter (algae, etc.). Neutral to alkaline water of moderate hardness is recommended. A three to five gallon tank is sufficient for breeding, and the young can be reared in the same tank with their parents, provided that some cover or refuge is supplied (floating nylon mops, for example).

Although the parents may make dashes at the fry, the latter always seem agile enough to escape. In any event, the parents do not pursue the chase relentlessly. Many young are not dropped at a time but they are large at birth and easy to raise. At the $^1/4$-inch stage, only two or three spots are present on each fry but these are so crisp and distinct that the fry hardly seem to be of their parents! For something a bit different and out of the ordinary, the aquarist can't go wrong with *Poecilistes*.

The Lethal Light

[All-Pets Magazine, November, 1963]

The use of fluorescent lamps as a source of light for the home aquarium was considerably accelerated by the publication of the now classic article, "Fluorescent Lights for Home Aquaria", which appeared some fourteen years ago. 1. Prior to this time, the incandescent lamp reigned supreme in the hobby. However, the advantages of fluorescent lighting were threefold: (a) they provided a large, uniform source of light, (b) they produced relatively little heat, and (c) they consumed very little current.

Although only two indictments stood against the use of such lamps, they were still quite damaging. Not only did fluorescent lights have an unnatural effect on the colors of the fish, but also it was reputed to have in general a poor effect on the growth of aquatic plants. Both indictments were quashed, however, with the appearance on the market of a then new type of fluorescent lamp, i.e., "warm tint" (by General Electric) and "warm white" (by Westinghouse). This lamp type was, perhaps, the most important development in aquarium lighting in years.

However, it is quite clear that hobbyists have never really fully understood the rationale behind warm white (using this now as a generic term) fluorescent lighting and its relationship to plant growth. It has been commonplace to hear statements such as, "Plants require light energy in the red end of the spectrum; this warm white provides, while daylight types and other do not." How true is this statement?

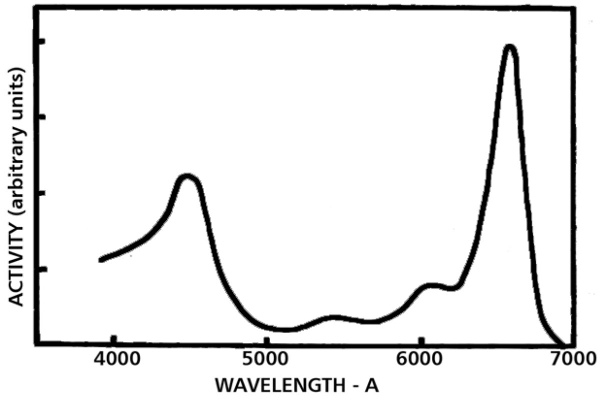


Table I indicates that in the red range (6000-7000 angstroms), warm white bulbs indeed do provide more effective energy than do white, cool white or daylight bulbs. The fact of the matter is, however, that plant activity is dependent upon two spectral areas, not merely just one (see figure 1). The area of wavelength, 4000-5000 A, a predominately blue area, is also important in chlorophyll synthesis activity. These two bands, red and blue, must be provided for optimum plant growth, and they must also be present in the proper ratio (i.e., about 1.8-1.9, red/blue). Warm white bulbs supply both wavelengths in the proper ratio all right, but their total energy output is relatively low.

Then in 1962, the aquarium hobby experienced its second lighting revolution, i.e., its introduction to the "Gro-Lux" fluorescent lamp. 2 As with fluorescent lighting in general, few hobbyists have subsequently evaluated this new lighting source properly. As far as the nature of the light output of the Gro-Lux bulbs is concerned, it differs very little from that of the warm white type. Its contribution lies in the tremendous increase in total effective energy that it produces vis-à-vis warm white (see Table I), for its red/blue ratio is almost identical to that of warm white (1.88 vs. 1.85).

A vital point is that the eye is sensitive mostly to the wavelength area lying between 5000 and 6000 A, and so this increased power of the Gro-Lux lamp is not particularly visible to the eye. Such lighting merely takes on a reddish cast to the eye due to its concentration in the red range. Its effect on fish coloration is amazing; in particular, reds and blues are enhanced beyond description. However, recent reports by hobbyists have revealed that perhaps all is not well. This type of lighting is fast obtaining a reputation for increasing the mortality of fish eggs and fry, i.e., the "lethal light." The interesting part of all of this is that although it is perfectly true, the fault really lies with the aquarist, not the lamp.

There is considerable evidence to support the contention that the various components of white light have a differential lethal effect on fertilized fish eggs and embryos. In 1959, the

TABLE I
LIGHT QUALITY OF SUNDRY FLUORESCENT LAMPS
(arbitrary units)

LAMP	EFFECTIVE ENERGY	TOTAL	RED/BLUE RATIO	
	4000-5000 A	6000-7000 A		
Warm white	35	65	100	1.85
White	50	58	108	2.16
Cool white	64	50	114	0.78
Daylight	78	56	134	0.72
Gro-Lux	80	150	230	1.88

egg mortality in the trout hatching tanks at the Cold Spring Harbor fish hatchery of New York State jumped to over 90%, in contrast to the usual mortality of about 10%. Experiments quickly showed that the white light from 40-watt cool white fluorescent lamps was responsible. Further investigation has indicated that the violet-to-blue bands are highly lethal, with lethality diminishing as progression is made towards the red band. Many aquatic organisms spawn during cloudy, windy, or rainy weather, conditions during which only the less lethal green-to-red light penetrates to any depth. Furthermore, many fishes deliberately conceal their eggs or lay them in places such that they are protected from light (e.g., many killifishes lay their eggs among plant thickets).

Other protective adaptations have d been made also. Many fish eggs, for example, are yellowish, a color that filters out the lethal blue rays. In experiments with rainbow trout, Dr. Karl Handorf found that a greater resistance to the lethal effect of all kinds of visible light was exhibited by the more intensely colored yellow eggs than by paler eggs. In addition, in the late stages of embryological development in fishes, large melanophores (black pigment carriers) are common over such sensitive portions of the body as the brain, spinal cord, and abdominal cavity. Also, large xanthophores (yellow pigment carriers) are often found together with these melanophores.

A re-examination of Table I then, shows the reason for the lethality of Gro-Lux lighting. It emits twice the energy in the lethal blue range than does the more commonly used, warm white or white bulbs (cool white and daylight types are seldom used by aquarists). Yet, because the visible output of Gro-Lux lighting is relatively low, aquarists overlook the fact that its effective energy output is high. The conclusion? On an equal energy basis (say roughly 11 warm white bulbs for every 5 of Gro-Lux), Gro-Lux is no more lethal than warm white. The fault rightly is to be placed at the door of the aquarist for not respecting the tremendous energy output of this revolutionary light source. One cannot have his cake and eat it too. It is one thing to provide a high-energy light source to display fish at their best, and another to illuminate the aquarium used for breeding.

REFERENCES

1. Coates, C. W. and J. W. Atz, Fluorescent Lights for Home Aquaria," AQUARIUM JOURNAL, December 1949, pp. 299-302.

2. Pieroni, F. A., "Gro-Lux Lighting," TROPICALS, Mar.-Apr. 1962, pp. 28-32.

On Mixing Fishes

[Aquarium Journal, August 1956]

The community tank is the logical solution to the problem of many different species of fish and a limited number of aquariums. Quite often, however, this solution raises additional problems, one of which is the selection of aquarium fishes that will live together in harmony and good health. Beginners frequently choose fishes solely on the basis of appearance and neglect factors that determine whether a fish will really prove satisfactory in the community tank.

The significance of some of these factors is brought out in the photograph of how not to populate a community aquarium. This tank contains a Jack Dempsey, an angelfish, a neon tetra, an *Anostomus anostomus* and a black molly. As interesting and beautiful as these fishes are individually, they are eminently unsuited to living together. The disparity, for example, between the size of the Jack Dempsey and the neon tetra is certain to prove disastrous to the smaller fish. The question of size may not be apparent when fishes are first introduced into the community tank. Quite often, baby cichlids prove very satisfactory in this type of aquarium; but as their size ultimately exceeds that of their tank-mates, what at one time may have been a neighbor, might then prove to be the main dinner course.

Another source of difficulty in our "how not to" example is the differences in feeding requirements of these fishes. The black molly will only do best when a sufficient amount of vegetable matter mainly in the form of algae, is provided; the Jack Dempsey, on the other hand, would prefer a piece of canned shrimp or other food containing animal matter. Not to be overlooked is the difference in mouth sizes between the largest and smallest fish. A disregard of this factor can result in starvation for either of them.

Although the *Anostomus* would be peaceable enough as far as the Jack Dempsey is concerned, the temptation of the angel's ventral fin extensions or "feelers" would prove too much and it would not be long before these fins were reduced to stubs. Other fishes besides Anostomus are notorious fin nippers, large tiger barbs, for example. Victims include fishes with long and flowing fins such as pearl gouramies and bettas.

Shy fishes are seldom happy in the presence of aggressive ones although occasionally this technique is used to remove some of their timidity. Many angelfishes would reach ripe old ages if spared the company of high-spirited tank mates. Sometimes shy fishes will be more at ease in a well planted aquarium and prove less sensitive to noise and minor vibrations. However, many cichlids relentlessly uproot or otherwise destroy aquarium plants. A few fishes nibble plants down to their roots, prime offenders in this respect being *Metynnis* and related fishes as *Mylossoma*.

If a lyretail had been added to our illustration, it would stress the importance of light and water conditions on some fishes. Fishes of the genus to which the lyretail belongs, *Aphyosemion*, prefer subdued light and soft, acid water. These conditions are not compatible with the requirements of the molly, which prefers hard, alkaline water and good lighting. Incidentally the neon tetra also does best in soft acid water and subdued light.

Exceptions to the examples discussed can and do appear but for maximum success, the beginner should ask himself these questions before choosing fishes for a community tank:

1. Is there now or will there be at maturity a great difference in sizes among the fish?
2. Are any of the specimens known to be bad fin nippers or even downright predatory and dangerous to other fishes?
3. Will there be significant feeding differences among the community tank occupants such as requiring live versus non-living foods, animal versus vegetable foods?
4. Are some fishes shy and retiring while others are aggressive and high-spirited?
5. Do any fishes require aquatic vegetation for their well being while others are known to be destructive of plants?
6. Are water conditions to be maintained in the tank especially regarding pH and hardness conducive to the health of only certain of the fishes?
7. Will the lighting of the tank be too intense for some fish and insufficient for others?

Any affirmative answers are an indication that future difficulties may be experienced in the maintenance of the community aquarium.

On Purchasing Aquatic Plants

[Aquarium Journal, September 1956]

Most aquarists would agree that two things are expected from the purchase of an aquarium plant: first, that the plant itself be healthy and second, that it not harbor aquatic pests, parasites or diseases. Unfortunately not much is known, at least in aquarium circles, about aquatic plant diseases, and the aquarist is forced to rely on visual observations of firmness, intenseness of color and extensive root system as indications of a healthy plant.

Roots are not a consideration in purchasing plants such as *Hygrophila* which are propagated by cuttings, butt Amazon sword plants and others that produce stems from a single point above the roots must have a healthy root system. Younger plants re-root faster and more satisfactorily than older ones.

Avoid purchasing plants that are stringy or limp. These are indications that the plant has lost water, a sure sign that something is wrong. Plants in this condition are usually pale in color, also. This is especially true with members of the genus *Cryptocoryne*, which, when in good condition, exhibit deep green to brownish-red colors, and when in poor condition are yellowish.

Algae can quickly ruin any aquarium plant if allowed to remain for long. The softer varieties of algae can be easily rubbed off with the fingers from the leaves of broad-leaved plants. If the part of the leaf under the algae has not turned brown or yellow then no harm has been done and the plant will respond quickly to its new environment. Many hard varieties of algae do exist and are extremely difficult to remove from aquatic plants. Algae that have settled on fine-leaved plants like *Ambulia* are next to impossible to remove without destroying the plant.

Plants are like Pandora's Box when it comes to turning loose a multitude of evils in an aquarium. It goes without saying that plants should never be purchased from an aquarium containing sick fish. Leeches, protozoans, bacteria, and worms have all been known to use aquarium plants as convenient taxis from one aquarium to another. This is why it is so important that plants be disinfected before introduction to the home aquarium in spite of careful inspection of the plant beforehand. A solution of potassium permanganate, 1/4 grain to the gallon, can be used to soak plants overnight for this purpose.

Snails are a controversial matter in the aquarium. Some aquarists like them, others don't for quite a few snails eat aquarium plants or are carriers of fish parasites. In any event, the decision as to whether or not snails will be in an aquarium should be left up to the aquarist and not forced upon him via aquatic plants harboring either snails or their eggs. The snails themselves may be removed easily; however, many aquarists overlook the small jelly-like masses found on stems and underneath leaves. These are snail eggs, and if not removed the aquarium will soon be overrun with snails. In most cases, and if there are not too many, the eggs can be rubbed off with the fingers.

Other things being equal, the aquarist who chooses his aquatic plants with care will start off with the first requirement for a beautifully planted aquarium while his less careful counterpart will probably entertain the doubtful privilege of studying the "What to do when in trouble" sections of various aquarium texts.

On Planting the Aquarium

[Aquarium Journal, October 1956]

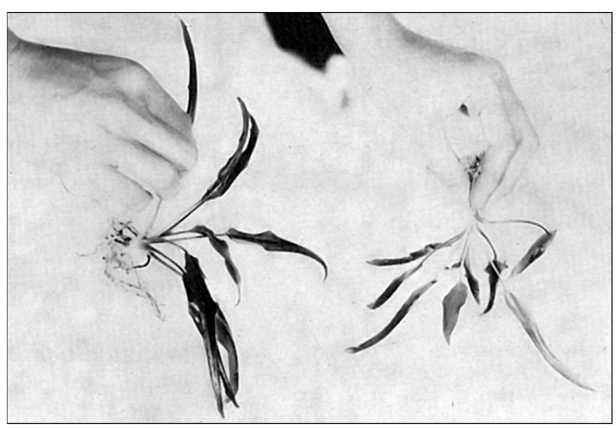
Many aquarists subscribe to the "push 'em in, poke 'em down" theory of planting aquarium plants. However, it doesn't take these hobbyists long to learn that the beauty and utility of aquatic plants deserve, and their requirements demand, much more thoughtful treatment.

Care must be exercised in the physical handling of aquatic plants for they are frequently quite brittle and break easily out of water. The stems of *Hygrophila*, for example, snap with the least application of pressure. It is even a greater loss when the leaves of center plants are broken through mishandling, for new ones are grown slowly. Our photograph illustrates both a poor and a good technique for holding center plants. There are times, however, when it is necessary to deliberately break off one or more leaves. Leaves that are yellowed or hopelessly damaged by snails should be removed before planting.

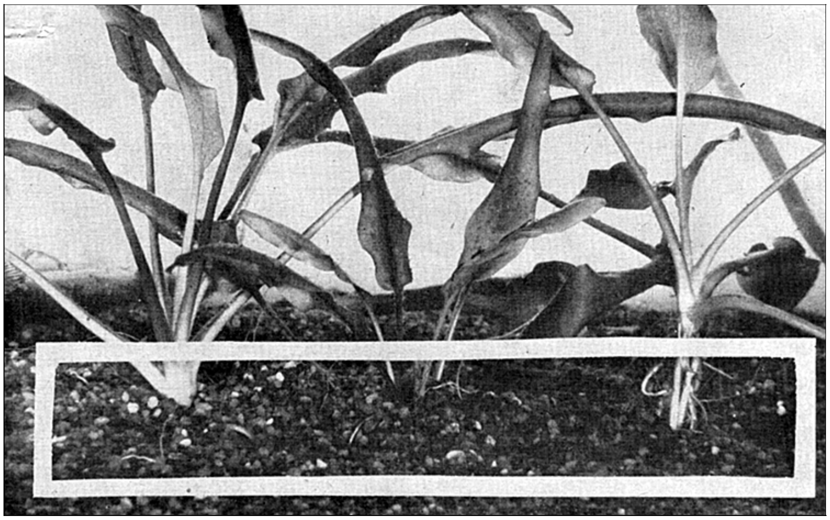
The classic method of arranging the sand in the aquarium to receive plants is to slope it from about 1 inch deep in the front to 2-1/2 inches at the rear. If the aquarist supplies each plant with enough sand or gravel to provide a satisfactory anchor for their roots, there is no reason why the depth of sand cannot be altered to produce the most eye-pleasing results. It is a good practice, however, to maintain an unplanted low area in the aquarium where the fish will expect to be fed each day. The shallow depth of sand in this area will be quicker to indicate and in some cases, lessen, the tendency toward pollution due to over-feeding.

Plants may be placed anywhere in the aquarium, but bear in mind that tall plants tend to obscure the shorter species and are best displayed at the sides or, better still, at the rear of the tank. Since most center plants have vigorous roots and compete strongly with their neighbors for nourishment, smaller plants should be planted a comfortable distance from them.

Before planting cuttings from plants like *Ambulia* and *Hygrophila*, it is advisable to cut an extra half-inch from the already cut end. This fresh end takes root more swiftly than one that has aged and been allowed to decay. Give each



The right and the wrong way to handle aquatic plants. The plant on the right is being held correctly. Photo by the author.



Three ways of planting aquatic plants having crowns. The plant on the right is not planted deeply enough; the plant in the center is inserted too far. covering its crown; the plant on the left is planted correctly. Photo by the author.

another nearby. The remaining water can be added without disturbing the plants or sand by directing the water flow against a submerged saucer or the hand itself. If both hands are needed to direct the flow, a piece of floating cardboard will also do the job.

With care and thought expended in the planting of aquatic plants, the plants themselves obtain that much needed "start" and repay the aquarist with faster growing and healthier stock.

cutting room to grow by planting them separately rather than in bunches.

Center plants are retarded in their growth when their crowns are buried. Our photograph shows one *Cryptocoryne* plant that was planted too deeply, one not inserted deeply enough and one planted correctly.

In planting some of the sagittarias, the aquarist may have a difficult time preventing the plants from bobbing back up to the surface for these plants have very buoyant roots and leaves. In hard waters, lead strips wound loosely around the base of the stems solve this problem. Plastic discs are available for use in soft acid waters where lead is toxic to fishes.

A not inconsiderable problem is that of avoiding slopping water about during the planting operation. This is accomplished by planting with the aquarium only half-filled with water. In deep tanks, planting sticks extend the effective range of the fingers and being slim, reduce the tendency to dislodge a plant when planting

On Aquarium Maintenance

[Aquarium Journal, December 1956]

The first day an aquarium is set up it presents a bright, sparkling picture. Without the subsequent intervention of the aquarist, however, it will not take long for this picture to change. It is perfectly natural for an aquarium to develop algae of its own accord, for plant leaves to brown and decay and for debris and fish wastes to accumulate as a mulm on the bottom. These are all natural processes, common in nature and also to be found in the aquarium. To a certain extent, all of these processes can be kept under reasonable control, but there is no way in which an aquarist can lean back and achieve a self-cleaning, self-maintaining, and self-correcting tank.

A good deal of the work involved in aquarium maintenance can be lessened by preventing undesirable processes from getting out of control. This the aquarist can do merely by careful observation of the aquarium and its activities. The following is a checklist that should become a part of every aquarist's technique in maintaining his aquaria.

1. Observations of the water in the aquarium:

(a) Temperature — In aquaria containing no thermostatic heaters, this is especially important. Tropical fishes can undergo a daily variation in temperature of from 5° to 10° F. with no ill effects whatsoever, but there are upper and lower limits. In most cases, 69° to 70° F. is the lowest it should go and 85° F. is the highest. For certain fishes, such as white clouds, it may go lower and for breeding some fishes, pearl gouramies for example, it may go higher. It is understood, of course, that daily variations in temperature are those that take place over the course of a day and are not to be confused with sudden changes taking seconds or even minutes to be accomplished.

(b) pH — Often, dangerous chemical changes in the chemistry of the aquarium water can be detected by a simple pH test. An overabundance of decomposing organic matter will often produce a lowered pH. This will be indicated by the test. For most fishes, the pH should not stray too far from the neutral point of 7.0.

(c) Hardness—Many aquaria increase their hardness content over a period of time due to evaporation of water and by chemicals added to the water by rocks and gravel. Excess hardness is detrimental to many egg-layers and many aquarium plants. The hardness in the average aquarium (community tank) should be kept under 200 ppm.

(d) Oil slicks on the surface of the water — Such coatings should be removed by floating sections of newspaper or preferably paper towels on the surface. The oil will be absorbed by the paper and can easily be removed. Such oil slicks may be caused by oily foods, the aquarium cement or by external sources such as paint fumes. The latter is a serious condition for the aquarium.

(e) Cloudiness or green water — The later may be due to algae encouraged by excess light. The first may be due to excess feeding or the death of one of the tank's inhabitants. This has been covered in previous Beginner's Corner.

2. Observations of the plants in the aquarium:

(a) Growth of leaves—Healthy plants show steady growth and formation of new leaves. If they are not and if most of the leaves are turning brown, then something is wrong. Usually it is a matter of insufficient lighting.

(b) Algae on leaves — Algae seldom does plants any good and should be removed as quickly as they form. Especially dangerous are the so-called hair algae that grow on plants. If not removed early, it will be all but impossible to remove later. Some kinds of hair algae may be encouraged by an excess hardness in the aquarium water.

(c) Holes in leaves — These may be caused by snails, some fishes such as silver tetras or by some unidentified plant diseases.

3. Observations of fishes in the aquarium:

(a) Swimming — Healthy fishes are either lively swimmers or move swiftly when disturbed. Listless swimming, rubbing on plants or along the bottom are danger signals, either of disease or an unhealthy increase in the bacteria or infusoria content of the water. Peculiar positions adopted by fishes are also cause for suspicion. Remember that some fishes normally assume positions that are abnormal for other kinds of fishes. Under this heading would come pencil fishes, upside-down catfishes, and others.

(b) External evidence of disease — External parasites can often be seen on the skin and fins of sick fishes. The most common diseases are "Ick" and "Velvet." Some internal disorders can be observed by color changes in the fish.

The symptoms should be studied carefully, the diseases diagnosed and then the proper treatment applied.

(c) Fin-nipping and fighting — Fins should be carefully observed for evidence of being nipped or frayed. This usually indicates that not all the inhabitants are compatible. Injuries to the body are also signs of fighting although sharp rocks or coral in the aquarium can produce a similar appearance. Frayed fins may be due to fin rot, not fighting.

4. Observations of the aquarium:

(a) Black gravel — This is an indication of excess feeding. The gravel should be removed (the aquarium may have to be taken down if the condition is excessive) and the type and amount of feeding should be checked. Black gravel can also occur if too fine a dry food is used or if uneaten live food burrows into the gravel and dies.

(b) Uneaten food on the bottom — This is a forerunner of black gravel and the food itself will certainly fungus. Probably the food is either unsuited to the fishes in the aquarium or else it is fed in too large a quantity.

(c) Filters, air stones and heaters — These should be checked periodically to insure that they are in functioning condition. Filters should be cleaned regularly in order that they continue to help the aquarist maintain the cleanliness of his aquaria.

On Leaks in Aquaria

[Aquarium Journal, January 1957]

One common area of discouragement to the beginning aquarist is the leaking aquarium. Not only is unconfined water a nuisance but also en route to seeking its own level, it may cause considerable damage to furniture, carpets, and any other items whose appearance or serviceability is impaired once wetted.

The bond that provides for the creation of a leak-proof aquarium is formed by a combination of aquarium cement, metal, and glass. Here the aquarium cement bears a heavy responsibility, for if it should pull away from either the glass or the metal, a leak results. Unfortunately, many hobbyists create circumstances that lead to this condition. For example, leaks may be caused by:

a) Lifting an aquarium while it is full of water.
b) Pressing too hard on the outside of the aquarium glass while the aquarium is empty (common during cleaning operations).
c) Maintaining an aquarium on an uneven surface.
d) Allowing the cement to dry out during storage of an aquarium.

On the other hand, the aquarist can prevent leaks from these causes by following a few simple rules:

a) Never lift a completely filled aquarium. It is much safer to empty it, or at least drain all but a few inches of water, before attempting the move.
b) Exercise great care when cleaning an empty tank. If possible, clean the outside glass with the aquarium filled with water.
c) Always provide a level surface to support a tank. If in doubt about the level of any surface, a piece of 1/2 or 3/4-inch plywood can be cut to fit and placed under the aquarium to provide an even support.
d) When storing aquaria, keep some water in them and use a tight fitting cover. The moisture thus formed will prevent the aquarium cement from drying out.
e) Pre-test all aquaria in an area that cannot be damaged by water seepage by filling them completely with water. New tanks sometimes leak when first used and this procedure may prevent unpleasant surprises.

Once a leak has occurred while an aquarium is in service, all is not lost. Many leaks stop of their own accord once the cement has absorbed a little water. Quite often the pressure of water against the glass will effectively seal the aquarium. If a receptacle can be placed under the drip to prevent any water damage then the aquarist might wait a few days before taking any further action. A small amount of fine earth added to the aquarium water may help end the flow by clogging the leak at its source. Unfortunately most of it will settle to the bottom of the tank where it is unsightly. Filtration and some siphoning will remove most of this excess.

If the leak does not cure itself, then the tank must be emptied and repaired from the inside. Exterior methods are usually worthless. Make sure that the tank is completely dry and clean of any grease, dirt, and sand particles. Apply a coat of liquid aquarium cement on all inside joints and allow to dry. The final step is sealing all corners and joints with a thin strip of aquarium cement in the form of a rope, 14 of an inch in diameter. This is pressed firmly into place. It may be that either the liquid or the regular aquarium cement will do the job alone but the double insurance is cheap and much surer.

On Filtration Part I

[Aquarium Journal, February 1957]

Although mechanical filtration of aquarium water is thought by some to be merely the lazy man's way to keep an aquarium clear and sparkling, there are so many points in its favor that it bears careful consideration by all beginning aquarists. Some of the benefits that can be derived from filtration include:

1) Removing assorted aquarium debris (food particles, broken or decayed plant parts, sediment, etc.)
2) Removing freely suspended algae.
3) Decreasing the salt content of aquarium water.
4) Cleaning cloudy aquarium water.
5) Removing excess carbon dioxide from the aquarium water.
6) Saving hours of valuable time by reducing the need for siphoning the aquarium.

This list, while encouraging, is not intended to present mechanical filtration as a cure-all. There is no substitute for the careful application of basic aquarium-keeping principles.
All filters are primarily concerned with removing unwanted materials from an aquarium. This can be accomplished in two ways, viz., physically and biologically. However, filters employing these different principles also differ in application and maintenance. As there are many roads to Rome, so the mechanical scheme of one filter may differ appreciably from the next. For clarity's sake, therefore, each filter type is best considered separately.

The Outside Filter

The basic part of the outside filter is a plastic box, hung outside the aquarium in an inconspicuous place. Water is introduced into the filter box from the aquarium via a siphon. It is returned to the aquarium via an airlift, a device that lifts water by virtue of the fact that a column of water plus air is lighter than just a plain column of water and so will rise. The filtering material is of two types:

a) A granular material, usually charcoal but occasionally gravel or sand.
b) A fibrous material such as glass wool or nylon.

Both types are usually used in the same filter, either in layers or in separate compartments provided for them. The arrangement is such that the incoming water passes through glass or nylon wool first, charcoal next and is then returned to the aquarium.

The purpose of the glass wool is to remove sediment and other floating or suspended material such as algae. The charcoal also serves to filter solid materials from the water and, in addition, will also absorb bacteria and infusoria within its pores. In this manner, a cloudy tank is soon cleared. Neither material, however, will function when overloaded with dirt. The hobbyist should frequently inspect the filter box and clean when it becomes necessary.

One indicator to an overloaded or excessively dirty filter is the water level in the filter box. When clean and operating normally, this level should be lower than the level in the aquarium. As the filtering materials become clogged with dirt, the difference in levels decreases. Often, the airlift splutters because it cannot pull enough water through the dirty glass or nylon wool to feed itself. Some outside filters are so constructed that they can be cleaned by a method called "backwashing." This consists of removing the filter box, placing it under a faucet, and directing a brisk stream of water into the compartment that houses the airlift stem. The resultant flow of water that is opposite that when in normal operation flushes the dirt out of the filter box at its top. Other filters can be cleaned by placing the glass or nylon wool under a stream of water and kneading it with the hands. The charcoal can be cleaned by rinsing it with clean water. This can be done with the charcoal in the filter box. Quite frequently, the plastic tubes of the siphon and airlift as well as the box itself become coated with algae. The algae in the tubes can be removed with the stiff brushes on flexible wire handles sold for this purpose. A bottlebrush is helpful for removing the algae in the filter box. Stubborn growths can be loosened by soaking overnight in a strong salt solution. Clorox and soap may be used but before the filter is placed back into service, every trace of these compounds must be washed away.

The effect of circulating the aquarium water and aerating it via the airlift produces some valuable secondary effects as a byproduct of filtration. The clearing of cloudy water, although due in part to the action of the charcoal, is aided by this process. The circulation provided helps remove unwanted carbon dioxide from the aquarium. Finally, it has been observed that fresh charcoal tends to reduce the concentration of salts that builds up in aquaria that have been in use for a long period of time.

On Filtration Part II

[Aquarium Journal, March 1957]

Last month, we took a close look at the outside filter. There are times, however, when this type is not suitable for the aquarium the hobbyist has in mind. The size of the tank, space requirements, and aquascaping may dictate the use of other basic types. In countries other than the United States, the outside filter is not as popular as the following types.

The Inside Filter

Inside filters come in a variety of shapes and sizes. Some are rectangular boxes, a few are cylindrical, and there are even triangular models that fit into a corner of the aquarium. There are two basic designs in inside filters. The first type is hung almost submerged in one corner at the top of the aquarium and water is introduced into the filter box by means of an airlift. The aquarium water passes through glass or nylon wool, then charcoal, finally to be returned to the aquarium proper through holes in the bottom of the filter box. Since part of the filter box and the airlift extend above the top frame of the aquarium, the cover glass must be cut to fit around it.

The second design rests upon the bottom of the aquarium. Since it is submerged, there is no problem in getting the aquarium water in through holes in the filter top or sides. The water is removed from the bottom of the box via an airlift that works just as well (if not better) under water as out. As in the other inside design, the water flows first through glass wool and then charcoal. Since no holes (other than one for an air line) need be cut into the cover glass for this type of filter, it is especially valuable for aquaria containing fishes that are prone to jump. Most inside filters are used in the smaller aquaria since they are rather compact. Their filtering rate, although relatively slow, is adequate for the size tank in which they are used.

Inside filters must also be kept clean if they are to do their job. Since they are, in most instances, submersed, it is not difficult to determine whether they need cleaning or not. In any event, they are cleaned much like their cousins, the outside filters, except that backwashing is not applicable.

The Under-the-Sand Filter

This is our first filter type operating on a "biological principle" rather than a simple mechanical principle of removal. Its action differs considerably from the action of the other filters. The motive power to circulate water through the filter is still an airlift, however, there is no filtering box. In this case, the aquarium sand or gravel acts as the filtering material. As sediment is drawn to the upper surfaces of the sand via the suction of the airlift, oxygen-loving (aerobic) bacteria break down this material into harmless salts and gases. This bacterial action is quite different from the action afforded by decay bacteria when they break down organic materials in a sand or gravel deficient in oxygen. In the latter case, the sand turns black with noxious products such as hydrogen sulfide (the "rotten eggs" odor reminiscent of the high-school chemistry lab).

As long as we supply the aerobic bacteria with enough oxygen to enable them to break down organic solid materials into harmless compounds, our aquarium will remain clean and clear. The circulating water supplies the needed oxygen and the distribution of this circulation is determined by the design of the individual filter. One type has a large porous plastic cylinder connected to an airlift. The tube is buried underneath the aquarium sand and water is drawn through the gravel, into the tube and out via the airlift. A second type utilizes a flat sheet of plastic with many holes and a third makes use of a network of small, perforated plastic tubes in place of the porous cylinder.

With certain qualifications, there is no maintenance attendant to the use of these filters, for microorganisms do the cleaning. Overloading the filter is dangerous, however, for decay bacteria may replace the aerobic kind and foul the aquarium. A close watch should be kept on this type of filter, especially about the sand or gravel bed. Samples of aquarium sand can be taken at intervals and inspected to see that the filter is doing its job. If the filter has not been overloaded, there is no danger in shutting it off. The aerobic bacteria tend to live in the upper part of the aquarium gravel and can still carry out their task, albeit, more slowly.

It has been noted that continuous operation of these filters affects aquatic plants to some degree. Some plants will produce a vigorous root growth but a sparse leaf system under this type of filtration. This can be avoided by only running the under-the-sand filter at night when the leaves are not carrying out the growing process.

Besides their no-maintenance feature, the under-the-sand filters do not present unsightly boxes, charcoal, glass wool, etc. to mar the appearance of the aquascaping. All in all, they are valuable time savers for the aquarist.

There are a few odds and ends among filters such as the turbine-type used by marine aquarists that we have not discussed. Generally speaking, they are of little interest to the beginner. The most important point to remember about any filter is that it cannot replace the aquarist. No filter will work miracles. Properly used and inspected frequently, however, they will prove to be one of the most valuable items of equipment available to the hobbyist in the keeping of tropical fishes.

Aquarium Fish Names – Part I

[Aquarium Journal, April 1957]

The ichthyologist and the aquarist share the problem of introducing system and order to a bewildering array of fishes. One way of handling this problem is to note similarities between individual fishes and think of these fishes as forming one class or kind. Thus, the many are reduced to one. The first such system to come into wide use was proposed by the great Swedish naturalist, Karl von Linné (Latinized to Linnaeus) in 1735. Roughly, he placed living things in a succession of groups, each group being more restrictive in the admittance of its members until finally, the lowest group contains but a single member. Proceeding from the highest (most general) to the lowest group (most specific), they are: phylum, class, order, family, genus, and species.

Frequently, the prefixes sub- or super- are used to provide additional intermediate groups. The relationships of the members of these groups were considered by Linnaeus and his followers as "natural" ones, based upon similarities in anatomy. Now most zoologists and botanists base groups of animals on the concept of evolutionary relationships. Their main criteria for these groups are still anatomical, but the philosophical approach is different. The actual naming of a fish follows the binominal method of Linnaeus; first, the generic name (which has its first letter capitalized) and second is the name applied to a particular species, a member of a genus and with its first letter not capitalized. Not a part of the name but often following it (and not in italics as is the scientific name) is the name of the person who has named the species. For example: *Hyphessobrycon innesi* Myers.

Notwithstanding the beauty and logic of this system, it leaves much to be desired by aquarists. Unfortunately, the formal interests of the scientist may not satisfy the practical needs of the hobbyist. The name, *Hyphessobrycon innesi*, for example, is difficult to pronounce, unreasonably long and not very descriptive for the average hobbyist. As a result, aquarists use a blend of popular and scientific nomenclature that is successful in some instances and unworkable in others. In this particular example, *Hyphessobrycon innesi* is known simply as the neon tetra. To a newcomer in the hobby (and after seeing the fish) the "neon" part is perfectly reasonable but "tetra" may be a mystery. This can be explained by what may happen when aquarists must decide on how to name a particular fish:

1. The unaltered scientific name may be used. This happens usually when the name is easily pronounced, short or if the fish is rare and kept only by a few avid hobbyists. Examples: *Epiplatys chaperi, Corydoras aeneus*.
2. The scientific name may be shortened and only the generic or specific name used. This is usually then combined with a popular name and is the form most frequently encountered. Examples: scat (from *Scatophagus argus*), giant danio (from *Danio malabaricus*), scalare (from *Pterophyllum scalare*).
3. An entirely colloquial, usually descriptive, popular name may be devised. Examples: angelfish, upside-down catfish, goldfish.

At times, the scientific names that are used by aquarists may be changed by ichthyologists. When this occurs. The name usually does not follow suit. The name "tetra," for example, is from the genus *Tetragonopterus* and the names of many small fishes of the family Characidae include the word "tetra." The fact that this scientific name has been sharply limited to a few characids (not often seen by aquarists) by ichthyologists has neither prompted aquarists to rename the old series of tetras or prevented them from using the name for newly discovered ones. From the aquarist's point of view, it is just too much trouble and it isn't really necessary.

Although popular names are useful to the hobbyist, their unqualified use is not without dangers. One advantage the scientific name has is that it remains the same no matter what country is involved. Popular names, on the other hand, usually vary greatly with the country of origin. *Hemmigrammus ocellifer* is known in the United States as the "head-and-tail light." In England, it is known as the "beacon" and in Germany, as the "Spot Salmer." Salmer, as used by German aquarists, is roughly equivalent to the American use of tetra, being usually applied to members of the family Characidae. Even within a single country the same popular name may refer to different fishes in different places. Thus, the term "silver tetra" has been applied to three or four different species of fishes in this country.

Although no one would consider it in good taste or reasonable in aquarium circles to use the scientific name of a fish when the popular one is well known and easier to use (such as the jawbreaker *Gymnocorymbus ternetzi* for the black tetra!), hobbyists should make it a practice to become familiar with them. Gardeners and hothouse enthusiasts seem well enough at home with botanical terms and there is no reason why aquarists cannot follow suit, especially if it aids us in accurately identifying our fishes and preventing misunderstandings.

Aquarium Fish Names - Part II

[Aquarium Journal, May 1957]

Last month, this column discussed the scientific method for describing and classifying aquarium fishes and the use of popular names. Actually, aquarists are probably more familiar with scientific names than they realize. The use of the terms cichlid and characin is quite common, for example.

For the aquarist, the most general classification that is of interest is the family. The family is composed of one or more genera (singular = genus), which, in turn, is composed of one or more species (singular = species, not specie). Most tropical fish handbooks arrange their fishes in order of the families. Very little concern is given to the order of fishes and the few books that do allude to them do this only in passing. Ichthyologists create family names by adding idae to a root. Thus *Cyprinus* (the generic name of the carp) becomes Cyprinidae, for example. When the scientific names are used by aquarists, the endings are usually modified to make them shorter and easier to pronounce. Cichlidae become cichlids, Characidae become characins, or better characids. In other cases, the scientific name is dropped altogether and a popular one substituted. Examples: Poecilidae becomes livebearers, Cyprinodontidae becomes killifishes, and Anabantidae becomes bubble nest builders. Although some of these popular names are excellent and useful, others are questionable. To illustrate, not all Anabantidae build bubble nests and not all livebearing fishes are Poecilids.

Some aquarists confuse the genus with the family. There is no such thing; for instance, as "the molly family" or the "barb family." The mollies are all members of a single genus and the barbs must share their family with the rasboras and a host of others.

When families are broken down into groups containing one or more genera, these groups are known as subfamilies. Scientific subfamilies always end in -inae. The subfamilies that are considered as such by aquarists usually do not agree with those of the ichthyologists. An example of an aquarist grouping - one that does not correspond to subfamily is the dwarf cichlids. There is no scientific subfamily that groups cichlids according to size. In any event, it is a rare aquarist who is familiar with the groups of genera included in subfamilies.

Aquarists should learn to recognize the distinguishing features of the common families: The characins with their jaw teeth and adipose fins (there are a few exceptions in both characters), the cichlids with their large mouths, spiny fins and one nostril on each side, instead of two as in most other fishes. The cyprinids (minnows) have toothless jaws, specialized throat teeth, and lack of adipose fins. To a considerable extent, the member of the same family may be expected to exhibit the same behavior and share similar living requirements. Thus, from a knowledge of just which family a fish belongs to, the aquarist may obtain a considerable amount of information without ever having seen the fish before. There are dangers with this system, however. Witness the deadly piranha and the dainty pencil fishes sharing the same family!

There is one area of confusion in classification that mystifies some aquarists. This is the term variety. Varieties are groups of a single species whose individual differences are of such a minor nature (such as color) that separate specific names are not justified. It is an error to refer to two or more species as varieties of each other. Examples: It is wrong to refer to *Corydoras aeneus* as a different variety than *Corydoras paleatus*; it is correct to say that the red swordtail is a different variety than the green swordtail (both are varieties of *Xiphophorus helleri*). The term subspecies is usually used to designate slightly different groups of one species that occur in nature. The term variety is usually (but not always) limited to variation of one species that originates in captivity.

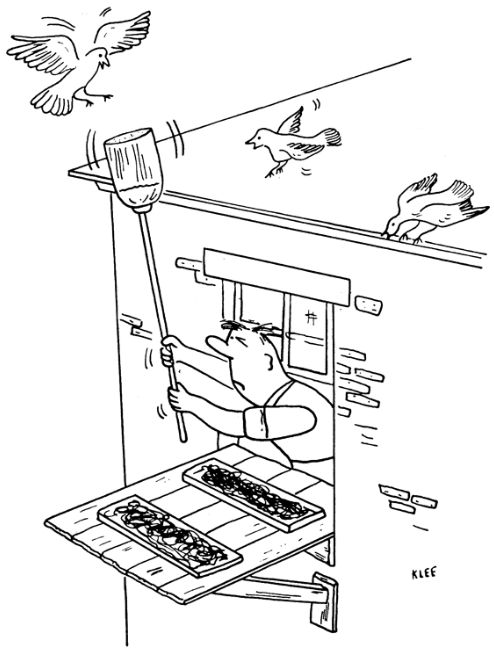
Undoubtedly, the beginner will learn a great many of both the popular and scientific names as he progresses in the hobby. Each of them has its place. If there is any "rule" for using fish names, perhaps it is this: use the term that is acceptable and reasonable to achieve the goal of clarity and brevity with your fellow hobbyists. At the same time, the aquarist should work toward becoming familiar with the significance of scientific nomenclature in order to help in increasing his knowledge of tropical fishes.

Prepared Foods for Fishes

[Aquarium Journal, June 1957]

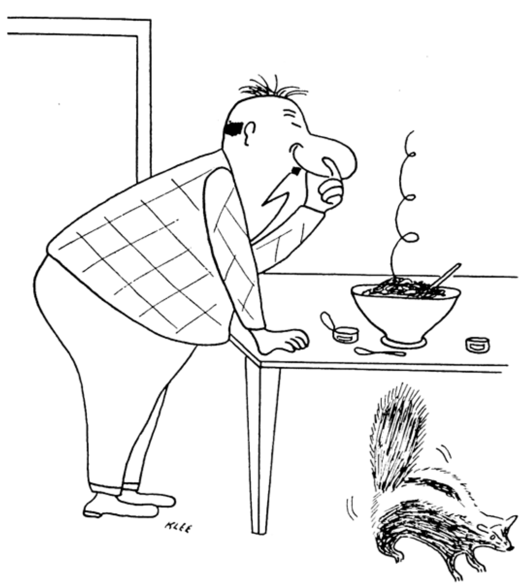
Our column this month takes refuge in the ancient adage, "One picture is worth a thousand words." There are times when a point is so obvious that it is overlooked, something that often occurs in the case of prepared fish foods, in particular. By prepared fish foods, we refer to the many commercially manufactured brands that are available to the aquarist in cans, jars, or tubes and in many varieties and sizes. With a little fun poking at our January column, "On Canned Foods for Fishes," let's look into the advantages of prepared foods and the disadvantages of some others.

Yes, preparing one's own fish foods can become a little involved! There will always be



aquarists who prefer their own "private stock" but they will be far out-numbered by those who prefer to keep the work involved to a minimum.

POINT 1: There is no work or messy preparation attendant to the use of prepared foods.
POINT 2: Prepared foods keep indefinitely without refrigeration.



Here our aquarist friend who knows that certain wet foods quickly spoil unless refrigerated or dried, is busily defending a batch of shrimp and porridge from members of the local Audubon Society. Many aquarists also feel that freezing or drying fish foods is "strictly for the birds."

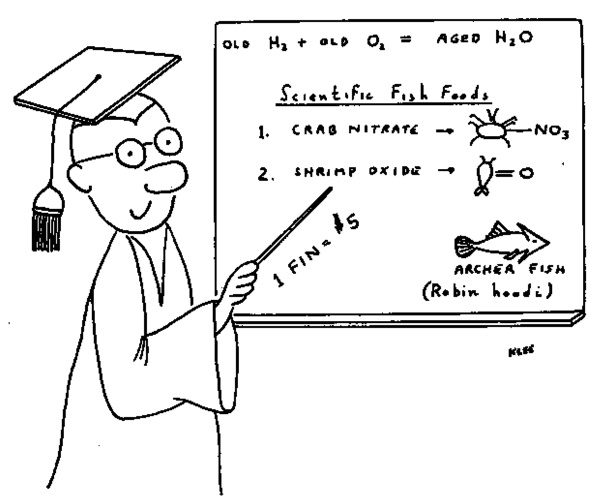
POINT 3: Odors are kept to a minimum with prepared foods.

The aquarist in this cartoon doesn't know that the odor he is detecting is not from that batch of fish food he is whipping up. On some warm days, however, the aroma would be the same without the "woods pussy-cat."

POINT 4: Prepared foods make variety and balance easy.

Our last cartoon depicts the blackboard in a class on fish foods, the vitamins, and minerals needed and what makes up a balanced diet. Of course, fish food manufacturers take care of all this work for the aquarist and present balanced mixtures with elements that are calculated to benefit our tropical fishes.

As it is with almost all things, nothing is all good or all bad. There is something to be said for all types of fish foods. In any event, the be-



ginning aquarist is on firm ground with a diet for his fishes, of prepared foods interspersed with occasional feedings of canned and live foods.

On Selecting and Placing an Aquarium

[Aquarium Journal, July 1957]

In the words of A. Fraser-Brunner, a respected British aquarist and ichthyologist, "Far too many people start off on the wrong foot by acquiring an aquarium first and deciding what to do with it afterwards." Undoubtedly, the planning beforehand stage is important in our hobby and certainly deserves a closer inspection than it has received in the past.

The size of an aquarium is always an important consideration. It has often been said that the beginner tends to choose too small a size and this probably is true more often than not. The case for the larger tank is strong and involves a number of points. Probably the most important centers about the tendency of the beginner to overfeed his fishes. The smaller the tank, the greater is this tendency. Unfortunately, the smaller tank also pollutes more readily. Larger tanks have a sort of increased "buffer" capacity that enables them to resist short periods of overfeeding. This principle extends also to temporary drops in surrounding temperatures. Lastly, the larger aquarium affords greater exercise area for our more swiftly moving tropicals. What do we mean when we say "larger" tank or "smaller" tank? The dividing line may vary from one aquarist to another but for our purposes, it is the 10-gallon aquarium. It is even preferable to start out with a little greater capacity, say 15-gallons. This must not be carried to unreasonable extremes, however, as our cartoon suggests!

There is a trend nowadays to purchase tall, narrow aquaria. These proportions are best suited to the display aquarium but, contrary to some opinion, they can be used for breeding also. It is just that many of our tropical fishes axe best bred in shallow water and the taller aquarium would then be used only partially filled. The only real disadvantage to the tall, narrow tank is that, gallon for gallon, it should not contain as many fishes as its lower, wider counterpart. To a certain extent, the fish capacity of an aquarium is dependent upon the area of its air-water interface. For two aquaria of identical capacity, this will be smaller for the taller tank. If the hobbyist fully understands this, then even this will be of no disadvantages for the goal of the aquarist is the "living picture" and not to see if tropical fishes can be packed in an aquarium like anchovies in a can.

Although most available commercial aquaria of under 50-gallons are constructed in this country of stainless steel frames, some are manufactured with painted, common steel frames. The latter are cheaper but of less desirable appearance. Of more importance, it is a constant battle to keep them from rusting. In the long run, the aquarist will probably replace these tanks with stainless steel ones anyway so it is best to consider stainless steel tanks in the beginning.

The placing of an aquarium often dictates the size and shape of an aquarium. To the extent that some of these factors are beyond our control, there are several that may decide for one particular location over another. It is an understandable temptation that prompts us to locate an aquarium near a window. After all, an unlimited supply of free light is nothing to take "lightly." There are a number of disadvantages attendant to this practice, however. Daylight is a difficult light source to control. It multiplies algae problems many fold. The aquarist may get involved in all sorts of juggling with paper, paint, cardboard, Venetian blinds or shades in order to keep plants growing and algae down. In addition, back lighting is seldom conductive to showing tropical fishes at their best. An artificial light source with a reflector is probably the most convenient solution.

The location of electric outlets is another factor that merits attention. There is nothing more unsightly than electric wire strung around a room, not to mention the hazards involved. A little thing perhaps, but troublesome if overlooked.

An aquarium on a radiator is one of those "what not to do" procedures. The aquarium may not be the only thing that blows hot and cold under these conditions! A properly constructed or purchased stand supporting the bottom of the tank evenly and located well away from heating units is the best solution. A thermostatically controlled electric heater solves the temperature problem. Remember that certain areas of the house that are known to be overly warm at certain times, the attic for instance, are to be avoided.

Since water is heavy (about 8-1/3 lbs. per gallon), care must be exercised that the floor is not overloaded with aquaria. There are better, more gradual ways to introduce the downstairs neighbors to the tropical fish hobby.

Aquarists are always thinking of expanding their collections, up to a certain point. The expansion will be much smoother and of greater satisfaction if the acquisitions are planned. Perhaps this entails settling on a few basic aquarium sizes and shapes and placing them where they are easily supplied and serviced and where future aquariums can be easily accommodated. Whatever the individual problem, planning can repay the effort many fold.

On Aquarium Stands

[Aquarium Journal, August 1957]

Although aquarists may grumble at thoughts the word "housekeeping" may provoke, it nevertheless is well applied to our hobby. There is much untidiness inherent in the aquarium devices that aquarists take for granted. We contain heat and circulate water, pump air, distribute electricity and, in the process, we deal in lines, hoses, tubing, wires, valves, pumps, heaters, lights and, of course, aquaria. With poor housekeeping, all this can form quite a quagmire of aquarium equipment.

Perhaps the first step is good aquarium housekeeping is a careful and efficient placing of the aquariums themselves. For the aquarist with a few tanks, a commercially constructed metal stand is a practical investment. The most common arrangement is for two tanks, one on the top of the stand and the other on a shelf below. There is usually enough room on the lower shelf in addition to an aquarium for an air pump. Two tanks housed this way present a

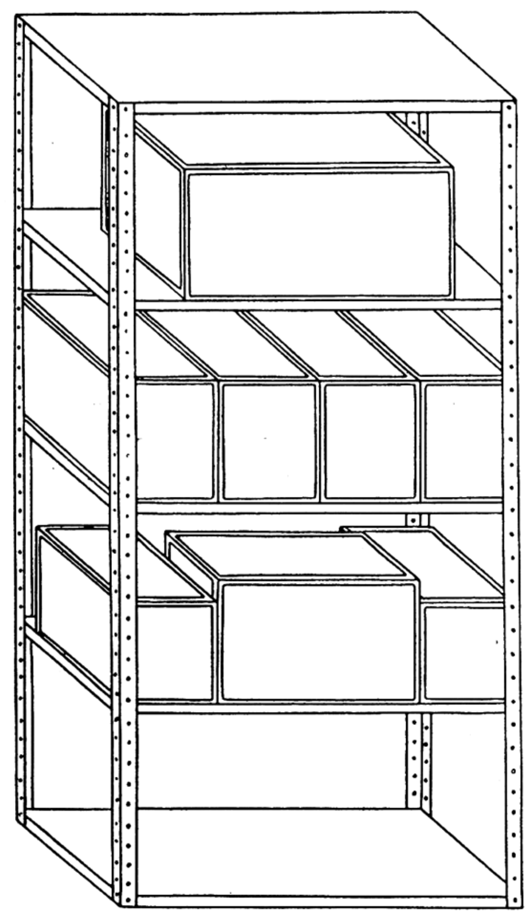


FIGURE 1

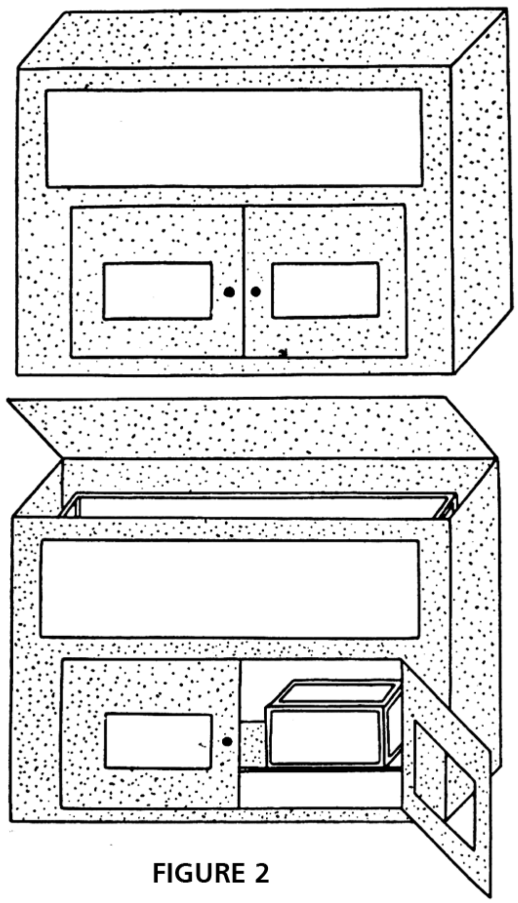


FIGURE 2

very neat appearance and afford short airlines and electric wires (if located near an electric outlet). An added advantage is that the water will not damage these stands as it would were the aquarium situated on top of expensive furniture.

For the aquarist with many tanks other solutions are practical. One that I have found useful in using is merely commercial shelving that consists of four slotted angle-iron pieces (72 inches long) and the sheet metal shelves themselves. The shelves are 36 inches long and come in 12, 15 and 18-inch widths. They may be placed on the stand with almost any spacing. The stands are assembled with nuts and bolts, and braces are available to provide more rigidity, if needed. I use 5 shelves but place aquaria on only 3 of them (see figure 1). The tank capacity of these stands is respectable. Each shelf will accommodate up to 20 gallons of water, i.e., four 5-five gallon tanks, five 2-1/2-gallon tanks, one 15-gallon or one 20-gallon tank and various combinations such as two 5-gallon tanks and one 8-gallon tank. Of course, some of these capacities are with the aquaria placed sideways but such an outfit is ideally suited to aquarists interested in breeding tropical fishes. Lights, valves, lines and wiring are easily mounted on these stands via the many holes provided in the angle iron. Since factory stands rust easily, I have found it advisable to paint the top of each shelf bearing aquaria with asphaltum varnish. The entire stand can be painted to suit the individual taste or a particular decor. These stands can be purchased at many places, surplus-sales stores being one example.

For larger aquaria and for stands that must fit in specified areas, a stand constructed of 2” x 4” lumber is easy to make (see figure 2). The ones I have constructed have utilized carriage bolts so as to be easily dismantled or even altered to a different length.

Although all these devices minimize wiring, airlines, etc., they do not completely conceal everything. To accomplish this, some sort of cabinet must be constructed that will allow only the face of each tank to be displayed. One such example is illustrated in figure 3. Before construction of such a stand is initiated, however, several points should be considered:

1. Keep the back of the cabinet open to minimize condensation and provide circulation and the introduction of fresh air and the expulsion of stale air.
2. Bear in mind that enclosed aquaria are usually harder to service than those not enclosed. Some thought must be given to the cabinet design to minimize this problem. The top aquarium in figure 3 is easily serviced for it follows from design of the cabinet. The lower aquaria are more difficult to service but they are small

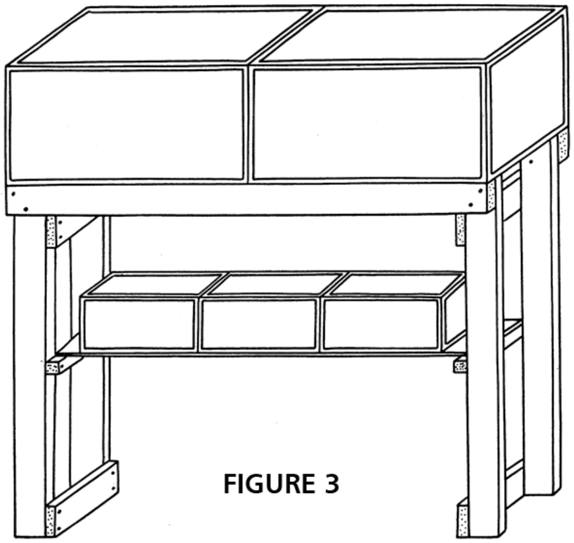


FIGURE 3

and enough room has been left on the top of them to enable a short-'handled net to be used. 3. If the cabinet is also to house other objects such as books or records, the design must take into consideration possible water leakage. I have seen some designs that actually waterproof the compartments containing aquaria with asphaltum varnish and also lead any water seepage to a jug. All of this is, of course, concealed.

The design of both 2" x 4" stands and cabinets is much of a personal matter to suit particular requirement. They have been mentioned merely to show what can be done to bring order and, in the case of cabinets, beauty to an array of aquaria.

When aquarists first enter the hobby, their accumulation of tanks is often catch-as-catch-can. This may result in many tanks of odd sizes and makes their orderly arrangement that much more difficult. No one will look a gift aquarium in the mouth (even though it is of 16-1/2 gallons capacity or perhaps a maddening 25-1/4 inches long) but a careful plan of future acquisitions will do much to make the arrangement of aquaria on stands a neater and more practical proposition.

Artificial Aquarium Lighting – Part I

[Aquarium Journal, September 1957]

A recent evaluation of five separate formulas conceived by as many authorities for the amount of artificial illumination required by an aquarium produced some interesting results. Applying these formulas to a standard 15-gallon tank and assuming incandescent bulbs to be used 8 hours a day, the wattages suggested were 50, 60, 75, 80, and 100. These differences of opinion are not singled out for the purpose of criticizing their sources, but rather to emphasize the uncertainties entertained in an analysis of artificial light and the aquarium. They indicate that the beginner must rely to a certain extent upon his or her own experimentation, tank by tank, until the desired results are obtained. In general, these results are of two kinds: (1) illumination that displays tropical fishes at their best and (2), lighting that produces optimum plant growth.

There are two major types of artificial lighting in use today, incandescent and fluorescent. Unfortunately, neither of them is ideal for aquaria. A quick summary of their respective advantages would appear as follows:

Incandescent

1. Low initial costs, high operating costs.
2. Displays most fishes best.
3. Promotes good plant growth.

Fluorescent

1. Low operating costs, high initial cost.
2. Provides light with a minimum of heat.
3. Provides an even and distributed source of illumination.

In spite of the apparent advantages of incandescent lighting in providing the desired results mentioned previously, fluorescent is usually recommended for the beginning aquarist. It has been felt that the heat and algae problems so often accompanying the use of incandescent lamps would be that much more of a burden to the beginner. If the aquarium is located so as to avoid hot weather problems (in the basement, for example) or if, during the summer months, the incandescent lamps can be replaced with the fluorescent type, then incandescent lamps would be the better choice. Actually, a combination of the two light types, barring expense considerations, is probably the closest thing to ideal aquarium lighting.

It is difficult to talk of incandescent light in relation to natural daylight since the latter is a variable quantity. In general, it can be said that incandescent contains a greater proportion of yellow rays and fewer blue rays than daylight in comparison with fluorescent. However, incandescent is very strong in pink and red rays. It is these pinks and reds that bring out the subtle colors of many fishes and promote a lusty plant growth. Unlike fluorescent lamps which usually are no hotter than 100°-120° F., incandescent lamps become too hot to handle. In addition, their spherical shape tends to concentrate this heat in small areas and as a result are capable of heating aquarium water to dangerous levels in hot weather. With fluorescent lamps, however, the tubular form distributes not only the heat but also the light itself. This prevents the casting of shadows and reduces complications in maintaining the correct water temperature. Such a distribution also reduces areas of rigorous algae growth along with the problems that such growth brings.

The aquarist who invests in fluorescent lighting will find it relatively expensive compared with incandescent lighting. There is extra equipment in the form of starters and ballasts, and in addition, lamps and sockets are more expensive. For the same amount of light delivered, however, operating costs for fluorescents are only about 1/3 as much as for incandescents. The lamp life of a fluorescent tube is many times that of its incandescent cousin.

There have been several approaches in attempting to minimize the disadvantages of each lighting type. In incandescent lighting, for instance, use has been made of the Lumiline incandescent bulb. The Lumiline resembles a small fluorescent tube but requires no ballast. It distributes light evenly, as do fluorescents, but the heat problem remains. The initial cost of the Lumiline bulb lies between that of the normal incandescent and fluorescent lamps. A second method used to improve the use of incandescent lamps for aquarium use has been the placing of a strip of heat reflecting glass between the reflector and the aquarium. A large part of the heat produced by these lamps is via radiation and is effectively stopped by the glass. The heat reflecting glass is not too expensive (about as much as Lucite or Plexiglas) but is only obtainable from glass specialists or upon special order.

On the other side of the ledger, the use of "warm-white," "warm-tint" or warm white deluxe fluorescent lamps has helped somewhat in providing a fluorescent lamp emitting more of the red end of the spectrum. The use of pink fluorescent lamps in conjunction with daylight or warm-white fluorescent lamps has been tried by the author, but is it an expensive proposition and problems exist in properly "mixing" the two lights.

Artificial Aquarium Lighting – Part II

[Aquarium Journal, October 1957]

To return to the lighting problem in respect to the question "how much and how long" in Part I of this article, let us examine the bases upon which lighting formulas are chosen. Generally, these have been water depth, nominal aquarium size in gallons, square feet of bottom surface, tank length, and watts per gallon of water. However, there are other factors that are usually left out in these computations, viz., types of fishes and plants in the aquarium, reflectivity of the sand or gravel, number of plants in the aquarium, type of reflector used,

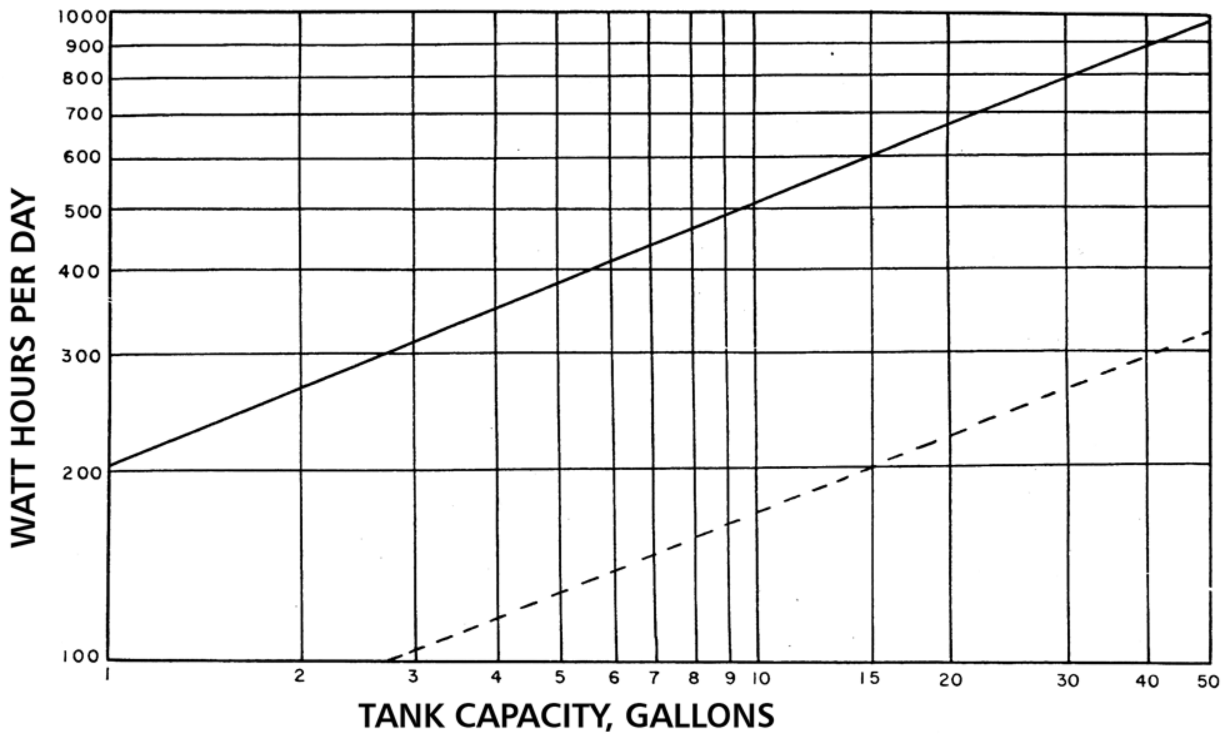


FIGURE 1

etc. All of the formulas consider that quantity of light and duration of light are interchangeable in some ratio? Experiments have shown, however, that this is not necessarily so. For example, 100 foot candles (a measure of the amount of light) for 10 hours does not produce the same effect as 1000 foot-candles for 1 hour. Another difficulty has been with equating incandescent light with fluorescent light. A 20-watt fluorescent lamp may emit as much visible light as a 60-watt incandescent but white light is composed of colored rays not all of which can be utilized by growing plants. Thus a plant may utilize more proportionally of the light from an incandescent bulb than from a fluorescent tube.

The best answer to the problem of "how much and how long" lies with the condition of the aquarium itself. If the plants are declining and perhaps brown algae is evident then the amount and/or duration of the light should be increased. In some cases, weak lighting produces a spindly growth in plants, caused by their attempt to push nearer the source of light. If, however, blue-green algae is found smothering aquatic plants or if such vigorous plant growth is obtained that is characterized by growth and flowering above the water's surface then the intensity and/or duration of light should be decreased.

As a first approximation for the aquarist who is new to the hobby, Figure 1 provides a starting point. The figure assumes an aquarium of standard dimensions and a reasonable illumination time (between 6 and 12 hours). From the direction provided by this figure, the hobbyist can then experiment to find the best combinations and conditions for each aquarium. For example, consider the lighting required by a standard 15-gallon aquarium. Entering the figure at the bottom at 15 gallons, a vertical line intersects the dotted line at 200 watt-hours and the solid line at 600 watt-hours. The dotted line is applicable to fluorescent lighting and the solid one pertains to incandescent. The term "watt-hours" is merely the lamp wattage multiplied by the number of hours a day the lamp will be on. Thus, 600 watt-hours per day for an incandescent lamp can mean the following combinations, 50 watts for 12 hours, 60 watts for 10 hours, 75 watts for 8 hours or 100 watts for 6 hours. For a fluorescent lamp, 200 watt-hours per day could be obtained by using a 20-watt lamp for 10 hours a day. The spacing of the lines on the figure may seem to be a little strange but it follows from the light theory used in its preparation.

Once the size and type of lamp, together with the hours used a day, is determined, the placing of the lamp must be considered. For display purposes, the best location is at the top front of the aquarium. Rear locations will silhouette the fish and side locations may be dangerous to them. Since the plants will grow toward the source of the light, however, the best location for the most vertical plant growth would seem to be somewhere at the top center of the aquarium. This dilemma can only be solved by either providing two sets of lights or by moving one set.

There is much improvement needed in the aquarium lighting field and the problems that exist face beginner and expert alike. Perhaps the solutions to these problems will fall to the beginners who bring to the hobby an enthusiasm unencumbered by the weight of "standard aquarium procedure."

On Planting Arrangements

[Aquarium Journal, December 1957]

Although in principle it may be desirable to present the display aquarium as a setting from nature, it is not always possible to reduce it to practice. For example, in spite of the fact that piranhas and many other tetras are found in the same natural habitat, it would be folly to mix them together in a community aquarium. We may also expect to encounter an assortment of problems when it comes to planning tank plantings. One procedure that is usually made all the time is to place plants from one geographical region with fish from another. Cryptocorynes, for example, are not native to South America yet many South American fishes (neon tetras, flame tetras, etc.) look well in and are frequently placed in aquaria planted with cryptocorynes. Although such a procedure is not "natural," I think it is a justifiable compromise.

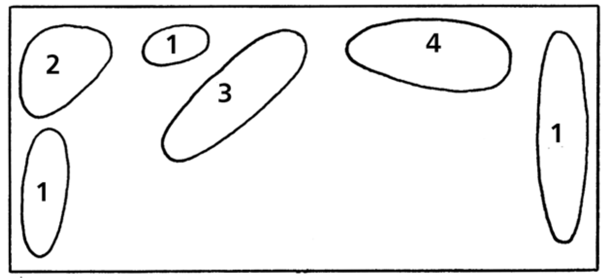


Figure 1
1 - Dwarf Amazon sword plant
2 - Amazon sword plant
3 - *Ambulia*
4 - *Hygrophila*

With this and like compromises in mind, the following suggestions are offered as reasonable and useful principles or guides for planting the aquarium:

(1) Do not plant too many varieties of plants. The resultant hodge-podge makes it impossible to maintain centers of interest and the eye will rest uneasily upon the scene.
(2) Do not over plant. Too many plants cause an overgrown, "weedy" appearance. In addi-

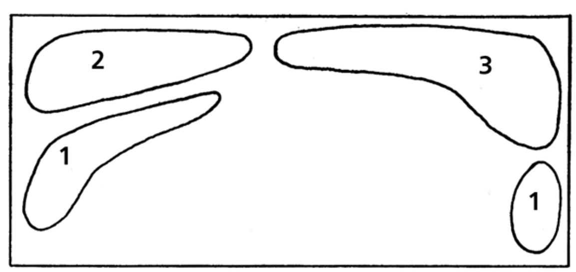


Figure 2
1- *Cryptocoryne nevillii* or *C. willisii*
2- *C. griffithii*
3- *C. haerteliana*

tion, the swimming space for fishes is curtailed.

(3) Place only those plants together that will prosper in the same environment. A certain *Cryptocoryne* may survive in a dim light situation whereas a cellophane plant would decline. They will not live together.

(4) Place only those fishes in the aquarium that will prosper under the same environmental conditions that the plants require. A brightly illuminated aquarium, for example, may suit sword-plants well but be detrimental to the well being of sensitive killifishes such as the lyretail.

In order to develop a feeling for harmonious combinations of plants and to exemplify the principles advocated, four tank plantings will now be considered.

A. A Planting for the Well Lighted Aquarium

This planting (Figure 1) utilizes dwarf Amazon swordplants, narrow-leaf sword-plants, Ambulia and Hygrophila. It is suitable for a 15-gallon tank that receives a moderate amount of light. The number of varieties of plants is kept to a minimum and the varieties are well suited to each other.

B. A Planting for the Moderately Lighted Aquarium

Here (Figure 2), the varieties of plants are limited to three or four species of Cryptocoryne in a 15-gallon aquarium. The plants tolerate both soft, acid water and fairly dim lighting conditions. Certainly the more sensitive killifishes, Rasboras, etc. would be at home in this type of planting.

C. A Special Purpose Aquarium: Planting for Labyrinth Fishes

Again, a total of but four varieties of plants are used (Figure 3). The plants themselves are adapted to bright lighting conditions that are enjoyed by most labyrinth fishes. Since such

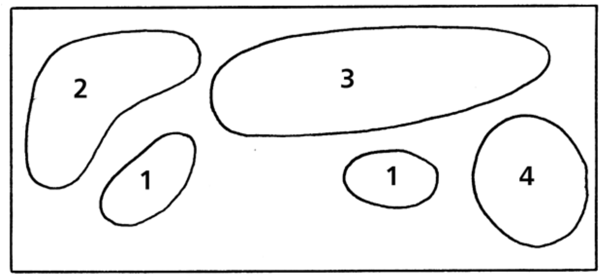


Figure 3
1- *Bacopa*
3 - *Ambulia*
2 - *Hygrophila*
4 - Water fern

fishes do not need much swimming space, the aquarium is more densely planted than would the case be otherwise. Therefore, this planting is not too much for a 15-gallon tank.

D. A Planting for a Large Aquarium

For a large tank (over 30 gallons), the number of plant kinds as shown in Figure 4 has been increased to nine. The plants will prosper together. Note, however, that *Cryptocoryne griffithii* plants are placed in the corners that are assumed to be somewhat more darkened than the rest of the aquarium. *Cryptocoryne haerteliana* will do well under brighter conditions than its cousin, *Cryptocoryne griffithii.*

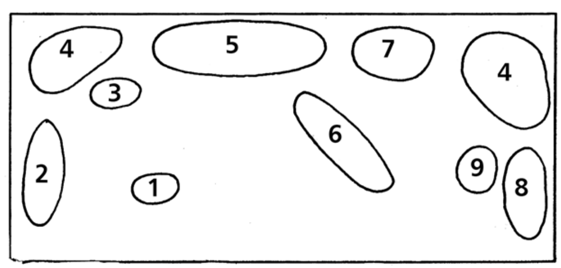


Figure 4
1- *Aponogeton fenestralis*
6 - *Ambulia*
2 - *C. nevillii*
7 - Amazon swordplant
3 - *Hygrophila*
8 - *Ludwigia*
4 - *C. griffithii*
9 - Water fern
5 - *C. haerteliana*

On Catfishes

[Aquarium Journal, February 1958]

Because tropical catfishes are so markedly different in form from our well-known native species, they usually command the attention of those viewing them for the first time. The most commonly found catfishes in the aquarium represent but two types, the armored catfishes of the genus *Corydoras*, and the sucker-mouthed catfishes exemplified by the bizarre *Plecostomus*. The former type is by far the most useful and have much to recommend them to the beginner. They are droll little creatures and are interesting fishes in their own right. What other fish will "wink" at its owner! When added to this the fact that they are valuable scavengers and, at the same time, harmless to other fishes, popularity of *Corydoras* is indeed justified. Perhaps a good rule of thumb to inject here is, for scavenging purposes use one *Corydoras* per 5 gallons of water.

The smaller sucker-mouthed catfishes such as *Loricaria* and *Otocinclus* are also desirable aquarium occupants. These fish are excellent scavengers and, in addition, remove unwanted green algae from plants, rockwork, and even the sides of the aquarium. While most sucker-mouthed catfishes are small and innocuous, the large sucker-mouthed catfish known as *Plecostomus* can be criticized on this score. Growing to over a foot in length in their natural habitat, they are much too large for the average aquarium. Even if purchased in a very tiny size, their rate of growth is such that it is only a matter of time before larger quarters must be found for them.

Experience has shown that they are prone to dig into the gravel and uproot plants when they get large. Worst of all, certain cantankerous individuals may actually attack other fishes. The beginner is certainly encouraged to avoid this "gentleman" and substitute the more cooperative *Loricaria* and *Otocinclus*.

Occasionally, a few miscellaneous species of catfishes are found in the aquarium. Bubblenest building catfishes of the genera *Hoplosternum* and *Callichthys* are unusual in appearance, active in aquaria and are good scavengers. However, they do grow to about 6 inches and will outgrow the smaller sizes of aquaria. Glass catfishes are sometimes to be had and, to some, are the strangest catfishes of all. If the aquarist has a spare evening, he might try counting the vertebrae on this fish!

There are a number of catfishes that are definitely not beginner's fishes. Foremost among these are the expensive African catfishes such as *Clarias, Synodontis, Heteronuestes*, etc. and the infrequently seen South American catfishes of the genera *Pimelodella* and *Pimelodus*. These catfishes are decided predators and will easily swallow fishes a third of their own size. Of course, as curiosities and with fishes their own size, they may be successfully maintained but as such, cannot be classified as beginner's fishes.

None of the catfishes can be said to be easily bred. A great many spawnings do occur with no assist from the aquarist and therefore fall into the "accidental" category. Of those that are bred with the least difficulty, it appears that the time required to condition the breeders is very long. It is a rare occurrence if more than two spawnings are obtained from one pair during any one year. However, *Corydoras aeneus* can be spawned regularly and many times a year.

As a summary it can be said that *Corydoras* and, to a lesser extent, *Otocinclus*, and *Loricaria* should form the bulwark of the beginner's catfish force. For that "something different touch" might be added an occasional glass catfish or, if a 20-gallon or larger tank can be supplied, a bubblenest building catfish. As far as those unusual and expensive catfishes equipped with suspiciously large mouths are concerned, the beginner should think twice before admitting them to a community aquarium. In this case, the "community" might shortly consist of only catfishes!

A Letter to the US Wildlife Service, Advice to "Fish Widows"

[Aquarium Journal, March 1958]

One of my favorite stories concerns a survey made by the U. S. Fish and Wildlife Service to learn more about the distribution of the dogfish, a small species of shark. The dogfish were captured and then released with a band that bore the message, "Notify U. S. Fish and Wildlife Service, Wash. Biol. Surv." Some time later, the Service received the following letter from an irate housewife:

"Dear Sirs,
My husband caught one of your fish and according to your directions, I washed it, boiled it and surved it. It was awful. You should stop trying to fool the public with this thing. There are better ways to spend the taxpayers' money. Sincerely,—J"!

Although this story illustrates some of the difficulties in being married to a fisherman, I cannot help but note that aquarists' wives have their problems too.

Some time ago I chuckled over an article in DATZ (a German magazine) that summarized the best advice that one "tropical fish widow" could give another. The following highly paraphrased version is offered with the hope that the wives of beginning aquarists as well as those misses contemplating marriage with persons known or suspected to be addicted to the tropical fish hobby might find useful.

1. Be optimistic and believe everything your dear man tells you about the purchases of his fish, plants, aquaria, and other equipment. True, that fish he told you cost only 50c may actually have cost $3 but remember, sooner or later he will voluntarily suggest that you buy a new hat or dress as a salve to his overburdened conscience.

2. Be resigned, contented, and satisfied with the few places in your home remaining to you and the children. The living room, dining room and even the bedrooms may be cluttered with tanks and equipment, but be consoled with the thought that cooking aromas will probably force him to keep the concentration of aquaria in the kitchen down to a bare minimum.

3. Be economical in your housekeeping. In this way you will compensate for the high cost of daphnia, shrimp, etc., that, being food, must certainly come out of the household budget.

4. Be inventive and learn to use substitutes when you can't find kitchen implements that are "temporarily" being used to strain brine shrimp, sift white worms and do other necessary jobs.

5. Accustom yourself to harrowing trifles like finding worms in the refrigerator or mosquito larvae cultures in the back yard.

6. Undergo physical training and conditioning to keep your body elastic and durable. Hikes for daphnia can often last the whole day and helping to lift heavy aquariums is not for the weak-muscled.

7. Develop a rich inner life or accustom yourself to long periods of solitude while your husband disappears for hours among his fish. You might culture a taste for TV or movies, or start a collection of Currier and Ives prints.

8. Study aquarium books and learn the peculiar language of the hobby. In no time at all words like *Pterophyllum* and *Aequidens* will be tripping lightly from the end of your tongue, and you will again be able to converse with your husband.

9. Be deceitful and untruthful when facing aquarist visitors. When your husband blandly announces that the water in his breeding tanks is at least 6 months old when you know that they were filled only the night before, look his visitors straight in the eye and back him up. The blackmail you can practice later may not be moral but it is legal between spouses and the profits are enormous.

10. Sit down, relax, and contemplate your own fish for there is a lot of wisdom in the old adage, "When you can't beat them, join them!"

On Bubblenest Builders

[Aquarium Journal, April 1958]

Since most bubblenest-building fishes are members of the anabantid family and most anabantids build bubblenests, an introduction to this family is in order. The anabantids, or labyrinth fishes as they are frequently called, have a distinguished circle of relations including scats, archerfishes, sunfishes, and cichlids. One of the features that sets the anabantids apart from these relations is the presence of an accessory respiratory organ (the so-called labyrinth) that enables them to breathe atmospheric air thus freeing them from dependency upon the oxygen dissolved in waters for breathing.

The majority of the species exhibit parental care of the young and usually construct a bubblenest of some sort. The bubblenest itself is constructed of air and mucus at the water's surface. Some species incorporate bits of plant in the nest to strengthen its construction. The over-all appearance of the nest may be flat to dome-like. The workmanship of these nests varies with the species of fish concerned. There are species that construct rather sloppy nests just as there are those that complete near works of art.

It might be expected that fishes developing accessory breathing organs are found in nature in stagnant or foul waters. These waters are generally low in oxygen, very warm and slowly moving, if they move at all. However, fish eggs, like their parents, need oxygen. What better way to obtain this oxygen under these conditions than by association with a frothy mass on the water's surface? This is a major reason for bubblenest construction by fishes; that is to get the eggs into a well-oxygenated environment.

The eggs do not get into the bubble-nest in the same manner in different species. Some, for example, lay eggs that are deliberately placed in the nest by the male fish. On the other hand, the eggs of many anabantids are lighter than water and, if the parents spawn below the nest, they will rise of their own accord right into the nest. Of course, if some eggs miss their mark, the male fish will retrieve them and place them where they belong. In some cases, the eggs are allowed to float free from the nest and to develop as best they can.

A number of generalizations can be made about the breeding of the bubble-nesters. These are helpful to keep in mind when aquarium breeding is attempted.

1. Anabantids require somewhat higher temperatures than is usual for breeding. For instance, in the case of the pearl gourami, this may range upward to 85° F.

2. Where parental care is given, it is the male who guards the eggs.

3. The male will seldom eat the eggs.

4. The fry are small when hatched and usually require the finest of first foods, i.e. infusoria or egg yolk.

5. The fry are very sensitive during their first 8 weeks to changes in the temperature of the air above the water's surface. It is during this time

that their supplementary breathing apparatus is being developed.

6. The raising of the fry is more successful in shallow water depths (up to 6 inches), than in deeper circumstances.

7. Spawnings produce large numbers of eggs.

In accordance with these generalizations, a typical spawning would be attempted as follows:
(a) Prepare a heavily planted breeding tank, 10 gallons or larger.
(b) Place a glass or plastic divider in the middle of the aquarium. Introduce the male into one section and the female into the other.
(c) Condition well, with frequent feeding.
(d) Raise the temperature to a minimum of 80° F. Later, this can be raised if no signs of willingness to breed are noted (like the male blowing a bubblenest).
(e) If all goes well, the female should fill with eggs and the male should start construction of the bubblenest.
(f) Remove the partition.
(g) Breeding should commence after a short while. With some fishes, Bettas in particular, the males are very rough with the females. If the female is not ready to spawn, the male may injure or kill her. If signs of this are detected, remove the female and try again either another time or with another female.
(h) After spawning, remove the female.
(i) The male can be left with the eggs but as the care that he gives the eggs is unimportant in the aquarium, he can be removed. In any event, the male should be removed by the time the fry are hanging from the nest, a matter of about 48 hours after egg laying.
(j) Cover the aquarium with a tight fitting cover and ensure that no drafts will reach the tank.
(k) After the yolk sacs on the fry have been absorbed, commence feeding with fine foods such as infusoria or egg yolk (such as is sold as strained egg yolk for babies). If infusoria is used, this should have been started before the spawning took place.
(1) Switch to larger foods, i.e. prepared, frozen etc. as, soon as the fry are large enough to eat them. As a rule of thumb, use food no larger than the eye of the fish.
(m) After 8 weeks, the young can be moved to larger quarters if it is desired to save most of them. Otherwise, thin out their ranks mercilessly to allow the remainder to grow rapidly.

As a list of bubblenest-building fishes that make good breeding subjects for the beginner, the following is offered:

Bettas (*Betta splendens*) - do not keep the female together with the male any longer than necessary. A temperature of 80° F. is optimum for breeding this fish.
Striped or giant gourami (*Colisa fasciata*) - Use a large tank for breeding, i.e., 15 gallons or larger.
Dwarf gourami (*Colisa lalia*) - A smaller tank (about 8-10 gallons) can be used for this fish. Fry are very small and harder to raise than other gouramies.
Blue or opaline gourami (*Trichogaster trichopterus*) - Use a 15 gallon or larger aquarium. The male may tend to bully the female. A very easy fish to breed and the young are hardy and raise easily.
Pearl gourami (*Trichogaster leeri*)-A shy fish. Disturb as little as possible. Temperatures of 85 - 90° F. may be necessary to induce spawning. A more difficult fish to spawn than the others listed.
Thick-lipped gourami (*Colisa labiosa*) - 10 to 15 gallons is about right for this fish.
Snakeskin gourami (*Trichogaster pectoralis*) - Produces large numbers of young. Very peaceful and very easy to breed, young hardy and easy to raise.

What You Should Know About pH - Part I

[Aquarium Journal, May 1958]

Although the term pH is used freely throughout aquarium literature, it remains no easy task to explain it to the satisfaction of all aquarists. Fortunately for us, the importance of pH lies not in its definition but in its application to the tropical fish hobby. Therefore, the following brief explanation is presented by wav of introduction.

Acids and bases form two important classes of chemical compounds. An example of an acid would be the liquid in an automobile battery; that of a base would be common household lye. When mixed together, they are said to neutralize each other. Since there are strong and weak acids as well as strong and weak bases, sometimes only a partial neutralization occurs. It remains for some system of measurement to describe the condition of a solution containing either acids or bases, or, a mixture of both. This measure is called, pH. The neutral point is given a value of 7. Any value below this denotes an acid condition; any value above denotes a basic or, a more frequently used term, an alkaline condition. Therefore, pure water has a pH of 7. However, due to chemicals contained in natural waters, waters used for aquarium purposes can vary over a wide range of pH. In nature, this range is approximately from 5.0 to 8.5. However, the range of pH most common in aquaria is nowhere near as great, i.e. it may be 6.5 to 7.5.

The scale used as a measure of pH is an unusual one. For instance, a pH of 6 is 10 times as acid as a pH of 7, a pH of 5 is 10 times as acid as a pH of 6 and, of course, a pH of 5 is 100 times as acid as a pH of 7! It works the same way on the other side of the scale for alkalinity. It can be seen, therefore, that a small change in pH may result in quite a big change in acidity or alkalinity.

There are two popular methods used by aquarists for testing for pH. The oldest' method uses an indicator solution which changes color when added to waters of varying pH values. The color of the indicator can then be compared with a color chart and the pH values can be determined. A newer system utilizes chemically treated strips of paper in place of the indicator solution. There are several advantages and disadvantages to both methods. The paper indicator is more convenient but does not show up pH differences as accurately as the liquid. What is not stressed very often, however, is that both the chemicals in the liquid indicator and in the paper, deteriorate with time. In this respect, the paper will outlast the liquid. If the liquid indicator kit is stored in a cool, dark place it may be used for 6 months, after which it should be discarded. If the paper indicator is stored away from moisture and light, it should last for a year. The color standards provided with both types quickly fade when exposed to moisture and light. At least two manufacturers of aquarium test kits partially solve this problem by using, as color comparators, vials filled with colored solutions. They are sealed from the destructive action of air and will last many years if not continuously exposed to strong light.

For many years, aquarists wishing to effect changes in pH in aquaria have utilized two chemicals. For decreasing acidity and increasing alkalinity, ordinary baking soda has been used. Chemically, baking soda is sodium bicarbonate, a relatively mild agent for this purpose.

For traveling in the other direction, Increasing acidity, sodium acid phosphate (sometimes called sodium biphosphate) is very often used. Strong acids such as hydrochloric and sulfuric could be used to effect changes in pH but due to the inherently corrosive nature of these materials and their powerful action, they are not suited to aquarium purposes. This holds true for powerful bases such as lye, also. In the aquarium, less drastic agents are to be preferred.

There are other suitable chemicals for changing the pH of aquaria. Sodium acid tartrate is one the author uses frequently. This chemical will increase the acidity of aquarium water but will not increase its mineral content as much as with the addition of sodium acid phosphate. More important, however, are the sundry organic materials such as tannic acid, oak leaves and peat extracts used to breed some of the so-called problem fishes. Since the acidity of natural waters is hardly caused by the presence of sodium acid phosphate, many aquarists feel that the acidification of aquarium water should be done with these more or less "natural acids." We shall investigate this idea further, but in the meantime, simply add that these natural materials impart some color (usually brown) to the aquarium water and are a bit tricky to handle.

Although fish may adjust to a wide range of pH conditions, sudden changes can prove fatal. It is never wise to change aquarium water more than % of a pH unit per week. In addition, the chemicals used to effect changes in pH should not be added directly to the aquarium. The chemical can be added to a cup of aquarium water, completely dissolved, and then added to the tank. Simple precautions such as these prevent shocks to the delicate balance that a fish maintains with its watery environment.

What You Should Know About pH - Part II

[Aquarium Journal, June 1958]

Is pH of concern to the beginning aquarist? The author feels that the answer is, "Yes." The only justification for a "no" answer is the happy fact that the usual supply of water as received by the aquarist from his tap is suitable for the usual collection of aquarium fishes. For the most success in the hobby, however, the beginner should know something about the pH of the water in his or her tanks.

As a generalization, water of slightly acid to neutral pH covering the range of pH of 6.5 to 7.0 is more suitable to tropical fishes than alkaline waters. The big exception to this statement is the class of livebearers. Here, the most suitable pH is on the alkaline side covering a pH range of 7.0 to 8.0. In his interesting little book, *Der Fisch in der Landschaft*, Dr. Werner Ladiges gives the following typical pH values for natural waters from which most of our egg-laying fishes are obtained:

1. Singapore (outskirts of city) - pH averages 6.0
2. Medan (city in Sumatra) - pH averages 6.15
3. South America (Neon tetra waters) - pH averages 6.6

In addition, there are many tropical fish waters in South America and the Far East in which pH values of as low as 5.0 have been recorded.

On the other hand, waters in which livebearers are found generally have higher pH values. In our own country, for example, natural waters are more alkaline than the figures given by Dr. Ladiges for parts of Asia and South America. In the United States, of the fresh waters that support a fish population, it is said that only 5% have a pH less than 6.7, 50% have a pH less than 7.6 and 95% have a pH of less than 8.3.

For most egg-layers, a slightly acid pH condition has the following advantages:
(a) It reduces bacterial concentrations, thus minimizing the chances of disease breaking out in an aquarium.
(b) Since bacterial concentrations are lower, there is a reduced tendency for fish eggs to become infected.
(c) Many fishes show more brilliant colors in such waters.

(d) Quite a few of the "problem fishes" (neon tetras, rasboras, etc.) breed best in this type of water.

A minor disadvantage is that, in acid waters, fishes are more susceptible to poisons such as copper than they would be in more alkaline water.

Although a fair part of the acidity in natural waters is caused by dissolved carbon dioxide, another large part is attributed to organic acids from decaying plant matter. These acids are generally lumped together as "humic acid" but when this is analyzed, the most important constituent seems to be tannic acid. This is the same acid found in tea and for many years, found service as an ingredient in burn salves. German aquarists put much emphasis on these natural organic acids and generally add them in the form of peat extracts. The peat is boiled in clean water after which the water takes on a deep brown hue. This brown water is then used to acidify water for tropical fishes, especially for breeding. American aquarists use peat extracts also and even extracts from oak leaves and similar plants. Occasionally, pure tannic acid is used. It is made up into a solution and it is the solution that is added to the aquarium. The fish must not be placed directly into this water, however. Quite often, an addition of tannic acid to the water will not appreciably change its color immediately. Then, overnight, the water will turn dark brown. This could be fatal to fishes. After a few days to a week, the color lightens and when it turns to a very light brown, it is safe for fishes. Peat extracts should be handled in the same manner. This peat water makes a fine breeding water for neon tetras and other difficult to-breed fishes. In addition, in such water, the fishes are at their best colors.

The choice of acidifying agent is a personal matter with the aquarist but no chemical used has a permanent effect in the water. There are other chemicals in water that ultimately alter these acidifying agents; therefore, pH should be checked at regular intervals. One interesting result of this destruction of the acid is that it results in softer aquarium water in many cases. (Hardness, or softness, of aquarium water is not the same thing as pH although they are frequently related.)

Since acid water is detrimental to most livebearers, an acidic condition can be corrected by the addition of sodium bicarbonate. Again, the action of sodium bicarbonate can be destroyed in time by natural chemical reactions in aquarium water, and the pH should be checked regularly.

The application of pH should never become a fad with the aquarist. For special purposes, such as we have mentioned in breeding some difficult fishes, it may be of paramount importance. For most purposes, it is of secondary importance, especially to the beginner. On the other hand, a simple test occasionally of the pH in an aquarium may serve as an early warning to undesirable conditions that may be developing. In such cases, knowledge of pH and the requirements for the particular fishes concerned may prompt remedial action that will result in healthier, better-looking tropical fishes.

Fish Disease

[Aquarium Journal, September 1958]

Maladies among aquarium fishes are uncommon provided the aquarist has treated his fishes according to the established principles of fishkeeping. However, even the best-laid plans break down now and then, so trouble may be encountered from time to time.

Of course, the first thing the aquarist must be able to do is to recognize that something is wrong. The earlier this takes place, the better. Fishes respond best to treatment when it is applied early in the course of the disorder. There are three main areas where symptoms are usually first observed: color, fins, and movement.

In some cases, color is intensified; in others the fish will appear pale or "washed out." Either is a sign that something is amiss. Since a healthy fish usually keeps its fins erect, a fish with folded fins may be a sick fish. Finally, listlessness, jerky motions, or attempts to scratch on aquarium gravel or plants are also danger signs.

For many of the common fish ailments, cures are available if applied properly and in time. Such diseases would include "ick" (*Ichthyophthirius*), velvet, and various skin infections such as fungus. Unfortunately, there are many other diseases for which there is no cure or for which treatment is ineffective most of the time. Among these would be counted such disorders as dropsy, tumors, and various internal parasitic diseases. Our success in treating external disorders as contrasted to our lack of it with internal maladies lies in the fact that aquarium fishes can hardly be given pills, hypodermic shots, etc., while on the other hand, medications can easily be added to the tank water. This, combined with the fact that external features are more readily observed and diagnosed, accounts for our greater success in treating disorders caused by external parasites or wounds.

It should be said that sick fishes must be kept in clean surroundings and provided with food that they will readily eat. Sometimes this means isolating them in a smaller, clean container and feeding with live foods. If possible, small and separate containers such as bare 5-gallon aquaria are preferred for treating sick fishes. With such quarters, the amount of expensive chemicals needed to effect a cure is decreased and undesirable side reactions with valuable plants are avoided. For fishes that are being treated by means other than chemicals administered in the water, a well-planted aquarium containing no other fishes is ideal. This would apply to fishes that are recuperating from bruises, torn fins, etc., or fishes that are being treated by a dip method.

Most methods of treatment involving chemicals involve the addition of the medication directly to the water. Liquids are simply mixed right into the tank water, but solids require a different technique. With a powder, and especially with crystals or tablets, it is necessary to first mix the substances with some of the tank water in a cup or other suitable container. Most of the chemical will dissolve and the liquid can then be poured into the aquarium, leaving behind any residual solid. More aquarium water can be added to the cup, the solid broken up with the back of a spoon and stirred into solution. This process is repeated until all of the solid is dissolved.

There are many materials used as medications in our hobby. These include salt, organic dyes, antibiotics, and metal compounds such as mercurochrome and copper sulfate. Each chemical has a range of disorders for which it is used. Salt combats many external parasites and helps prevent losses of vital substances from a fish's body through wounds or bruises. Some fishes, notably some catfishes, are intolerant to salt treatment and plants also cannot stand much salt. Dyes work well in certain cases and disappear over a period of time due to natural decomposition of the dye in water exposed to light. Methylene blue, unfortunately, is harmful to plants and acriflavine is suspected by some to cause temporary or permanent damage to reproductive organs. The metal compounds are tricky to work with as overdoses may kill the patients faster than the diseases. They also tend to accumulate in the aquarium water (as in the case of salt) and do not disappear as fast as the dyes. Antibiotics are valuable medications for parasites and wounds but have the disadvantage of being relatively expensive. It can be seen, therefore, that there is no one magic cure for even the disorders that can be treated.

In some cases, chemicals can be utilized without causing a buildup in the tank water. This is accomplished by the "dip" method. In most cases, a strong solution is made up, and the fish is suspended in the solution in a net. Usually, this solution is of such strength that the fish can only be immersed in it for a minute or so. This is the basis for the potassium permanganate treatment of "Ick" and the formaldehyde treatment of certain fluke parasites. In the case of wounds, the technique is often to swab the fish held in a net with the proper chemical, such as merthiolate or mercurochrome. In this way, very little of the chemical is introduced to the aquarium water.

This has not been a survey of fish ailments since they are adequately described in handbooks but rather an attempt to outline what is involved in recognizing, diagnosing, and treating fish diseases. It is something to be aware of before, rather than after, need arises.

Black Gravel

[Aquarium Journal, October 1958]

If there is one particularly nasty indication that something is amiss in an aquarium, then that sign is black or grey gravel. This discoloration is usually found directly below the usual feeding spot and can easily be seen at the point of contact of the gravel with the aquarium glass. It is not to be confused with mulm, which is a brownish accumulation of waste products and debris that is harmless and to a certain extent desirable. A black gravel condition, on the other hand, is definitely of a grey or black color. If it is stirred up, an unpleasant odor may be detected along with the release of small bubbles of gas from the gravel. If the odor cannot be detected while the gravel is in the aquarium, a handful taken out will leave no doubt as to what it is like. It is not only unsightly, but it is downright dangerous to your fishes.

The cause of black gravel is overfeeding with live or prepared foods. Quite often tubifex worms will work themselves into the gravel, die and the resultant decomposition of the remains will form noxious compounds and discolor the gravel. Even more frequently, a continued excess of dry prepared foods, especially the fine grinds, produces the same results. After the noxious chemicals have formed, fishes tend to stay away from the area and refuse to pick up food from the spot. Since they react against the harmful chemicals formed, they will prefer to eat only that food which is floating or sinking. This intensifies the buildup of food in the gravel and adds to the trouble.

The prevention of this condition is simple - do not overfeed. However, it is not always easy for a beginner not to overfeed. Filtration, the use of catfishes and other scavengers and frequent dip-tubing are valuable aids. As a means of checking, occasional dip-tube samples of gravel should be inspected for color and odor.

Once a black gravel condition is found, there are two courses of action the aquarist can take. If the extent of the condition is small in area, then the affected gravel can be removed either by siphoning or by dip-tubing, without disturbing either fishes or plants. Check especially the gravel at and near the edges of the aquarium and around rocks. This gravel should be discarded and replaced with clean stock. However, if the condition is extensive or general, all fishes and plants must be removed and the tank taken down. It is not necessary to discard the black gravel as it can be purified. In my early days in the hobby, the advice I was given was to place the blackened gravel in a roasting pan, put it into an oven and heat for several hours. My first mistake was in listening to this advice and my second was in following it. It was not that this technique did not work but there were several things wrong with the method as follows:

1. It played hob with the gas bill.
2. The aroma emanating from this "gravel de jour" being roasted, precipitated several altercations with the neighbors.
3. There was an interesting chemical reaction between the wet blackened gravel and the aluminum pan which was used. The compound formed was either gravel sulfate or pan chloride but it was never fully identified. It did leave interesting etch patterns all over the pan.
4. My wife threatened to initiate legal proceedings including separate maintenance, custody of the fish, and compensation for a new pan.

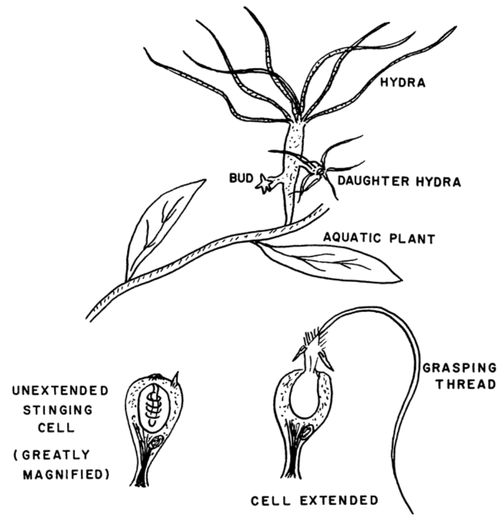
A cheap, simple, and effective method to rejuvenate the gravel consists in spreading the gravel on newspapers and allowing it to dry in the sun and bleach for a day or so. When the black coloration has disappeared along with any odor, the gravel can then be washed in a bucket by a strong current of water from a hose and reused safely.

Remember, one can avoid this trouble if care is taken in preventing overfeeding and vigilance is exercised to keep black gravel from ever getting very far.

Hydra

[Aquarium Journal, November 1958]

Hydra, according to Greek legend, was a gigantic monster with several heads, the center one being immortal. The destruction of this monster was one of the 12 labors of Hercules. Since two heads grew as soon as one was cut off, Hercules burned the roots with fire brands and at last severed the immortal head from the body and buried it underneath a rock. Afterwards, the arrows dipped by Hercules in this poisonous blood inflicted fatal wounds. Although Hydra is not quite the problem to the aquarist that it was to Hercules, it still is troublesome!



Hydra are actually one of the few coelenterates that live in freshwater. Their saltwater relatives are familiar to most of us, coral and jellyfishes, for example. These animals possess stinging cells on their body. They are especially numerous on the long, retractable tentacles that surround the mouth. When a food animal such as a daphnia or a fish fry touches one of the stinging cells, the cell ejects a harpoon-like organ and a paralyzing substance is injected into the victim. At the same time, a thread-like cell envelops the food animal. After the victim has stopped its struggling, the tentacles move to the mouth of the hydra where it is eaten.

There are many species of hydra to be found in our native waters. Their manner of reproduction is mainly asexual, a sort of budding process. After a bud develops on the mother hydra's body, it grows and finally detaches itself to form a separate individual. In unfavorable living conditions, hydra are also capable of producing eggs.

Living conditions in the average aquarium are very conducive to the growth and prosperity of Hydra should once they are introduced. These small creatures (1/16" to Y2") usually enter the aquarium on plants or in pond water used as an infusoria for fish fry. Although they do not attack adult fishes, they do eat live fish foods such as daphnia and are, at the very least, to be considered as pests. Since they avidly devour fish fry, they are the scourge of the fish breeder.

In general, hydra can be destroyed by heat and by an addition of ammonium nitrate. A dose of 0.1-0.2 grams per gallon is usually sufficient and a rise in temperature to about 85° F. helps the destruction. Neither plants nor fishes need to be removed. At first, the tentacles of the Hydra will appear to droop, and then the main body will shrivel. A few days later, the Hydra will release their hold on the plants or glass and fall to the bottom of the aquarium. The ammonium nitrate remaining in the tank will ultimately be utilized by the plants as a fertilizer.

On Some Problems in Breeding

[Aquarium Journal, February 1959]

As a bird in the bush is not the same as a bird in the hand so a fish egg is not the same as a fry. Many aquarists manage to spawn their fishes with little trouble only, to lose the eggs through that scourge of the fish breeder, fungus. Even if not all of the eggs are lost, it is a common occurrence to finish with but a few fry from what had happened to be hundreds of eggs.

Although there is little doubt that the final result of an egg that does not develop is fungus, there is some difference of opinion as to whether it is initiated by the fungus itself or from a primary infection of bacteria. Ignoring those eggs that are infertile and, as such, will never develop anyway, eggs that do not develop into fry occur because conditions are not favorable to them.

Some eggs, apparently, are light sensitive and quickly dissolve or fungus when exposed to moderate to strong light. The eggs of the neon tetra and of the lyretail, Aphyosemion australe, are examples. For the most part, however, the breeding of these fishes is a task for the more experienced aquarist and will not be considered here. As a general aid to the aquarist who is breeding fishes, however, it is recommended that the breeding aquarium be darkened somewhat after the fish have spawned, although this is certainly not necessary for some fishes, for example many barbs, goldfish and danios.

Other causes for the destruction of fish eggs are some unfavorable water conditions or condition. The two most important factors are pH and hardness. For many egg-layers, the chances for hatching a larger number of eggs are increased when soft, slightly acid water is used for breeding. These two factors are not independent in breeding, however. Dr. Gunther Sterba found, for example, that the optimum pH for breeding *Rasbora heteromorpha* varied with the hardness as follows:

Optimum pH	Hardness, in parts per million (ppm)
6.0	90-110
7.5	35-45
6.5	55-70

It should be noted that even the hardest water used here is generally classified as moderately soft water.

Compared to the parent fish, fish eggs are even more sensitive to changes in water chemistry. Many times it is absolutely necessary to transfer fish eggs from the breeding tank to a hatching container. This is usually done in the case of cichlids such as angelfish to avoid the possibility of the eggs being eaten. In such an event, it is very important that the water in the hatching container be very similar to that in the breeding tank. A simple solution here is to actually use the same water in both tanks. In addition, just as it is important that the differences is pH and hardness be small between the breeding and hatching tanks, so it is important that the temperatures be the same.

The greatest deterrent to the destruction of fish eggs is a rigorous cleanliness in the aquarium in which the eggs' are being hatched. All aquaria to be used for breeding should be thoroughly cleaned before spawning is attempted. Solutions of common table salt, methylene blue, and potassium permanganate can be used as disinfectants. The water used in the breeding tank should be clean but aged for at least a week. If this is done, cleanliness can easily be maintained in the breeding tank. Unfortunately, the first time food is added to the spawning tank for the breeding fishes, this condition is immediately destroyed.

Generally speaking, breeding fishes should not be fed while they are in the spawning tank. This especially applies to dry foods for much of it will escape to the bottom where it will ultimately cause the destruction of fish eggs, mostly by promoting bacteria growth in the tank. Live foods that do not fall to the bottom (daphnia, etc.), provided that it is eaten before it dies, is not quite as bad. Even so, fish wastes that are formed add to the problem of cleanliness. Most fishes whose eggs take only a day or two to hatch will not mind the lack of food while they are in the breeding aquarium. They are much too occupied with the spawning act. For fishes that afford parental care to the eggs (cichlids, etc.), these rules may be somewhat relaxed as the fish themselves, through the fanning motion of their pectoral fins, keep particles from the eggs. For those fishes that spawn over a prolonged period of time and whose eggs take a week or more to hatch (killifishes), feeding does become a problem. In this case, the eggs are best removed to clean quarters daily.

It is true that dyes such as methylene blue are a help in preventing fish eggs from falling prey to bacteria and fungus. The trouble with their use is that it is very difficult to administer specific doses; most dosages are guessed at and rely for their substances upon the eye. Unfortunately, an overdose of these dyes frequently damages the fish eggs and interferes with their development. The dyes should be used sparingly, barely tinting the water and the major dependence should be upon cleanliness and a careful consideration of pH, hardness, light, and temperature.

Introduction to the Headstanders

[Aquarium Journal, March 1959]

The family Characidae includes a great many fishes from Africa and South America. Ichthyologists place the various kinds of characins into several subfamilies. Aquarists also group the various kinds of characins under common rather than inclusive categories. One of these is "headstanders." It should be noted that these aquarium groupings are not congruent with ichthyological groupings since the former include members in the characid subfamilies Chilodinae, Prochilodinae, and Anostomatinae.

The peculiar common name of these fishes is derived from their unusual posture when at rest. They rest with their heads downward. They are not what one could call "beginner's fishes" but since they are frequently seen in the aquarium stores, some knowledge about the family may prevent unwise selections on the part of the newcomer to the hobby.
The headstanders are all native to South America and in appearance they are more or less elongated, spindle-shaped fishes. Some of them possess thick lips especially adapted for grazing on the various growths that are to be found on plants and stones. Their foods in aquaria consist mainly of algae, the soft parts of plants (especially decomposing plant matter) and dry foods that have fallen to the bottom. With the single exception of *Chilodus punctatus*, no member of the group has bred under aquarium conditions. As a result, they

are relatively expensive fishes. However, since headstanders are pretty fishes, you may be tempted to try one or two in a community tank.

A few frequently seen headstanders are: *Anostomus anostomus*, the silver headstander (*Chilodus punctatus*), the banded leporinus (*Leporinus fasciatus*), the small-mouthed headstander (*Abramites*) and the South American flag fish (*Prochilodus insignis*). The last two are not seen as often as the rest. Both *Anostomus* and *Leporinus*, in addition, include many different species and a fair number of these are at least occasionally imported.

When seen at first in dealer's tanks, the headstanders appear to be ideal community tank fishes. In their smaller sizes, this is very much the case, for they are active and friendly fishes. Unfortunately, all of them, with the exceptions of *Abramites* and *Chilodus*, approach gargantuan proportions. A full-grown *Leporinus* of some species would make a nice Friday night meal. Adult *Anostomus* and *Prochilodus* would not fall into the sardine category, either. Occasionally, large specimens of these fishes are kept in large aquaria with other giants of the aquarium world, cichlids, for example. Under these circumstances, both fishes and owner are happy. Sometimes, larger *Leporinus* and *Anostomus* will bully the smaller ones. There is frequently a well-defined "pecking order" among these fishes. It has also been observed that some individuals may nip at the long fins of gouramies and angelfishes. For their own protection, the long-finned fishes should be removed.

Abramites and *Chilodus*, however, are different matters. These headstanders usually do not exceed 3 inches in length. Of the two, *Chilodus* is the more friendly fish and will do nicely in the community tank. In coloration, *Abramites* is brownish with yellow to light brown markings; *Chilodus* is a simple but pretty silver with some black markings on the sides.

Any of the headstanders will serve as a conversation piece for the aquarist, especially if the tank in which they are kept is not covered. More specifically, the conversation will be, "Whose fish is this on the floor?" The larger headstanders in particular are outstanding jumpers and the moral here is to keep their tank covered at all times.

On Micro Worms - Part I

[Aquarium Journal, April 1959]

One of the best of the smaller live fish foods available to the aquarist is the micro worm. Many small aquarium fishes, although requiring minute organisms such as infusoria during the first few weeks of life, readily consume micro worms after this preliminary stage. The fry of larger fishes, cichlids and livebearers, for example, can be started on micro worms immediately after the fry are free-swimming.

Scientifically, micro worms are called nematodes although non-aquarists also refer to them as threadworms. Nematodes or threadworms are of practically universal occurrence. Nearly every sample of soil or natural water, nearly every plant and animal has its nematode inhabitants.

Basically, micro worms are cylindrical animals and bisexual in nature. The males are commonly less numerous and smaller than the females. No need to sex them though as they reproduce very freely and with little trouble to the aquarist.

There are many methods used in culturing micro worms, roughly, about as many methods as there are aquarists. A popular one utilizes a number of inexpensive plastic refrigerator dishes. The dishes may be of any type of plastic and they may be colored or transparent. It is also possible to use glass or enameled dishes. The only other requirement is add too much of the yeast. The amount that can be carried on the tip of a knife blade is enough. The yeast cells will rapidly grow and multiply in the culture, providing food for the micro worms.

Now is the time to introduce micro worms from an old culture. Do not just pour them in one spot. Use a stick or a spoon so that they are present all over the medium. A spoonful of worms and media from the old culture will produce sufficient offspring for the aquarist to start feeding them to his fishes within a few days.

After the introduction of the culture the lid should be placed upon the dish. Do not, however, have it fitting too tightly, as the worms, in spite of being in a semi aquatic environment, must have plenty of air. The container should be placed in an area where the worms will be kept warm, near a radiator, for instance. 75° to 80° F is the temperature range desired. Unlike white worms, micro worms like high temperatures and so will thrive in hot weather. The refrigerator dishes can be easily stored on top of one another.

In a day or so, the worms will be ready for harvest. The micro worms crawl out of the medium and up the sides of the dish where they can be easily scraped off with a knife blade, a stick or any other suitable implement that can be pilfered from the kitchen. Although the worms will crawl up the sides of the container, they will not leave it, so there is no worry on this matter. Your worry will be in trying to convince your wife of this fact! After the worms are scraped off, new worms take their places in a few hours. Thus, one container of micro worms can be used several times a day.

On Micro Worms – Part II

[Aquarium Journal, May 1959]

Microworms can be fed to your fishes in several ways. The simplest is to merely scrape the worms from the sides of the container with a stick or knife blade and swirl it in the aquarium water. Usually, however, the worms fall quickly to the bottom where they will remain alive for a day or so. This is fine for fishes that will eat foods from the bottom of the aquarium but not so good for those fishes that only eat foods that float in the water. In addition, they tend to clump together in a sort of "in union there is strength" philosophy rather than becoming uniformly distributed throughout the aquarium.

To avoid this, the micro worms can be dipped into a glass of aquarium water. The water can then be thoroughly mixed to distribute the worms. Finally, the water and worms are ready to be poured into the aquarium. This method works quite well and facilitates the feeding for a number of aquariums. The worms can be collected in one operation and fed in another.

An even better method involves obtaining a small test tube. The test tube is heated red-hot over a gas flame pierced with a needle so as to leave a small hole in the bottom when it cools. Care should be taken so that the s hole is in the test tube and not the aquarist's hand. Sometimes the piercing is done best by poking with a wire from inside the test tube while the latter being heated. Use a pair of pliers or a clamp to hold the test tube and needle during this procedure.

The tube can then be fastened to the side of the aquarium, with the top just above the surface of the water. The micro worms are then introduced into the test tube and according to the size of the hole and the amount of worms, a varying quantity of live food will be released over a long period. The worms will find their way out of the hole when they drop out anti will be eaten. The worms sort of get themselves out of one hole only to find themselves in another! Rather than making this special feeder an ordinary white worm feeder can he used if a small piece of cotton is used in the bottom of the feeder. This will plug the holes that are too large for micro worms yet the worms can still work their way through the cotton.

To keep the micro worm culture sweet, it is a good practice to stir it daily so that the medium is thoroughly mixed. There is no need to have smelly cultures; they are a sure sign that something is wrong. If, each week, one half of the culture is discarded and replaced with new, thoroughly soaked cereal, a micro worm culture can be kept indefinitely.

When the culture begins to turn grey, it is time to start another. They are so easily started and maintained and take so little space that several cultures of varying ages can be kept at one time. If this is done, there is no need to replace all of the cultures at one time.

Micro worms can be kept dormant at low temperatures. It is possible to store micro worm cultures in the refrigerator for up to six months. When kept cold, they will not reproduce for their life cycle is considerably slowed. This is an excellent way to store them when they are not needed.

Even if a culture has dried up it can nearly always be brought back to life by the addition of a little water. Micro worms have the power of resisting desiccation or drying up.

By following the points discussed in these articles, you can raise live food for baby fishes that is nourishing, easy to maintain and productive. Micro worms are a useful supplement to brine shrimp and can help you in raising large and healthy aquarium fishes.

A Fish Quiz

[Aquarium Journal, July 1959]

Southern Ohio Aquarists, an association serving the aquarists of the Southwestern area of Ohio, usually begins its meetings with an "icebreaker." In the case of SOA, the icebreaker takes the form of a fish quiz. Audience participation is always high and the results are always interesting. Here is a typical fish quiz:

SOUTHERN OHIO AQUARISTS
FISH QUIZ OF THE MONTH
Circle the correct answer. Each correct answer worth twenty points.

1. Betta eggs are heavier than water.
true false
2. No barb comes from South America.
true false
3. Which fish lays non-adhesive eggs?
(a) angelfish
(b) giant danio
(c) zebra danio
(d) *Epiplatys chaperi*
4. All characins have adipose fins.
true false
5. Livebearers prefer hard, alkaline water to soft, acid waters.
true false

When the answers for this particular quiz were totaled up and analyzed, it was found that, if nothing else, there certainly was a difference of opinion!

Question 1. Of the aquarists who answered this question, only 57% gave the correct answer of "true." Many persons assumed that, since the Betta builds a nest that floats on the water's surface, the eggs must also float upon the surface and so, be lighter than water. A close observation of a pair of spawning Bettas will show that the eggs are heavier than water and when released by the female, rapidly drop to the bottom. However, they are retrieved by the male who then carefully places them in the bubble nest.

Question 2. This was a general scientific question and was answered correctly by only 33%. With time, an aquarist usually learns where the natural habitats of his fishes are located. Many of the test-takers knew that at least some Barbs came from Africa and the Far East but balked a little bit at saying that none come from South America. However, the statement is true as the Barbs are definitely Old World fishes, none of them appearing in South American waters.

Question 3. This was a question with a trick. Evidently, the members of SOA were just not nibbling at the bait, though, for 87% of them got it right! Immediately ruled out were the angelfish and *Epiplatys chaperi*, both of whose eggs are very adhesive. This left the choice between the zebra danio and the giant danio. Many aquarists, however, knew through experience that the correct answer was the zebra danio. The giant danio, in spite of sharing the popular name with the zebra, lays adhesive eggs. Spawning non-adhesive egg layers is a bit more productive than with adhesive egg layers. When eggs are adhesive, they tend to stick to any and all objects, thus increasing the chances in aquaria for them to be eaten by the parent fishes.

Question 4. Although it is commonly accepted in the hobby that characins are "those little fishes with the adipose fins," not all characins have them. Of those who answered, 23% got the question right. The adipose fin (which is the little fin located on the back behind the dorsal, close to the tail) is lacking in some pencil fishes and hatchet fishes, even though these fishes are characins. Even so, the presence of an adipose fin is still a good guide to identifying a characin. Don't forget, however, that many catfishes have them too!

Question 5. Sixty per cent gave the correct answer of "true." Livebearers in general, do prefer hard, alkaline waters. In any other type of water, they tend to fold their fins and decline. We were rather surprised that so many answered incorrectly. However, the water in Cincinnati is both hard and alkaline, so even those who missed the question were probably using the right kind of water!

Wood in the Aquarium

[Aquarium Journal, September 1959]

Most every aquarist will agree that, properly done and not to excess, the addition of a piece of wood does wonders for the natural appearance and beauty of the home aquarium. Not only does wood possess a warm, rich coloration that blends so nicely with fishes, plants and rocks, but the texture of the wood itself provides a welcome relief from the usual smooth and shiny artifacts that are currently added to aquaria as decoration.

Unfortunately, the use of wood is not without some danger to tropical fishes. In countless instances, what has promised to be an artistic addition to the aquarium has only spelled death to the aquarium inhabitants. The piece of wood lying on the ground then becomes the focal point for the release of a gray cloud of bacteria and infusoria when immersed in the water. Shortly after, fish deaths occur on an alarming scale.

Sometimes, a thick, slimy coating appears on the surface of the wood and a few days later, the aquarist may notice a very disagreeable odor wending its way from the aquarium. The bacteria, the infusoria and the coatings are all evidence that a host of living creatures, some very harmful to fishes, are at home within and on the wood and must be dealt with before the wood is safe for aquarium use.

All wood, even wood found floating and water-soaked, must be cured. It might be mentioned at this point that some woods are more easily adaptable to aquarium use than others in that they are made safe more easily. For instance, green wood is highly unsuited to the aquarist's tanks. The longer the selected wood has lain under water, the better it is for our purposes. In any event, all wood should be cured before use.

For years, the common method for curing wood has been to boil it for a few hours in a strong salt solution. Afterwards, the wood is soaked in water to remove the salt, several changes of water speeding this particular phase of the process. This is fine for small pieces of wood but try boiling a piece of wood two feet long! It seems that the housewife just doesn't have pots two feet long by 4 inches by 6 inches, or whatever the particular shape and dimension of the wood desired for aquarium use.

A nicer method in many ways is the use of methylene blue. A few years ago, I had occasion to cure a piece of wood about 5 feet long and about 10 inches in diameter to be used in my largest tank. Naturally, boiling this was out of the question. I merely filled the tank with water and added about 100 grams of methylene blue. The water turned almost black; of course, fishes and plants were not present. The tank was used since it was the only container I had large enough, to contain the piece of wood. The water was aerated after two weeks and shortly after, the water was drained from the tank and replaced with fresh tap water. The log turned out to be stained a beautiful navy blue, just what I didn't want although it did appeal to me later on. Strong aeration was applied to the aquarium. In another week, the aquarium water was a bright blue. Again the water was changed and strong aeration was supplied. This time, the water turned just slightly bluish and in another week, the strong aeration had destroyed the last of the methylene blue dye. After the water was perfectly clear, fishes and plants were added. In about six months, the log turned its natural color as the absorbed dye was completely destroyed. Bear in mind that this first experiment was with a 180-gallon aquarium. The log was so large, that without the methylene blue I never could have used the wood in this aquarium.

Subsequently, whenever I desired to use some wood in an aquarium, I merely immersed it in a dark blue solution of methylene blue. If the wood is large, I use the aquarium it is ultimately going into as the container. After a week or two, the wood is removed, the water changed and the wood soaked in fresh tap water. Strong aeration is applied with this rinse water. Although the wood is stained a dark blue, the color disappears in the completed aquarium within a short time.

One caution however: be sure that all of the methylene blue not absorbed in the wood is washed or soaked out of the wood before placing it in an aquarium with plants. Methylene blue is not good for plants in strong concentrations. The dye remaining in the wood will not harm the plants, as it is not free to leave the wood to do the plants any harm. The dye itself, methylene blue, can be obtained from any druggist although he may have to order it for you. Normally, druggists stock methylene blue tablets which are of no use to the aquarist. What is needed is the powder. You will have fun working with methylene blue. The first thing you will learn is that a little goes a long ways. The second thing you will learn is that it stains better than blackberry juice. My wife, who is leaning over my shoulder as I write this, has just remarked as to why I haven't tried blackberry juice for curing wood. While I am dealing with this delicate situation, I hope that you will try wood in the aquarium and am sure that you will be pleased with the results.

Netting a Fish

[Aquarium Journal, December 1959]

If anyone wants a quick laugh in this hobby, just watch the average aquarist trying to net a fish! Some hobbyists cut a swath through the plants with every motion of the net. Of course, this is not without its advantages as it does provide the aquarist with an opportunity to examine the roots of his plants and check them for condition as they float to the surface.

Without a doubt, a fish in water is in its element; an aquarist with one arm immersed to the elbow decidedly is not. During the process of netting a fish, tempers must be contained; otherwise the aquarist will be outclassed every time. Most of the trouble can be avoided if an attempt is made to ease the net over the fish, avoiding all sudden motions. In any event, the fish should be coaxed into a clear corner, thus minimizing up heaving the planting.

Quite frequently, the use of both hands is necessary. One hand holds the net and the other is used to drive the fish into the net. Fish are quite willing to enter stationary nets and, if they are fleeing from another disturbance, they will hardly notice that they are entering a net in the first place.

Few people would take out after an elephant with a B-B gun, yet thousands of aquarists attempt to capture large fishes with nets the size of tea bags. It is not often that a single net will suffice for the average hobbyist's collection.
Two or three sizes will make catching easier and decrease the wear and tear on fish, plants and equipment.

Have you ever watched some aquarists after they have netted their fish? They will hold the net horizontally, the bag of which is fully open, and then peer intently into it. About this time the fish, perceiving clear skies overhead, take off into orbit. How these animals manage to miss the aquarist's nose is not easily explained. Fishnets are made with enough material (or else they should be!) so as to allow the net to be held vertically, the top of the bag being closed securely by the frame. In this way, not only is it impossible for the fish to jump out, but also he will have less likelihood of hurting himself by thrashing about. A folded net restricts the fish for his own protection. Unfortunately, some fishnets are made of stiff materials that do not allow this collapsing or folding. Check this feature before you buy your nets.
Perhaps we can close this discussion of nets and netting with three short but important points:

1. When netting any fish, try to keep gravel out of the net. In its struggles, a fish may injure itself on this abrasive material.
2. If you have used a net in a tank containing sick fishes, sterilize the net before using it in another tank. This can be accomplished by rinsing in a strong solution of methylene blue, acriflavine, potassium permanganate, or salt.
3. Finally, do not place a wet net on a flat surface where it may remain wet. Hang it up to dry so as to prevent rotting.

On Neatness

[Aquarium Journal, January 1960]

If aquarists were suddenly to give up their fishes and keep live rattlesnakes instead, there is little doubt that their hobby would become considerably neater. This is to say that hobby equipment would not be scattered about nor would cages be placed upon shaky supports and left half uncovered. I know that if I were forced to keep rattlesnakes, my motto would be, "A place for everything and everything in its place," with emphasis on the latter part of the motto.

Unfortunately, we do not have a strong motivation to be neat in the aquarium hobby. It is a sorry thing to state, but most aquarists' fish collections resemble Fibber McGee's hall closet. The most noticeable eyesores are the unending, haphazard strings of electric wires and airlines. No wonder some wives take a dim view of their spouse's hobby for it is clearly Hobson's choice whether to be strangled by airlines or electrocuted by lamp cords.

In a maze of airline tubing, it is interesting to watch an aquarist make an adjustment. Invariably, the proper air valve is located as far from the equipment it controls as is possible. The valve is turned and nothing happens. In desperation, it is turned up all the way - still, nothing occurs in the tank of interest. Meanwhile, however, fish in a totally different tank are being blown out of their aquarium at the rate of one per second.

Aquarists are always indignant when, standing in a pool of water, they touch a reflector that is home-wired and subsequently receive an electric shock. The fact that electric lines have both hot and cold sides is considered trivial for the books and besides, "The lamp lights with the switch wired on either line, doesn't it?" The answer to this question is, "Yes, but it is generally conceded that the object is to have only the lamp light up and not the lamp plus the aquarist."

Fish, peculiarly enough, are designed for life in the water. They do not do nearly so well on the carpet. In nature, fish jump up out of the water to catch insects or to elude a pursuing enemy. They fully expect that when they fall, they will again fall into water. It must come as a rude shock to some fish to land on rattan, wool, wood, or one of the new miracle fibers. Of course, covers would prevent such excursions but they are not foolproof, at least not in the sphere of influence of the sloppy aquarist. If glass covers are placed on the floor, on window ledges and the like, the aquarist soon learns several things:

(a) Falling glass retains its shape perfectly but sudden stops considerably affect dimensional stability (in other words, glass when dropped, breaks), and
(b) Glass is extremely strong in compression but weak in tension (in other words, a big foot produces a big hole). Part of the same problem concerns the aquarist whose covers are razor-sharp on the edges — the Blood Banks have overlooked a good thing here.

If there is one thing aquarists seem to collect, it is jars. There are little jars, medium-sized jars, big jars and it is a sacrilege to throw a jar out. A hobbyist, after all, never knows when he might want to transport his entire collection, fish by fish. The general impression produced is that of a pickle factory instead of a tropical fish collection. And where there are jars, there are covers. It can be shown scientifically that, although jars are subject to breakage, covers are not. Therefore, covers "multiply" like rabbits. I wouldn't hesitate to estimate that for every jar the aquarist hoards, there are hoarded 6.3 covers. In view of this, one of the most important items of equipment for today's aquarist is a bushel basket. It can be loaded with the junk that transforms a basically neat hobby into a source of dissention between husband and wife, and then placed alongside of the garbage pails. From there on, it is the city's problem.

Remember, for a neat hobby:
1. Conceal airline and electric circuits or else tack them neatly out of the way.
2. Cover all your aquaria and make sure all sharp edges are polished or taped.
3. Place paraphernalia in cupboards, out of sight.
4. Don't accumulate junk!

Copyitis – Spawning With Marbles

[Aquarium Journal, February 1960]

I often wonder if aquarists don't like to find the most awkward procedure possible to breed a given fish. It is either this or "copyitis" that must be responsible for so many recommendations for the use of marbles in spawning the egg-scatterers such as the tetras, barbs and danios. By "copyitis" is meant the practice of one writer repeating the previous one ad infinitum until the point is reached where no one remembers where the original information came from. Unfortunately, the “hand-me-down” is frequently in error but takes on the guise of an unalterable “truth” by so many repetitions. But perhaps this is not being fair to the advocates of marbles - perhaps there is really a strong reason for their use in breeding fishes. Unfortunately, the only one that comes to my mind at present is that the marbles provide a divertissement for the parents after the exhausting spawning act is completed. Everyone knows that a game of marbles is quite relaxing. Or could it be that the real purpose is to confuse the parent fish into thinking that the marbles are their eggs and so develop in them a superiority complex?

I have always viewed the use of marbles in the breeding tank with some mistrust. None of the accounts of the professional fish collectors mention finding marbles in the streams of Africa, Asia, or South America except for one instance in Singapore later traced to an East-West marble tournament of rice-growers. Yet, the books state that this is the way we breed fish. It is pushed as a sure-fire way to prevent the parent fish from eating their eggs. This is fine until the time comes to price marbles. It is even worse when the time comes to look for both eggs and fry, and “worser” when the time comes to start feeding the fry. Marbles, in short, are a nuisance in the breeding setup. What then is suggested? Simply a nylon net made out of tulle, the same material used for petticoats. (Here is a project your wife can supervise.) Make an open box of the net with nylon thread. The net-box can be stapled to two sticks and suspended in the aquarium used for breeding. Add several prospective parents, sit back, and watch for the eggs. On a clear slate bottom, the eggs are a cinch to spot. When spawning is completed, remove both the parents and the net. The fry are much easier to observe when the aquarium is unencumbered with marbles or other materials. Overfeeding is less likely to occur for the visual control of feeding is now a simple task.

Do not concern yourself with thought of eggs sticking to the net. Nylon netting with 1/8th inch holes will permit fish eggs to pass through without hindrance. Although the books correctly list the eggs of danios, barbs and tetras as slightly adhesive, this adhesion quality is not enough to cause many of them to stick to the netting. We are speaking now of the vast majority of these species as there are some exceptions. Of course, I do not maintain that professional fish collectors find tulle petticoats in the wilds of jungle streams with any regularity either, but the net does do a better job. If there are any further doubts about the relative merits of a bag of marbles versus a nylon net, just try dropping them on the floor. See for yourself which one is easier to pick up!

Longevity of Fishes

[Aquarium Journal, March 1960]

One of the most difficult questions to answer concerns the age to which an aquarium fish will live. Unfortunately, there have been no actuarial tables prepared for our tropical fishes. From time, to time, articles have appeared which have summarized the records of a number of aquarists as to the ages of their fishes. Although this is interesting information, it is impossible to arrive at “average” age figures for any specific fish. The best that can be done is to raise an eyebrow or two when a fish reaches an age that seems, in the light of years of experience, to be unusually high. Perhaps this is a better goal. After all, if it has been done once, it will be done once again and so any lists of maximum ages of fishes (to date) would serve as a goal or objective to first be equaled and second, to be surpassed. In this spirit, the following records of the Zoological Gardens of Wuppertal (Germany) and the Amsterdam Aquarium (Holland) are presented as a starting point.

It is perfectly possible that some aquarists have had experiences that would lengthen the maximum times shown in these lists. This information should, of course, be added to the aquarium literature. In most cases, however, the information contained in these tables will be quite surprising to most aquarists. They are examples of what can be done by adhering to the well-rounded principles of fishkeeping.

A. TETRAS (CHARACINS)

Copeina guttata	7
Ctenobrycon spilurus (silver *tetra)*	6
Gymnocorymbus ternetzi (Black tetra)	8
Hemigrammus caudovittatus (Buenos Aires tetra)	13
Hemigrammus ocellifer (head and taillight)	5
Hyphessobrycon bifasciatus (yellow tetra)	9
Hyphessobrycon serpae (=H. callistus?)	7
Hyphessobrycon flammeus (flame tetra)	4
Moenkhausia pittieri	4
Nannaethiops unitaeniatus (African tetra)	6
Pristella riddlei	4
Leporinus friderici	17
Metynnis roosevelti	*8*
Metynnis schreitmulleri (= M. hypsauchen?)	6
Nannostomus aripirangensis (pencilfish)	4
Prochilodus insignis	7
Serrasalmus nattereri (piranha)	7

B. DANIOS

Brachydanio albolineatus (pearl danio)	8
Brachydanio nigrofasciatus (spotted danio)	4
Brachydanio rerio (zebra danio)	8

C. RASBORAS

Rasbora einthoveni	11
Rasbora heteromorpha	6
Rasbora trilineata	7

D. BARBS

Barbus binotatus (spotted barb)	20
Barbus chola	12
Barbus cumingi	6
Barbus everetti (clown barb)	6
Barbus gelius (dwarf barb)	3
Barbus lateristriga (T barb)	18
Barbus nigrofasciatus (black ruby)	7
Barbus oligolepis	8
Barbus schwanefeldi	11
Barbus semifasciolatus (half striped barb)	19
Barbus ticto	13
Barbus titteya (cherry barb)	4

E. ANABANTIDS

Anabas *testudineus* (climbing perch)	11
Colisa lalia (dwarf gourami)	7
Trichogaster leeri (pearl gourami)	6
Trichopsis vittatus (croaking gourami)	7

F. CICHLIDS

Aequidens pulcher (blue acara)	6
Astronotus ocellatus	17
Cichlasoma bimaculatum	13
Cichlasoma biocellatum (Jack Dempsey)	6
Cichlasoma facetum (chanchito)	10
Cichlasoma severum	11
Hemichromis bimaculatus (jewelfish)	14
Pterophyllum eimekei (angelfish)	6
Symphysodon discus	5
Tilapia mossambica	9
Tilapia natalensis	12
Tilapia nilotica	12

G. CATFISH

Corydoras aeneus	7
Corydoras julii	6
Corydoras melanistius	7
Corydoras paleatus	7
Loricaria microlepidogaster	8
Malapterurus electricus (electric catfish)	5
Plecostomus commersonii	6

H. KILLIFISHES

Aplocheilus lineatus	7
Epiplatys chaperi	10
Pachypanchax playfairii	5
Rivulus cylindraceus	3

I. MISCELLANEOUS FISHES

Anguilla vulgaris (common eel)	6

Botia hymenophysa	6
Badis badis	8
Melanotaenia maccullochii (Australian rainbow)	8
Melanotaenia nigrans	17
Pantodon bucholzi (butterfly fish)	7
Protopterus annectens (lungfish)	7
Scatophagus argus (scat)	7
Tetraodon fluviatilis (puffer)	6
Toxotes jaculator (archer fish)	6

It should be remembered that these records are from two public aquaria in Europe and, as such, were in the thick of World War II. Certain of the species mentioned are on record, as living for longer periods.

On Our Hobby in Depth

[Aquarium Journal, April 1960]

"**Romeinen, vrienden, burgers, leent mif 't oor.**
Begraven kom ik Caesar, niet hem prifzen.
Het kwaad, dat mensen doen, leeft na hen voort;
Het goed wordt vaak met hun gebeent' begraven
Zo moge't zifn met Caesar."

Mark Anthony's eulogy upon Caesar's death may seem a strange beginning for a beginner's column (especially in Dutch!) but try me for a while. When Ghana was given its independence, I didn't have to look at a map to find out where it was. The word, Savannah, brings to my mind not a picture of the seaport of Southeast Georgia, but rather a vision of tropical grasslands scattered with trees. All these apparently unrelated associations have come about as a result of my experiences within the tropical fish hobby and in scratching a little bit deeper than its surface.

How many aquarists really appreciate the many facets of our hobby? Dealing, as it were, with creatures from foreign lands it would seem to be a reflex action to collect bits of information about countries, languages and assorted sciences. Many aquarists have developed second hobbies as a result of their tropical fish interests — photography is a good example. Fathers skip "birds and the bees" lectures when their sons are engaged in the creation of a new strain of guppies or other livebearers. And who cannot help appreciating world geography when it is learned that this fish comes from Siam, that one from Zanzibar and still another from Bolivia?

Ours is an unstable hobby. Few aquarists last beyond the three-year mark. Again and again, we have seen newcomers jump into the game of fishkeeping full force, collecting one tank after another and amassing dozens of different species of fishes only to drop out as swiftly as they entered. They learn a little about a lot of fishes but nothing much about any single one. No wonder they become bored! The very task of maintaining a large haphazard collection of fishes becomes a load from under which they are happy to escape.

How much better it would be to take each fish, one by one, and really learn something about it. Consider the lowly black ruby barb, for example. Originally, it came to us via a seaman who experienced no little difficulty in "bringing it back alive." Today, it is easily bred in quantities and we have forgotten its origins. Where is the black ruby barb's homeland? Under what conditions of water and climate does it live? What of the country of its origin? What does its scientific name mean? Answer these questions and the others that suggest themselves and you have increased your interest in the hobby and learned something in the bargain. (Members of my aquarium society will please refrain from asking me for the answers to these questions about the black ruby, as I am not sure that I can answer them!)

Several years ago, I wanted to know more about the colorful dwarf cichlid, *Pelmato-*

chromis kribensis. Twelve tanks were turned over to this fish and this fish alone. After some years of experimenting with temperatures, pH, hardness, addition of organics, etc., and after reading and listening and more reading and more listening, *Pelmatochromis* became a friend of the family. I know something about him and perhaps he knows some thing about me! In the bargain, I learned a little about Africa, its topology and topography, its climate and politics. What a wonderful hobby - one fish and two years down and 900 fish and ? years to go! Oh yes, the Dutch? Well, there was an article about *Pelmatochromis* that I wanted to read in a Dutch aquarium magazine – 'nuff said?

Cichlidophiles

[Aquarium Journal, May 1960]

To those of you who fancy 1-inch guppies, 1-1/2-inch tetras and even 2-inch gouramies, it may come as a shock to learn that there are aquarists who consider any fish under 3 inches as fish food for their own fishes! These are the cichlidophiles or lovers of cichlids. True, there are pantywaists among the cichlids but a sharp distinction is made then by using the term, "dwarf cichlids." The fish we are talking about could easily grace any Friday evening meal.

Cichlidophiles are an unusual lot. They are forever converting bathtubs and horse troughs to house "a few more pairs." Where we deal in brine shrimp, they traffic in monstrous 3 to 6-inch red crawlers. Cichlidophiles often use standard nets only to handle their fish foods, preferring homemade equipment for the fishes themselves (old windsocks, for example!). This is indeed a devoted group and for good reason, too. Cichlids are large, colorful, and flashy tropicals. Their painstaking attention to parental duties is an object of admiration by many aquarists and the first fishes to be seen by visitors as they cross the threshold are the big cichlids. Due to their size, they are easily trained and frequently take food from their owner's hand.

Cichlidophiles are easy to spot. For one thing, they seldom are seen buying aquarium plants. Their charges would only uproot them and destroy the plants if given the opportunity. Secondly, Cichlidophiles are frequently seen at drugstores buying bottle after bottle of tincture of merthiolate, so helpful for swabbing the bruised areas on their pugnacious cichlids. Thirdly, the water bill of the average Cichlidophile is apt to be appreciably higher than that of his small fish fancier counterpart. This is due to the need for the frequent water changes to offset chemical and biological changes caused by large fishes with ravenous appetites in relatively cramped quarters.

Perhaps, however, Cichlidophiles have the most fun. Here is "Norman," the blue acara, with fresh battle scars received in a fight with "Poindexter," a firemouth cichlid. "Cederic" and "Cecily," the jewelfishes, are busily fanning a new batch of about 1000 eggs. Ah well, anyone have an old 60-gallon tank for sale?

Metals and Other Materials Poisonous to Fishes

[Aquarium Journal, June 1960]

This month we start off with the following proposition - that oxygen is one of the most dangerous elements known to mankind! In support of this theory, the following facts are presented:

1. Oxygen is extremely poisonous to humans. Concentrations in the air of 100% will kill a man as well as concentrations as little as one part per billion.
2. In all fires causing fatalities last year, oxygen was found to be present. It is extremely flammable.
3. This element is particularly insidious as it is

colorless, tasteless, and odorless. It, therefore, strikes without warning.

Despite the "truth" of these statements, we all know that there is more to it than that. As a matter of fact, oxygen is indispensable to all mankind. In a similar manner, we could make out a case against any metal in the aquarium. Being reasonable, however, we classify metal dangers in the aquarium realizing that there are many other factors that must be considered before an individual case can be treated. Therefore, our first table is an introduction only and in any event, is relative only.

Highly poisonous	Copper, Silver, and Mercury metals
Poisonous metals	Zinc, Aluminum, Nickel, Chromium (in valence 3 state), Cadmium, Tin, and Lead
Slightly poisonous metals	Cobalt, Lithium Manganese, Iron, and Chromium (in valance 6 state)
Nonpoisonous metals	Strontium, Calcium, Sodium, Barium, Magnesium, and Potassium

As an example, Mr. J. R. E. Jones has conducted experiments to determine the lethal dosages of these metals for the three-spined Stickleback, *Gasterosteus aculeatus*:

Silver	0.003 mg/l
Mercury	0.008 mg/1
Copper	0.015 mg/1
Aluminum	0.07 mg/1
Lead	0.1 mg/1
Zinc	0.3 mg/1
Nickel	0.8 mg/1
Chromium	1.2 mg/1

Of course, these figures were for particular aquarium and water conditions. It is known that some poisons (copper and zinc, for example) reinforce each other's poisonous effect upon fishes. It is also known that the hardness of the water affects the toxicity of these metals, also. In general, these metals are less poisonous in hard waters.

Among other "noteworthy" poisonous substances in the aquarium we have:

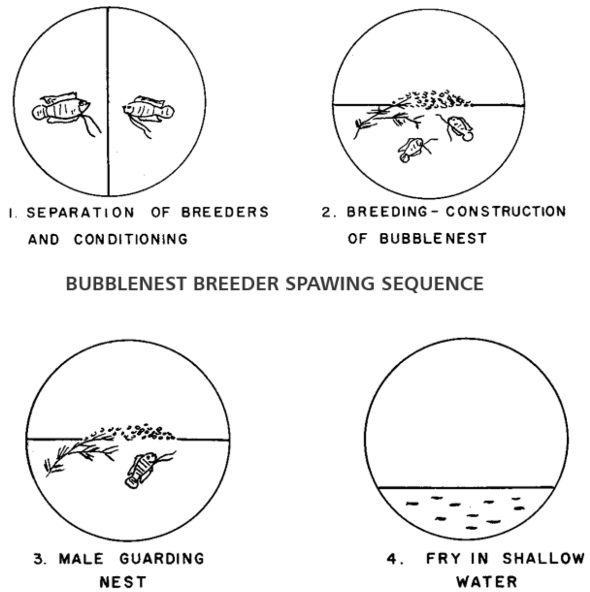
Chlorine: dangerous to fishes at concentrations of 0.1 mg/1. Note that chlorine is added to drinking water at a concentration at about 0.25 mg/1.
Phenol: An industrial waste product discharge. Dangerous to fishes at concentrations of 0.1 mg/1.
Nicotine: Dangerous to fishes at about 10 mg/1.
DDT: Same as nicotine.

In cases of wholesale deaths of fishes, all of these poisons should be suspect. New copper plumbing, a phenol discharge into the city water system, a cigarette dropped into a tank all of these are possible causes for catastrophe on an aquarium scale.

The Bubble Nest Builders

[Aquarium Journal, July 1960]

In many parts of the world, the native waters are known to be very low in oxygen content. Since, like the parent fishes themselves, fish eggs require oxygen to hatch out, nature has provided an interesting and ingenious solution to this problem. This is the "bubblenest," a frothy mixture of air bubbles, mucous and bits of plant life that floats at the top of the water and in which the bubblenest-building fishes lay their eggs. In this way, the eggs are assured of having the oxygen they need.



BUBBLENEST BREEDER SPAWING SEQUENCE

With most of the common bubblenest builders, the males are by far the more colorful of the two sexes. In some, like the betta, the fins of the male are larger and more pointed. Before actual breeding is attempted, the male should be separated from the female in a partitioned tank and both fishes should be well fed. If the temperature is slowly raised to 80-85°F over a period of a week or so, the male should start the construction of a bubblenest. When the nest is completed, the partition may be removed. Spawning is best described as a twisting motion of the male around the female's body as they both swim under the bubblenest. The eggs, being lighter than water in many cases (but not in the case of the Betta!) float up into the nest. For those eggs that do not float, the male carefully places them into the nest. After spawning, both fishes may be removed and in most cases, the female definitely should be taken out.

The water in the hatching tank should be shallow, not over 6 inches deep, and the tank itself should be topped with a tight-fitting cover. The young fish are very susceptible to draughts, especially in the 4th to 5th week of life. For 2 or 3 days, the male stands guard over the nest (actually, he stands guard below the nest as above it, he would dry out very fast!) After this time, the young hatch out and the male should be removed. The fry cling to the water's surface and the sides of the glass. Since the fry are very tiny, only the finest of first foods will do. Infusoria cultures made from lettuce, straw, beans, dried aquarium plants, etc., are usually used although powdered egg yolk is also satisfactory. The egg yolk should be strained through a handkerchief. When your laundry man finds out what the stains on the handkerchief are, he will probably think you are very sloppy at breakfast or else short of napkins. Ignore him, though, for an explanation would only upset his whole day. If the laundry man happens to be your wife, the whole matter must be treated with more delicacy and diplomacy.

After a week or two, brine shrimp or finely powdered dry food may be fed also. With this fare, the young grow rapidly and should be transferred to larger quarters as they outgrow the original breeding tank. Each year, many thousands of bubble nesters die as a result of overcrowding. The number of eggs laid by these fishes is quite large and, as a class, far surpass any other popular aquarium group of fishes. Be prepared for large numbers of fry.

Breeding Patterns of Aquarium Fishes - Part I

[Aquarium Journal, September 1960]

INTRODUCTION

A major part of the enjoyment to be had in the aquarium hobby is due to the fact that aquarium fishes can be bred in captivity. To the non-aquarist, the breeding of "toy fish" under artificial conditions is truly a source of wonderment. Even those of my friends who are not the least bit interested in fishes or our hobby, still crowd about as I exhibit a fish egg or point out a pair of fish undergoing spawning activities. True, everyone has heard about fish eggs and many have eaten caviar, nevertheless, a viable fish egg is like a cow in a pasture —

you may pass it countless times in an auto and never give it a second look, but face to face with one for the first time, said cow undergoes an examination that would be embarrassing if it were human.

Newcomers to the hobby are surprised when they learn about the many different guises under which the spawning act of a fish appears. True, the end is the same in all cases — the continuation of the species. But the variations on this theme of Mother Nature's are just the things that make our hobby interesting and, in view of this, our column for the next several months will be concerned with the patterns of breeding behavior of aquarium fishes. By the time this series is completed, you will have an outline of all the ways in which our fishes breed.

One convenient way to classify the breeding methods of aquarium fishes is to split them into two basic patterns: those fishes that exhibit parental care, and those, which do not. This scheme works well with all aquarium fishes except the bitterling *(Rhodeus armarus).* Although the bitterling itself exerts no parental care, by the process of depositing its eggs into the valves of freshwater pond mussels (a mussel frequently used *is Unio pictorum),* care is provided both the eggs and the newly-hatched fry by virtue of the protection afforded by its shell as well as the aeration received by the respiratory current of water produced by the mussel. It is, furthermore, a strange fact that the male bitterling is excited not by the presence of the female bitterling alone, but by the presence of the mussel in which the eggs have been laid. At this point, the male releases his milt where it is then drawn into the mussel to fertilize the eggs. Since the mussel is not hurt in this relationship, we have a symbiosis unique in the aquarium fish world. The bitterling pays its host back, since the larvae of the mussel attach themselves to the skin of the fish where they undergo further development. Were the bitterling a pretty fish, aquarists would undoubtedly know much more than they now do about mussels in the aquarium. In any event, the bitterling's behavior is unique in our hobby and having mentioned this unusual procedure, we can accept it and return to our dichotomy of, no parental care - parental care.

The term, "parental care," deserves some elaboration, as there are degrees of care at least to the following extent:

1. Care of eggs to hatching
2. Care of eggs and newly hatched fry
3. Care of eggs, newly hatched fry
   and beyond.

These points will be discussed in more detail in a future article of the series. I should like to make it clear to the reader that my use of the term, parental care, does not necessarily imply design on part of the fish. The guppy, in effect, provides parental care by the protection afforded by carrying its young for over three weeks within its body. This definitely is care of the developing egg although the guppy has little to say about the matter and, indeed, neutralizes this protection by exhibiting a certain taste for its own young. Our use of the term will, therefore, be quite extensive but, in general, will apply to those fishes who afford some care of the eggs *after* they are laid and fertilized.

All aquarium fishes (with the exception of the bitterling, already discussed will be divided into two groups and sub divided as follows:

GROUP A - No Parental Care

1. Free breeders
2. Migrants
3. Plant breeders
4. Egg placers (no parental care)
5. Soil breeders

GROUP B - Parental Care

1. Livebearers
   a. Oviparous
   b. Ovoviviparous

2. Mouthbrooders
   a. Maternal
   b. Paternal
3. Bubblenest builders
4. Nest builders
5. Pit breeders
6. Egg placers (parental care)
   a. Cave breeders
   b. Minimal breeders (parental care)
   c. Supersurface breeders

Most of these designations are standard in the hobby, a few I have supplied myself of necessity. Breaking the chart down into its most specific components, we have 17 (16 plus the bitterling) breeding patterns of aquarium fishes. It remains now to examine each of these in more detail.

Breeding Patterns of Aquarium Fishes - Part II

[Aquarium Journal, October 1960]

The Free-breeders

This designation applies to those fishes that simply release eggs and milt into the water. However, it should be noted that the so-called free-breeders usually breed with definite relationship to some object or objects in their environment such as aquatic plants, or the bottom or even the surface of the water. In nature, the free-breeders usually have more or less well-defined breeding seasons although this can be controlled to a considerable extent in the home aquarium. The spawning act may occur in open water and in such cases, it frequently happens that the females swim above the males, thus the eggs fall down into milt-laden water and are fertilized.

Free-breeding does not always take place in open water, however. Many fishes will seek shallow water, over sand and gravel, for spawning. In these instances, the bottom acts as a repository for the sexual products. It is also quite usual for free-breeders to seek shallow spawning grounds containing bottom covers of plant growths. It might be thought that this helter-skelter breeding pattern would result in a large number of eggs being unfertilized - evidently, however, this is not the case.

As might be expected, the eggs of the free-breeders are usually not adhesive and even those that do exhibit adhesive qualities, do not show but slight tackiness. In general, when we speak of the eggs of the free-breeders, we are speaking of eggs that are heavier than water, sinking to the bottom after being released. Many free-breeding marine fishes, however, lay floating eggs and, if we are going to stick by our definition of free-breeder, some aquarium fishes do also. For example, several members of what usually are considered bubblenest builders lay floating eggs and then abandon them to the fortunes of nature. The climbing perch, *Anabas testudineus*, for example, qualifies on this score and so does the kissing gourami, *Helostoma temmincki*. Mostly though, our aquarium free-breeders are represented by tetras, barbs, and rasboras with certain notable exceptions in these groups.

In the past, free-breeders were bred in aquaria containing a layer of marbles on the bottom. Since most of the free-breeders relish their own eggs, the marbles afforded protection to those eggs that made it down to the bottom. Nowadays, nylon nets are also used (Marion's Baby Savers and breeding nets are a good example) although commercial breeders still use wire cages. Since the eggs of these fishes are prey to numerous creatures, nature has made up for this by the many eggs released by a single female. Although nowhere near as productive as marine fishes (especially the pelagic species), free-breeding freshwater aquarium fishes still lay eggs by the hundreds. Under aquarium conditions, most of these eggs can be saved and breeding free-breeders can be very productive indeed. Coupled with this is the observation that these eggs are somewhat more resistant to fungus, the bane of the cichlid and killifish breeder. Often whole tanks are populated with the offspring of a single spawning. The free-breeding pattern may not be the most interesting of all aquarium fish breeding patterns, but it is the modus operandi in the propagation of most of our egglaying aquarium fishes. Since these fishes are the backbone of our hobby, we can be thankful for the promiscuity of the free-breeders.

The Migrators

We can explain this breeding pattern very easily by mentioning the salmon and the eel. These fishes migrate to different waters to deposit their eggs, sometimes a matter of thousands of miles. Aquarists do not do much with migrant fishes and it may seem strange to discuss this breeding pattern here. I keep a pet eel but certainly have no intention of spawning it nor do I intend to provide a miniature Sargasso Sea to emulate its natural spawning grounds. However, the point of discussing the migrators is that these fishes experience a drastic change in environment, associated with spawning. It may well be that aquarists are interested in spawning certain fishes that, unbeknown to them, are actually migrators. The scat, for instance, may be a "short trip" migrator from salt to freshwater and certain gables may also enter this picture. If so, then we must provide some drastic changes in environment to breed them. Certain of the larger characins are known to migrate upstream to spawn, similar to trout. This problem is not a field for the beginner although, for the sake of completeness, we mention it here briefly.

Breeding Patterns of Aquarium Fishes - Part III

[Aquarium Journal, November 1960]

The Egg-Placers (no parental care)

This breeding pattern concerns itself with those fishes that carefully place their eggs on one substrate or another as opposed to say, the plant breeders, which lay their eggs on less well-defined surfaces and merely drop them without much effort on the part of the spawning pair. It goes without saying that these eggs are adhesive, mostly' over all of the egg. Since the egg-placers take some care in placing their eggs, aquarists must take some care in providing the surface preferred by the fish. Examples of egg-placers are Rasbora heteromorpha — preferring to place its eggs on the undersides of broad-leaved center plants—and the *Corydoras* catfishes that frequently affix their eggs to the aquarium glass. Artificial surfaces are often used in aquarium breeding. Besides glass, mentioned already, slate, roughened pieces of plastic and other materials have been used.

In the no-parental-care category, the egg-placers are a small group and usually represent what might be called aberrant forms of breeding behavior as contrasted with their near-relatives. In the parental care category, we shall see that the egg-placers form a large and important group of aquarium fishes.

The Plant Breeders

This is an important breeding pattern. Most of our killifishes, pencil fishes and glass fishes (*Ambassis* or *Chanda*), belong to this group. The spawning fishes search out clumps of plants to which the eggs of some species are attached by means of a long, sticky thread. Occasionally, the search is not so deliberate as in the case of the medaka, which usually carries its eggs in a clump (like grapes) from its vent, subsequently to have the eggs deposited in plant thickets as the parent fish brushes past. As might he expected, production with the plant breeders is not great as the eggs of many at least are laid mostly singly and over a period of time. Current aquarium practice frequently substitutes other materials for plants, nylon mops being heavily favored.

Many of the plant breeders are beginner's fishes, *Epiplatys chaperi* and the medaka, to name but two. In the case of the killies, the eggs are relatively large and embryonic development is easy to follow. As large eggs usually result in large fry, initial feeding problems are simplified as brine shrimp can be used immediately, bypassing messy infusoria cultures. It is characteristic of many plant breeders that the development time of the egg is long. This introduces to the aquarist, problems of water condition and quality. The longer an egg is in the development process, the longer is the exposure to forces of destruction (fungi, etc.). Here the principle of the isolation of eggs from one another is encountered as well as concern with anti-bacteria solutions such as methylene blue and acriflavine. The beginner learns much through his experiences with the plant breeders, especially certain of the killie species.

Since the plant breeders are usually not very prolific, there is some burden upon aquarists to maintain and breed these species so as to keep them in circulation among aquarists. It is apparent that large, commercial fish hatcheries cannot justify the production of these numerous species on a profit basis.

The Soil Breeders

The soil breeders bury their eggs in the bottom strata of their natural environment. Mostly, this is merely the mud or plant detritus so often encountered in jungle waters; however, peat moss and fine sand are used frequently by aquarists, as substitutes, since they are easier to handle and cause less danger of egg deterioration. Again, practically all of the soil breeders are represented by the killifishes and the breeding pattern is characterized by continuous egg laying over a period of time and by very long egg development periods. Contrasted with the plant breeders, the eggs of the soil breeders are non-adhesive (they may be covered with fine hairs, however) but the remarks made for large egg size, ease of feeding of the newly hatched fry and availability of the different species commercially, holds for both groups.

Soil breeder eggs take the longest of all aquarium fish eggs to hatch, sometimes up to 6 months. Actually, there is a fair line of demarcation as to hatching time. Many soil breeders lay eggs that hatch within 4 to 6 weeks while others are in the 8 to 12 week category. The latter fishes are referred to as "annual fishes" although many aquarists lump all soil breeders under this classification (an error, in my opinion).

It is of prime interest to decrease these hatching times and, at the same time, increase the percentage hatch or yield.

To accomplish this, a firm foundation in the knowledge of water quality and other environmental conditions is needed by the aquarist and, needless to say, is a field best avoided by beginners. As the aquarist gains experience, however, he will find working with the soil breeders very rewarding, indeed.

This completes our discussion on the non-parental-care breeding patterns and subsequent articles in the series will treat those patterns of breeding in which parental care is exhibited by one or both of the parent fish.

Breeding Patterns of Aquarium Fishes - Part IV

[Aquarium Journal, December 1960]

Group B — Parental Care

1. Livebearers

The importance of the livebearing fish to the aquarium hobby cannot be overstated. Countless persons have become confirmed aquarists after but a brief exposure to the livebearer. A strong lure of these fishes is, of course, their mode of reproduction.

Consider the breeding steps saved with these fishes when compared with the egg layers:

(a) Although provision may have to be made to separate the young from the parents, there is no special substrate needed to receive the newly hatched fry. On the other hand, some egglaying fishes need spawning mops; others need beds of plants or peat moss, etc.

(b) Since the eggs of livebearing fishes develop within the mother fish, there is no egg-fungus problem. Therefore, there is no need for antibacterial preparations such as methylene blue, acriflavine, etc.

(c) Livebearing fishes are, for the most part, adaptable to hard, alkaline waters. This is the type of water most often found right from the tap in the U.S. There is no need to soften or acidify the breeding water. The reverse might be necessary (i.e., harden and alkalize) but this would be required only rarely and, in any event, is much easier to effect than the reverse.

(d) Livebearer young are usually larger than the young of their egglaying brethren. Thus, infusoria type cultures are not necessary. Dry foods are readily taken and feeding in general is easier.

(e) In general, livebearers mature more rapidly than egg layers. This is especially true with guppies. Therefore with livebearers that part of the breeding plan wherein the fishes are brought up to breeding size is considerably shortened.

There are a number of minus signs in the livebearer ledger, to be sure (they are more susceptible to disease, for example), but we are concerned here with breeding patterns. Since almost everyone interested in aquarium fishes has a fair idea of the livebearing breeding process, we will not repeat the details here.

After considering the copulation act of the livebearers, their gestation period and finally, the delivery of the young, one tends to jump to conclusions and draw some close comparisons between these fishes and mammals. Actually reproduction in mammals differs quite a bit in details from reproduction in livebearing viviparous fishes. A dissection of many kinds of gravid viviparous fishes will show that the female merely acts as a repository for the eggs. Nourishment of the developing egg is supplied by a yolk just as in the egg layers. In mammals, however, the young are nourished by the mother. Of course as aquarists familiar with the hatching of the eggs of egglaying fishes know, the eggs must be aerated. The same holds true for developing embryos in the livebearer - oxygen must be supplied to the eggs. Thus, the developing embryo in the livebearer is intimately associated with the tissues of the ovary and so the oxygen is supplied by the mother fish via her blood stream.

It must be said, however, that there are livebearers in which the association between mother and young is more intimate. If we examine a developing egg of *Heterandria* (the least killifish, for example), we would find that the amount of yolk is insufficient to meet its needs. Thus, *Heterandria* must derive a part of its nourishment from the mother fish. Besides *Heterandria*, a few rare aquarium fishes also undergo this form of development. (members of the family Goodeidae and some others).
For the aquarist, a classification of the livebearer could be based upon frequency of brood production. Thus we would have three groups as follows:

Group I: Guppies, Swordtails, and Platys
Regular brood production. Young dropped at intervals of about 25 to 35 days, depending upon temperature and lighting conditions.

Group II: Gambusia and Mollies
Irregular brood production. Greatly affected by

seasonal or artificial changes in temperature or light. However, since aquarium conditions are fairly constant, these fishes may appear to deliver at constant intervals in captivity.

Group III: Heterandria and Poecilistes

Broods of 2 or 3 young appear regularly at intervals of four to six days. The brood intervals only, will depend upon temperature and lighting. Therefore, the interval may be extended to 30 days or more as temperature drops and the amount of light is decreased.

In short, Groups I and II are similar in that only one group (occasionally two) of embryos is developing in the ovary at the same time. Group III, however, may have 6 or 8 different groups developing concurrently. Groups I and II differ, superficially, mostly in their temperature-light dependence. Group II is much more dependent upon these two factors.

Thus, we see that the livebearing breeding patterns are more involved than would be surmised at first glance. In any event, we have parental care, involuntary as it might be, with subsequent protection of the developing egg to hatching.

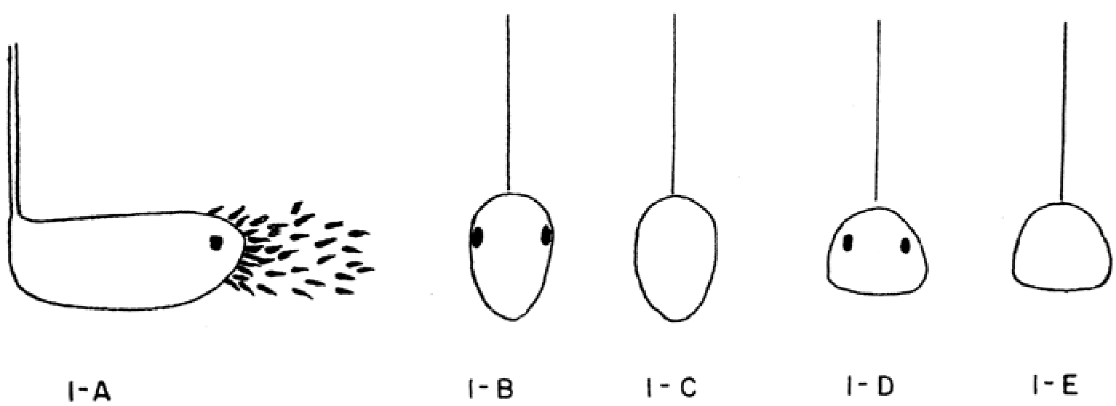
Breeding Patterns Of Aquarium Fishes – Part V

[Aquarium Journal, January 1961]

2. Mouthbreeders

As we have seen, most livebearers afford parental care to developing fish eggs merely by providing a safe incubation site. In a sense, the mouthbreeders are similar to the livebearers since they too, provide such a site. Of course, here we are concerned with oral incubation. Many fishes are found to be mouthbreeders including some anabantids and catfishes, *Osteoglossum,* etc., but to the aquarist, "mouthbreeder" usually signifies certain members of the cichlid genera, *Haplochromis, Tilapia* and *Geophagus.*

After spawning in a manner typical to their classification (for example, the mouthbreeding betta, *Betta pugnax,* spawns in a manner similar to the familiar *Betta splendens),* one of the partners gathers the eggs in his or her mouth. Depending upon the species in question, either the male or the female will orally incubate the eggs. In the case of the several species of mouth breeding bettas, it is always the male; for the Egyptian mouthbreeder,



MOUTHBREEDER "DUMMIES."
(1-A) Normal dummy, side view, with fry flocking to mouth region. (1-B) Normal dummy, front view. (1-C) Normal dummy except eyes missing. (1-D) Abnormally-shaped dummy. (1-E) Abnormally-shaped dummy with eyes missing.

it is the female; for some *Tilapia* species, it is the male (paternal incubation) but in others, it is the female (maternal incubation).

The incubation time for mouthbreeders is long - 9 days to 2 weeks is typical although some tilapia species have been known to stretch this to 4 weeks! Since the incubating parent usually takes no food during this time, the fish should be in the best of condition prior to spawning. Although most authors state that no food at all is taken by the incubator during the egg development period, this is not true in all cases. In any event, incubators usually lose body weight during this period. From time to time, the incubator moves its jaws in such a fashion so as to thoroughly mix the eggs. This, apparently, is a deterrent to fungusing and helps provide oxygen to the eggs.

Many scientific experiments have been performed with certain of the mouth-breeders (notably the cichlid members) due to a characteristic action of the young, i.e., in times of danger the free-swimming fry swim back into the mouth of the parent fish. Peters experimented with "dummy" mothers on *Haplochromis multicolor* fry. The dummies were made of plastic with glass beads simulating the eyes of the "mother" (see figure 1). When the fry were disturbed, they would flock to the area of the dummy that normally would contain the mouth (see figure 1-A). Models of different shapes were constructed, some without eyes.

With the normal dummy (figure 1-B), the fry reacted in the usual manner but when the eyes were removed (figure 1-C), the reaction was not quite as strong. When the shape was changed (figure 1-D), the fry reacted little and when the same model was provided without eyes (figure 1-E), there was no reaction at all. Perhaps in a future column we can explore other interesting mouthbreeder experiments and the significance of the results.

3. Bubblenest Builders

In previous columns, we have discussed the bubblenest builders fairly extensively. Therefore, we shall spare the details here.

In general, however, the bubblenest is a device of nature for aerating developing eggs in what would otherwise be an oxygen-deficient, stagnant environment. Thus, the swamplands of Asia and Africa provide the aquarist with most of his bubblenest builders. There are representatives of this group scattered all over the fish world but, in general, are concentrated in certain catfish groups and the anabantids. The latter form an important aquarium family, supplying the hobbyist with gouramies and bettas. However, not all gouramies and bettas build bubblenests. The kissing gourami, for example, builds no nest but merely allows the eggs to float to the surface (the eggs contain a relatively large quantity of natural oils which permits them to float). As for aquarium bettas, there are more species of mouth-breeding bettas than there are of bubblenest building species.

With aquarium mouthbreeders, parental care is supplied by the male fish. After construction of the nest (using mucous secretions, bits of plants, air, etc.) and subsequent egg deposition, the male stands guard below the nest. The development time is moderately short, a matter of several days, and after the fry are free-swimming, parental care ceases. All in all, the bubblenest is primarily an incubating device (although it does afford some protection from bottom-feeding fishes) that works well in waters with little or no current.

Breeding Patterns of Aquarium Fishes - Part VI

[Aquarium Journal, February 1961]

The Nest Builders

There are a number of fishes that build nests (we are interested here now in other than bubblenests) but the best-known nest building aquarium fish is probably the stickleback. The stickleback has a rather “ceremonious” sex life, to wit, to attract females the male builds a house, changes color, and does a dance!

To return to the nest building aspect for a moment, the male starts by digging a shallow hole in the bottom covering of the aquarium, carrying sand away via its mouth much in the manner of some cichlids. The nest itself can be constructed of many materials but a favorite is “thread algae.” To hold the nest together, the male coats the nest with a sticky substance from its kidneys, the nest itself being shaped by directed pushes of the snout. When this is finished, the male tunnels through the nest by wiggling through it.

When the male is ready for the female, he goes through four stages. These stages are arbitrary and I have used them for convenience only. The important things to note here are the various actions and reactions of the male and female.

1. The first stage consists of overtures between the male and female. The male swims zigzag fashion towards the female, and this (if she is ready) causes her to swim towards him, head up. Incidentally the male will only be stimulated to do his zigzag dance for a female that is swollen with eggs.

2. In stage two, the female’s approach causes the male to swim towards the nest and make a series of thrusts into it with his snout. This stimulates the female to follow. Also, he turns on his side and raises his dorsal spines towards the female. At this time he points towards the nest entrance. This stimulates the female to enter what I call the third stage.

3. The third stage finds the female swimming into the nest, prodded by the snout of the male. When the female has laid her eggs, the male enters and fertilizes them.

4. The fourth and final stage is similar to actions of the sunfishes - the male guards the nest and fans the eggs. Unlike in the case of the cichlids, the female takes no part in this activity. The male may spawn more than one female in his nest. Male sticklebacks are aggressive and readily attack one another.

Scientists have interested themselves in this nest building activity of the stickleback. Dr. N. Tinbergen, a lecturer in animal behavior at the University of Oxford, has performed many experiments with sticklebacks. He found it was possible to induce a female to spawn, once she was in a real nest, merely by prodding the base of her tail with a glass rod! Dr. Tinbergen discovered that a male swollen with food was courted as if it were a female. The story of the stickleback, as with all nest builders, is fascinating and adds much to our knowledge of animal behavior. It should be mentioned that several of our rarer aquarium fishes, certain of the elephant fishes and catfishes for example, are known to be nest builders in nature.

We have not yet hit upon that combination of circumstances which induces them to spawn in captivity.

The Pit Breeders

With the pit breeders, we encounter a much simpler breeding pattern. Many of its elements have already been covered in other breeding patterns. Our native sunfishes, for example, scoop out a shallow basin-like nest, from the bottom of which all pebbles are carefully removed, leaving a layer of fine sand or gravel to which the fertilized eggs adhere. In this case, the work is carried out by the male but in the case of the cichlids, both parents assist in the process. Pit breeders, in general, are hard on plants, especially during spawning time. From time to time, aquarists encounter pit breeders where they are least expected. One example would be several of the *Metynnis* species. These are characin fishes but breed in a manner similar to the cichlids.

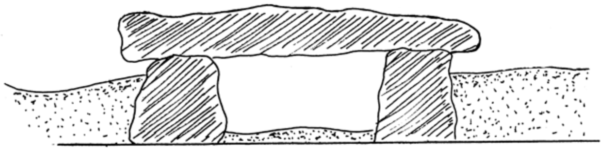


FIGURE I: Artificial cave. Sketch by the author.

Breeding Patterns of Aquarium Fishes - Part VII

[Aquarium Journal, March 1961]

6. The Egg Placers (parental care)

With a look at the egg placers (parental care), we conclude our survey of the breeding patterns of aquarium fishes. For the sake of convenience, I have divided this pattern into three sub patterns and each will be discussed separately.

(a) The Cave Breeders

In some respects, the cave breeders resemble the pit breeders in breeding pattern. Indeed, some fishes breed via both patterns although such fishes are generally thought of as cave breeders first. Primarily, it is a matter of security and concealment. If a breeding tank is so set up that it is darkened, secluded and rarely disturbed, the effect to the parent fish is much the same as a cave for this is just the "atmosphere" that a cave provides. For example, most large cichlids are pit breeders (neglecting now the mouthbreeders among them) and, in general, are not to be considered as shy fishes. On the other hand, most dwarf cichlids are thought of as cave breeders and furthermore, as diffident fishes. If we provide a secluded, darkened, seldom disturbed aquarium, the dwarf cichlids frequently breed in a typical pit breeder fashion. Of course, if the fish are not supplied some sort of a cave in the first place, then they may be forced to switch to pit breeding if they breed at all.

Cave materials are varied. Many dwarf cichlids I have kept have fashioned makeshift caves merely by digging under a filter. Flowerpots are ready-made caves and often are provided by aquarists. Figure 1 shows a more elaborate cave constructed of stone and slate. The one thing a cave must have is a firm basis upon which eggs may be laid. The cave breeders are not too choosy as to whether their eggs will be placed on the floor, sides, or roof of the cave. Although the aquarist may construct a cave that satisfies himself, it seldom satisfies the fish and the latter have to re-do the job to their satisfaction (Figure 2).

The cave breeders display the same high degree of parental care, as do the pit breeders and, in addition, provide greater interest as (1), the cave-building feature is an extra-added attraction, and (2), no two caves look alike even when constructed by the same fish! Besides the dwarf cichlids, many members of the nandid family (*Polycentrus schomburgki*, for example) and the goby family are known to be cave breeders.

(b) The Minimal Breeders

As the name implies, parental care is exercised with the minimal breeders but it is minimum. Therefore, these fishes are transitional in breeding pattern between previously discussed patterns. For example, *Pyrrhulina rachoviana* and *Copeina guttata* are both characins, hence related to *Hyphessobrycon* and *Hemigrammus*, which, as we have seen, are egg scatterers but with no parental care. The males of both *Pyrrhulina* and *Copeina*,

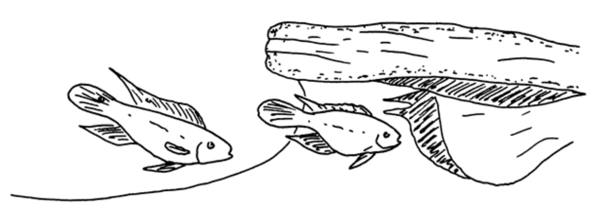


FIGURE 2: Cave breeders examining newly-finished spawning site. Sketch by the author.

FIGURE 3: Breeding pair of *Copeina arnoldi* locking fins preparatory to leaping out of the water to deposit their eggs.

however, do stand and guard over the eggs and furthermore, fan them. Whereas *Copeina guttata* is a pit breeder, *Pyrrhulina* merely lays its eggs on the leaves of aquatic plants. This is parental care at a minimum. Not too many of our aquarium fishes fall into this classification.

(c) The Supersurface Breeders

This is a most unusual breeding pattern. The eggs are actually laid out of the water (from 2 to 10 inches above the water line!) and involve a considerable amount of gymnastic activity upon the part of the spawning pair. The following remarks pertain only to *Copeina arnoldi*, the only (?) supersurface breeder kept by aquarists. The question mark will be explained later.

The male looks for a favorable site involving a firm surface above the water line. If the surface is inclined (a piece of slate laid against the glass, for example), it is easier for the fish to utilize it. Both fish position themselves just below the surface of the water (figure 3) and appear to lock fins to some extent. They then leap out of the water, landing (and momentarily sticking) on the site selected. Here the eggs are deposited and not on top of one another, either. The eggs are in a compact, but flat mass. The whole procedure is repeated many times until all eggs are deposited.

As if this were not enough, the male then stands guard under the eggs and performs another essential function … that of jumping out of the water and splashing the eggs with water in order to keep them moist! In fact, German aquarists call this fish, the splashing samlet. The male keeps this up for several days until the eggs hatch, at which time, the young drop to the water. Perhaps the nicest aspect of this whole procedure is the fact that *Copeina arnoldi* is not particularly hard to breed and so could be tried by beginners.

If depositing eggs out of water is the requisite for classification as a supersurface breeder, then there are others beside *Copeina arnoldi*. Certain barbs (*Barbus arulius*, for instance) have been known to leap out of the water and deposit their eggs on the undersurface of the cover glass. Since drops of milt-laden water are carried along, the eggs are fertilized. The natural condensation on the cover glass keeps the eggs moist and some of them ultimately hatch. But the behavior of *Copeina arnoldi* is unique among aquarium fishes and must be seen to be appreciated.

Getting Too Big Too Fast

[Aquarium Journal, April 1961]

There is one pitfall area of the aquarium hobby where there is a shortage of warning signs. To put it bluntly, it is getting "too big, too fast." Due to the fact that our hobby is characterized by having an average "lifespan" of perhaps two to three years per individual, anyone who has been in the hobby for any reasonable length of time at all can recall case history after case history where persons have leaped enthusiastically into the hobby and made a big splash, only to retire a few years hence into spider-mounting, stamp collecting, bowling or just plain TV-watching. To be sure, there are many reasons why aquarists drop out of the hobby and perhaps we can discuss these at a later date.

By way of illustration, one acquaintance of mine comes t o mind rather readily. This gentleman entered the hobby in September of a certain year and six months later, had a fish room in his basement complete with 50 tanks. As might be expected, this fish room was replete with a labyrinth of electric wires, airline tubing, containers of fish foods, plastic bags, and what-have-you. Etymologists have a word for it and the word is "mess." This is not to say that our hobbyist was not successful, at least to a certain extent. To the amazement of all of us, he spawned ordinary, black lace and black angelfish in rapid sequence. Assuming that spawning fishes was child's play, he acquired some discus, several types of dwarf cichlids, and a number of killifish species.

Here is where his success story ended. He was unable to spawn any of the new fishes; the angels he reared were deformed and unsaleable (he counted heavily on selling fish he bred himself); and to top it off, his fish room became a prison in which he was forced to spend long hours cleaning tanks and filters, treating fish diseases and repairing equipment. A year later, tired, and discouraged, he was out of the hobby. His story, unfortunately, is far too common. I don't believe anyone should invest considerable sums in any hobby before they really ascertain whether or not it is a suitable interest for them. This is reason enough for a "go slow" philosophy but there are other reasons as well. It frequently occurs that only certain areas of the hobby interest any one individual (thus, if one finally decides that large cichlids are the ticket, why accumulate small tanks?). It took me years to choose (and experiment) between metal stands and wooden ones, between inside and outside filters, between incandescent light and fluorescent, etc. Some aquarists quickly accumulate considerable quantities of equipment only to find out later that they really needed something else. One aquarist I know has six vibrator pumps going full tilt, and his fish corner sounds like a hornet's nest. He wishes he could wave a magic wand and change them all into a single piston pump. Another friend bought nothing but the best . . . a double piston pump for his three small tanks. There is so much excess air available that he has to let most of it escape, and as a result, his fish corner sounds like a nest of cobras. I am presently in the process of bringing these two gentlemen together. Object? Rectifying the errors brought about by hasty decisions.

Up to now, I have merely warned about getting too big, too fast. Now I would like to caution about getting too big, period. Although some aquarists delight in rivaling the Aquarium Stock Company or their local fish dealer with row upon row of tanks, let us face the fact that too many aquaria is drudgery, not a hobby. In this circumstance, the aquarist is forever cleaning, repairing, and puttering. It really leaves little time for the fish! Wise aquarists have solved the problem by limiting themselves in the number of tanks they maintain. One way to do this is to specialize in some fish or group of fishes. Beware, however, for even the specialist can get too big and too involved. I have seen some guppy fanciers and killifish fanciers with 50 or 60 tanks and it is only a matter of time before they turn to something less tedious like raising iguanas for fun and profit.

In a way, I faced the same problem several years ago … at that time I had over 60 tanks in operation. Taking an objective view of the situation (well, a semi-objective view anyway … no aquarist is really objective when it comes to cutting down!), I decided on 16 tanks (I did permit myself the luxury of keeping one rather gigantic tank). This is what I maintain at the present. Of course, I can't go out and try to breed every fish in sight with this complement. But then I limit myself to studying perhaps three species at a time, and in this way really learn something about them. When I have finished with one species, out it goes (or else into a display tank) and in comes another. This has been a practical and satisfactory solution.

It seems advisable to caution the beginner against trying to breed every fish that comes their way, at least in the light of past experiences. Much more could be accomplished in the long run if efforts were concentrated on only one or two species at a time. In this way, the aquarist will never run out of fish (or plants, for that matter) to study and more will be learned ultimately. When the hobby is kept within reasonable limits, the time available for it will be more productive and ever so more rewarding.

On Condensation

[Aquarium Journal, May 1961]

Above any surface of water, the immediate atmosphere is particularly humid . . . this is true also for the air layer directly above the water surface in an aquarium. If the cover glass is even only fairly tight, this air is almost fully saturated with water vapor. If saturated vapor is cooled, some of the contained water must condense out and in the aquarium, this is usually on the cover glass itself. Now this in itself is not particularly troublesome except for two things:

1) If the condensation water comes in contact with an angle iron or pressed steel aquarium frame (and it usually does), the frame will rust. Even so-called "stainless steel" frames will show rust marks under these conditions. The combination of warm water and oxygen in the air quickly does its nasty work.

2) Invariably, deposits of salts will precipitate out on the frame in the form of whitish-colored

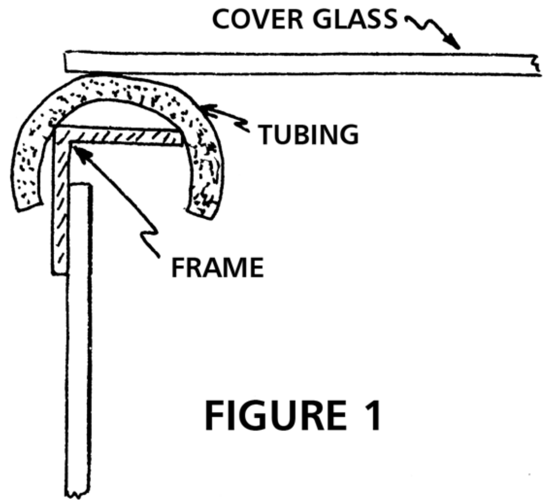


FIGURE 1

chemicals. This happens despite the fact that the condensation water itself is free of salts. These are usually calcium salts but in the case of water chemically softened, these salts are usually sodium salts. Deposits such as these may not be easy to remove, especially if they run down on the outside of the glass of the aquarium. On the frame, steel wool does a good job in removing the deposit but the glass stains are difficult to remove without damage to the glass.

To solve this problem of condensation, aquarists have experimented with various schemes for hanging the cover glasses so that either the cover glass does not touch the frame, or else the condensation water flows back into the tank without ever having touched the frame. Figure 1, for example, shows one of the simpler devices used for this purpose. Either small pieces or whole strips of plastic or rubber tubing are cut and placed upon the frame. This

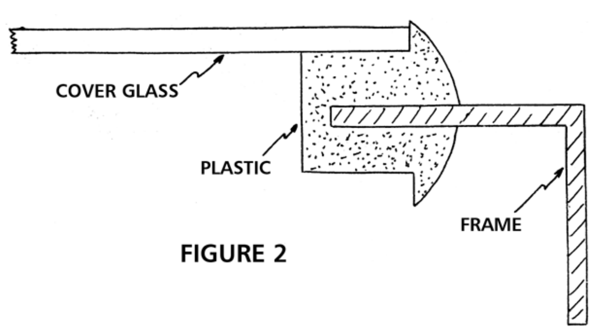


FIGURE 2

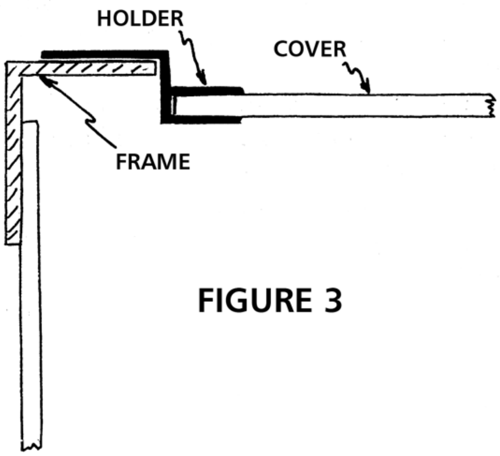


FIGURE 3

keeps the cover glass from touching the frame itself. Most of the condensation water falls directly back into the tank, however, some of it drips around the tubing where it is trapped underneath, ultimately to rust the frame. Even with this defect, however, it helps greatly. Figure 2 shows a slightly fancier method where cork or plastic is used instead of tubing. Here, the material must be cut to fit the frame, the lower sharp edge providing a point from which the water of condensation drips back into the tank. Unfortunately, most commercial aquaria have frames with the top edge rolled back onto relief, thus precluding effective use of such devices.

Some manufacturers make available stainless steel holders for the cover glass illustrated in Figure 3. One could also fabricate such hangers out of aluminum at home but this material deteriorates quickly in the aquarium, and the bother of constructing them outweighs any savings in cost.

One device that works well is simple to make and which has a pleasing appearance (especially in a fish room) is shown in Figure 4. A wire is bent as shown and is enclosed in plastic or rubber tubing. The cover glass is held on the tank in a slanting position. Thus, all condensation water drips to the lower edge where it falls into the aquarium. At no time will the water come in contact with the frame of the aquarium. By using heavy electrical wire, already coated with plastic, it takes only a minute or two to bend it into position. This is a very easy and effective way to lick the condensation problem.

Figure 5 shows three more methods of hanging cover glasses. Figure 5a does not require drilling through the frame, while Figures 5b and 5c do require drilling. The trouble with these flush-mounting methods lies mostly with the difficulty experienced in merely picking up the cover glass to gain entrance to the tank. The methods shown in Figure 5 permit only a very slight contact between condensation water and frame. The water condenses on the bottom of the glass (as well as on the bottom of the hangers ... therefore the hangers should be made of

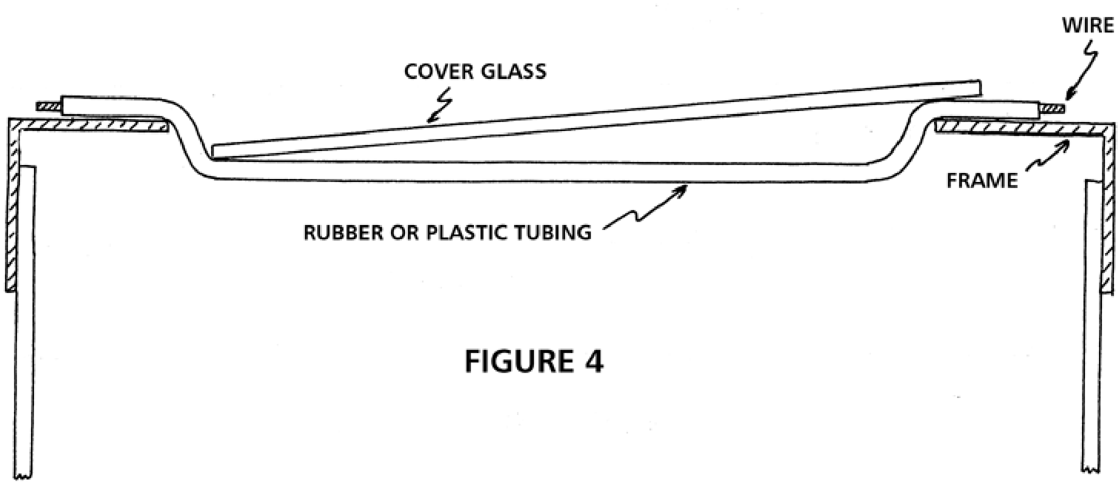
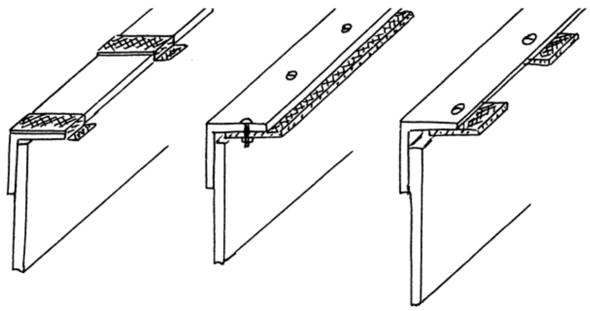


FIGURE 4



5-A 5-B 5-C

FIGURE 5

plastic) and falls back into the aquarium.

All sorts of devices can be fabricated to lick the condensation problem and aquarists with fertile minds will not want for ideas. Sometimes, a number of problems can be licked at the same time. Figure 6 illustrates such an instance. This queer looking device incorporates a solution to the condensation problem, permits the cover glass to be raised and maintained at several positions as well as containing the light source for the aquarium. The device may be constructed of plywood or plastic although due to the necessity of cementing a "drip strip" to the cover glass, the cover glass itself is best made out of plastic. The slotted cover glass retainer is removable and, in any case, need only be incorporated on one end of the aquarium. The figure shows the cover glass in its normal "full down" position as well as a cover glass in a "full up" position. In spite of its weird appearance, it works very effectively. By this time, many readers will no doubt be designing a cover setup to incorporate an automatic fish feeder and perhaps even an air pump!

The Numbers Game

[Aquarium Journal, June 1961]

It is generally agreed that the purpose of aquarium literature (books, magazines, etc.) is to inform rather than entertain. That these are not necessarily mutually exclusive events, however, is evident merely by scanning some past articles in the JOURNAL, particularly those written by Donald Simpson and Diane Schofield. Nevertheless, information is the primary objective and aquarists, whether rank be-

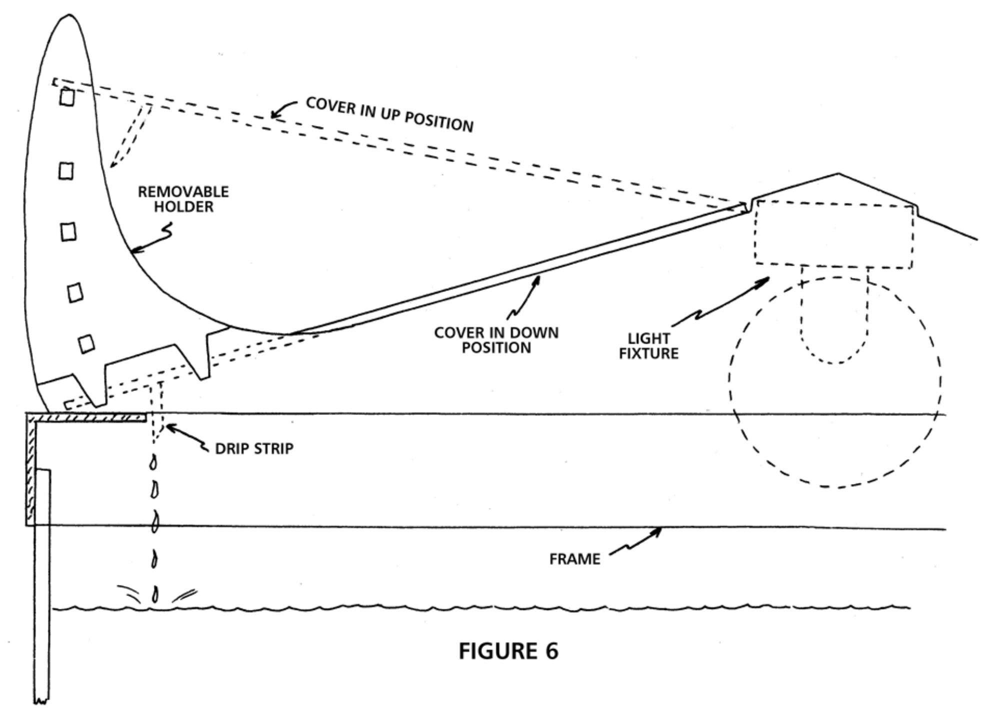


FIGURE 6

ginners or “old hands,” have an insatiable desire for such knowledge.

Usually, fare for beginning aquarists is served up on a “rule” basis, for such hobbyists are quite willing to accept the words of the “experts” as gospel. There are usually too many things to learn to allow time for arguments and critiques. Once the beginner has a goodly number of principles filed away in his mind and some practical experience tucked under his belt, there is time for reflection. First of all, he recognizes exceptions to the “rules.” Secondly, he begins to recognize the distinction between valid additions to the body of aquarium knowledge and rehash. Finally, he begins to question the conclusions of the experts themselves. If he is at all alert, he realizes that, in this game of nature, we are all beginners.

It is characteristic of our hobby that it suffers both from a lack of numbers and from a surplus of the “wee beasties,” a seeming contradiction. On the one hand, our books and articles lack the numbers that represent the results of careful experiments. Our descriptions of truly quantitative events are usually qualitative, flowered with adjectives that depend, for their effect, more on the emotions than upon reason. With one or two exceptions, we never see articles written on how to design an effective aquarium experiment. It is true that, through reason alone, man can add to his knowledge but the overwhelming source of our knowledge is through empirical means.

On the other hand, almost all of the numbers we do see in our literature are suspect. Since the sight of a number in a fish article is awesome (being a rare occurrence), it is accepted almost as being sacred, much as the Pythagoreans did many years ago in ancient Greece. For example, we read an article stating that the author obtained 500 eggs from a certain spawning. Isn’t it funny how fish always seem to lay eggs in round numbers? Why not 493 eggs? It would not surprise me if the number of eggs delivered per spawning by specific fishes is found to be correlated with the statement of the first author writing about the fish in question and not, as we would have expected, with fact. Of course, the number “500” could be perfectly valid. Suppose the author had measured the area covered by the eggs, say in inches. Then let us further suppose that he counted every egg in a small portion of this area, say an area ½ inch by ½ inch. By a suitable multiplication then (4 times the total area times the number of eggs in the sample), he obtains, say, 490. In this case, 500 is a pretty good number. But how often do you think this is done? More likely than not, the author has merely dipped his finger in the aquarium and held it up to the air, thus magically coming up with “500.” The reason I sound so flippant about this is that l have experimented with counting eggs. First, I estimated the number, and then I counted them (quite a job, by the way). Boy was I off! Of course my succeeding estimates were much better with the same species. When another species entered the picture, my first estimates were off by a wide margin.

Consider another article that reports that the pH of a certain tank water was 7.2. “Now,” we say, “Here is a reliable number.” But is it? Assuming that the aquarist really measures the pH (and didn’t use the finger method), should we accept this number at face value? Most pH kits today utilize either liquid or paper indicators. With either, the aquarist has to make a color comparison judgment. Assuming further that the aquarist is not color blind, his judgment will be influenced by many factors among which are the intensity and angle of the light present, the time of day (light changes in quality from morning to night), and even the way the aquarist views his sample. On top of this, it is known that both paper and solution pH kits deteriorate with time and with exposure to light. Once I took a sample of aquarium water and tested it on an electric pH meter (Beckman) and then divided it up into 25 vials. Then I asked 25 members of my aquarium society to measure the pH at home. The results were amazing! The figures reported ranged from 5.0 to 7.8 (the actual value was 7.20 plus or minus 0.05). After these values were reported, I again checked the original sample and found no significant changes.

Our hobby would take one gigantic step forward if all figures reported were also accompanied by a statement of how they were obtained. In the meanwhile, the aquarist just starting out would do well to reserve an open mind on the "numbers game" in our hobby.

Klee's Lemma of Maximum Perversity

[Aquarium Journal, July 1961]

In the world of mathematics, a lemma is a sort of theorem used to prove other theorems. By itself, it assumes no great importance. In conjunction with other things, however, it is indispensable. In this regard then, I think it is high time that "Klee's Lemma" is set down on paper for the critical perusal of all beginning aquarists. It is something that you will face shortly (assuming that you have not already been introduced to its implications) and you might as well be prepared now.

The full title of this lemma is, "Klee's Lemma of Maximum Perversity," and is named after the author mainly because he has succeeded so frequently in proving it. The lemma is stated briefly as follows:

"The propensity of a fish towards the acquisition of a disease, a tendency to die or a refusal to eat or breed, is an increasing function of its cost and/or the difficulty experienced in replacing it."

Of course, being a lemma it is couched in formal mathematical terminology and may be difficult to grasp immediately. Fortunately, one can sometimes understand a theorem by examining its corollaries and before we go too much farther, let us quickly dispose of the word, "corollary," by saying that it is a sort of theorem that follows as a natural consequence of a given theorem. It so happens that Klee's Lemma has 12,376 corollaries and it is understood that not all of them can be stated here.

Corollary No. I: Given a tank containing a neon tetra costing 35c and a scat costing \$3.50; only the latter will, upon introduction of the disease, get "ick." Note: In Singapore where scats cost 35c and neon tetras cost \$3.50, the corollary still holds but the neon will die.

Corollary No. II: Given a dealer's tank containing the last two breeders of a stated species in town; they will prove to be both of the same sex.

Corollary No. III: Given a purchase of a pair of fishes from a dealer's tank containing the last 1000 breeders in town and consisting of 999 males and 1 female; the female will be killed by its mate the very next day.

Corollary No. IV: Very similar to Corollary No. III except substitute the word "female" for "male" and vice versa.

Corollary No. V: Given a tank containing split-tail guppies, ramshorn snails, and gold danios with curvature of the spine, betta culls, and a discus; only the last-named will go on a hunger strike.

Corollary No. VI: Given a confirmed livebearer breeder and guppy devotee; the local water supply will be found to measure pH 6.0 with zero hardness.

Corollary No. VII: Given a confirmed killifish breeder, aphyosemion devotee, or tetra fan; the local water supply will be found to measure pH 8.0 with 350-ppm hardness.

Corollary No. VIII: Given an aquarist delighting in keeping fishes with nerves of steel such as rosy barbs, guppies, goldfish, etc, and an aquarist delighting in keeping nervous and skittish fishes such as *Monodactylus*, angel fishes, etc.; the former will be found living next to a cemetery and the latter next to a public school playground.

Although Klee's Lemma of Maximum Perversity has been stated in a form specifically concerned with fishes, it can also be restated to include other phases of the hobby as well. Rather than present such a restatement, we merely list two pertinent corollaries.

Corollary No. IX: Given an old, rusted, pressed steel frame aquarium housed in a basement on a concrete floor, and a brand new stainless-steel frame aquarium located on the second floor directly over a new sofa and several priceless works; only the latter will leak.

Corollary No. X: Given an aquarist who has just placed a good part of his collection outdoors in order to spawn them in pools during the summer; town council will pass an emergency ordinance to spray the village with DDT (effective immediately) to control the depredations of the gipsy moth.

Those aquarists who are psychologically prepared to live with Klee's Lemma, will probably survive to become dedicated hobbyists. The others will merely add to the increasing problems of mental health agencies in every community.

On Diseases of Fishes

[Aquarium Journal, August 1961]

The term "disease" in the aquarium hobby is a somewhat ambiguous one due to the fact that its exact definition will vary with the outlook of the person defining it. Thus, a medical doctor will define disease one way; a layman, in another way. If we take as our aquarium definition the general statement that a disease is a condition in which bodily health is impaired, then it is evident that there is a bit of classification to be done. For example, one can divide the diseases into two groups, inherited and acquired. The latter group can also conveniently be divided into two groups, diseases induced by unfavorable environment and diseases induced by parasites of one form or another. As one can see, asking general questions about fish diseases poses a real problem for the one assigned to answer; certainly, even this unconscious classification must take place before one can provide even statements of the most general nature that are intended to prove useful.

Except for those aquarists involved in line breeding certain species of fishes, by far the most common group in our simple disease classification is the group of acquired diseases. We can now view diseases induced through unfavorable environment as falling into three categories:

(1) Those induced by unfavorable water conditions (pH, hardness, temperature, oxygen deficiency, metal poisoning, etc.)
(2) Those induced by deficient diet (vitamin deficiency, for example)
(3) Mechanical damage (electric shock, physical attack by other fishes, dropping a fish container, etc.)

These three classifications are perhaps somewhat arbitrary but nevertheless useful for our purposes here.

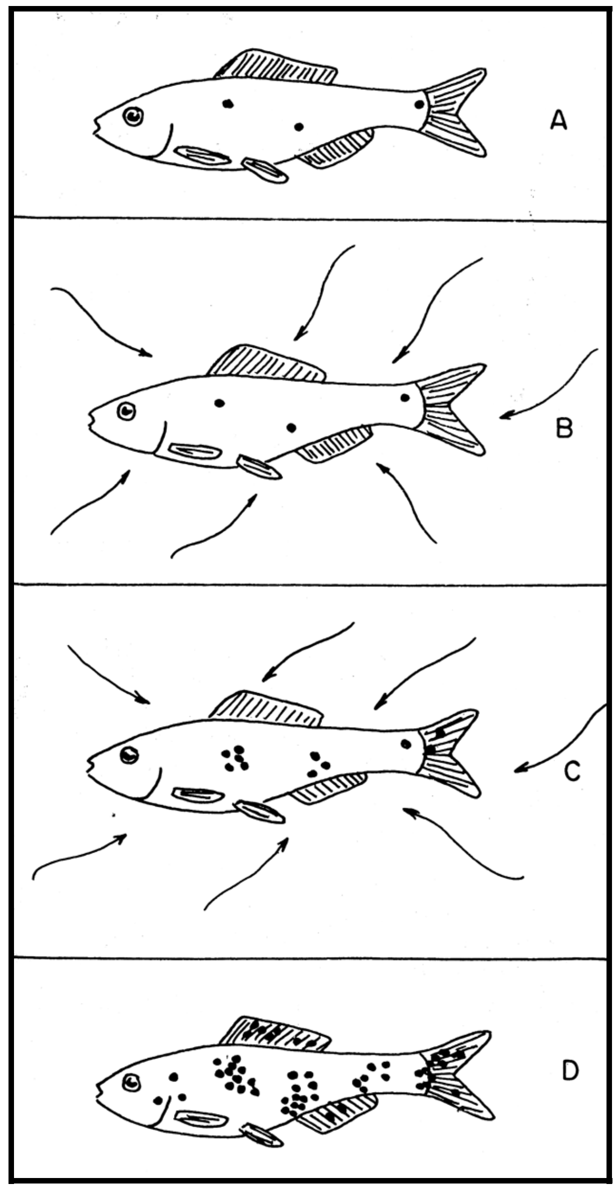
In general, the aquarist is better equipped to prevent diseases caused by these three types of environmental influences than other causes. For, if one can avoid accidents and if one adheres to the proven principles of fishkeeping

(i.e. manipulates the fishes environment correctly), then the aquarist will never experience difficulties of the sorts described.
To a very much lesser extent, this is true also with the second subgroup of acquired diseases, parasite diseases. Unfortunately, however, the acquisition of a disease in this subgroup may not always be the aquarist's fault. As a result, most of our attention in the disease phase of our hobby is directed here. Therefore, a closer look at parasitic diseases of aquarium fishes is needed.

On the one hand, it seems remarkable that fishes are not attacked by parasites even more frequently than we observe. For one thing, the number of different kinds of fish parasites is truly amazing; for another, the constant exposure of the soft skin of a fish plus the equally attractive sites of the gills and fins all act to the fish's disadvantage. Yet, on the other hand, we marvel at the resistance fishes do have to these parasites. The protective mucous of a fish's skin evens the score somewhat. The fact that fishes live and prosper even when infected by a small number of parasites indicates that, given half a chance, the fish will fight back. It is only when the few parasites become many, when the isolated lodger turns into an epidemic that the aquarist must enter the picture and try, if he can, to turn the balance into his and the fish's favor.

LEFT: FIGURE 1
A - "Healthy" fish infected with three "opportunist'" parasites.
B - Water conditions change to the detriment of the fish. Effect of this change in external environment denoted by arrows.
C - Taking advantage of decreased resistance of fish, "opportunist" parasites multiply.
D - "Opportunist" parasite multiplies to a point where it becomes a real threat to the fish.

For our purposes fish parasites can further be classified; we have not exhausted the field here! Consider, for instance, the "opportunist" parasite. This is a parasite that may infect a healthy fish in small numbers. While the fish's environment is favorable to it, the parasites do not multiply neither do they adversely affect the fish very much. Let the environment change now such that the fish is busy adjusting to the shock, and of course we associate with this process a weakening of the fish's resistance, and the opportunist parasite quickly multiplies, overwhelming the fish and its natural resistance, dooming it to certain destruction



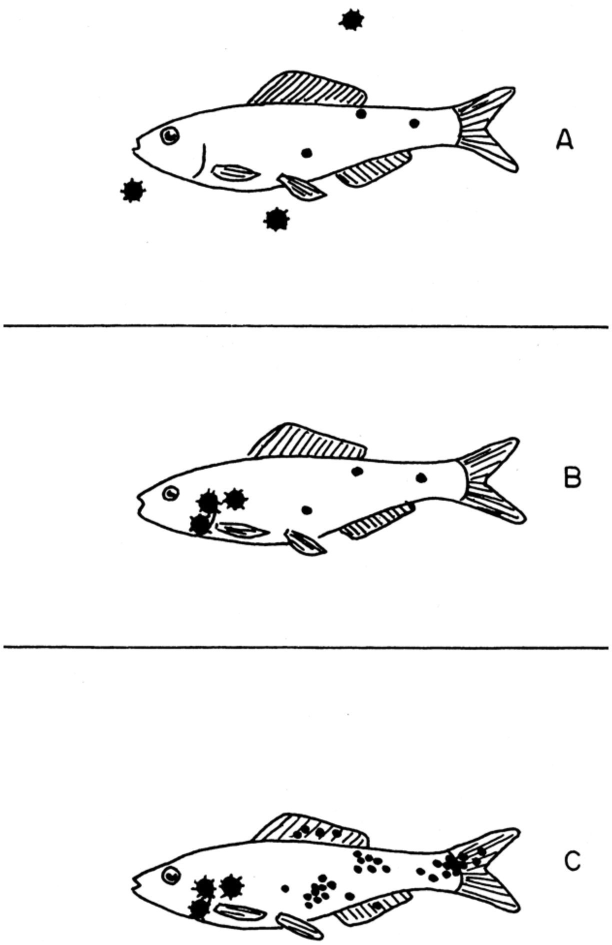


FIGURE 2
A - "Healthy" fish infected by three "opportunist" parasites (small dots). Fish not yet infected by "complete" parasite.
B - Fish becomes infected by "complete" parasite.
C - Fish is weakened by "complete" parasite. "Opportunist" parasite takes advantage of this fact, multiplies and almost completely takes over.

(see figure 1). Examples of such parasites are to be found in almost every aquarium, for example, Costia, Chilodonella, Cyclochaeta, Gyrodactlylus, Dactylogyrus, and others. When all is well, a few may be tolerated, otherwise these parasites are deadly.

Then we encounter the "complete parasite"; such a parasite is one that will attack a fish and multiply regardless of whether or not the fish is strong or already weakened. An attack by a

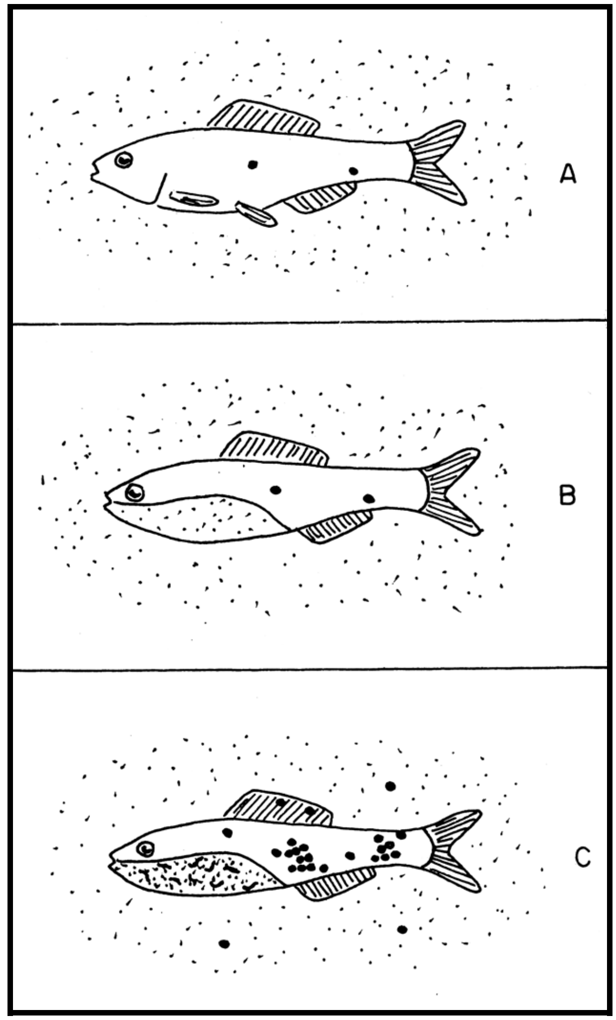


FIGURE 3
A - Fish infected by two "opportunist" parasites but exposed to internal parasites too small to be noticed by aquarist.

B - Infection of fish by internal parasites now begins. Ventral area is shown cut away to show extent of internal infestation.
C - Internal parasite multiplies, resulting in weakened fish host "opportunist" parasite again takes ad-vantage of the situation and takes over. Aquarist is aware only of the "opportunist" parasite.

complete parasite often induces a secondary attack by an opportunist parasite, thus aggravating the condition of the fish (see figure 2). For instance, a bacterial infection may pave the way for a subsequent fungus infection. Examples of complete parasites are Ichthyophthirius, Ichthyophonus, Plistophora, Diplostomum, and others.

The example used to show how secondary infections occur is much too easy, however. The complete parasite might easily be some sort of internal parasite, something that the aquarist might not recognize as such. Then, when the secondary infection becomes evident, the aquarist treats for it while the internal parasite remains unharmed to continue its deadly work. Thus, an attack of "ick" may be fought with drugs only to have the fish die of a bacterial disease of the kidneys (see figure 3).

The complete parasite is the scourge of the aquarium. Unfortunately, the subject of aquarium diseases is not very far advanced in our hobby and we can cure fishes of but really a few kinds of parasites. For "dropsy," the neon tetra disease and many others, we can do little but hope to prevent the spread of infection from one fish to another and from one tank to another. What we do know how to fight, we fight well. Thus "ick," velvet, the fish lice, fungi, and some others can effectively be combated provided, of course, that these are primary infections. Next to the fish itself, have sympathy for the aquarist who must advise you on matters concerning diseases in the aquarium.

How Long Does It Take For Killifish Eggs to Hatch?

[Aquarium Journal, December 1961]

It is not infrequently that this column finds itself in a dilemma. Often, it becomes necessary to criticize those aquarists who attempt to pass on archaic techniques, misleading statements or incorrect information to beginning aquarists. For example, readers of this column are familiar with my stand on those who still persist in recommending the use of marbles for spawning fishes such as the zebra danio. The trouble with criticizing (other than the critic may be embarrassingly wrong!) is that after a while, the beginner begins to pooh-pooh all statements he sees in print. Should it come to pass that, as a result of a single experience, his observations do not coincide exactly with those of experienced aquarists, then rabid iconoclasm really breaks loose! This month's column is devoted to some fence-mending in this respect and to show what those aquarists really are up against who try to answer questions pertaining to the aquarium hobby.

In all handbooks and in many magazine articles, statements are frequently made as to how long it takes for fish eggs to hatch. Now we are forever hearing statements from the rank and file like, **"That blankety-blank so and so said that these angelfish eggs would hatch in 4 days and since mine hatched in 2 days, now I**

TABLE II	
HATCHING TIMES FOR *Pachypanchax Playfairii*	
Number of days to hatch	Number of eggs hatched
10	3
11	7
12	17
13	18
14	23
15	2
16	8
17	10
18	9
19	4
20	0
21	0
22	1

TABLE I	
RANGES OF HATCHING TIME	
Aphyosemion "calliurum ahli"	9-17 days (58 eggs)
GTR (goldentail rivulus)	12-16 (25 eggs)
Epiplatys sexfasciatus	7-16 (60 eggs)
Pachypanchax homolonotus	9-17 (76 eggs)
Pachypanchax playfairii	10-22 (102 eggs)

don't have any brine shrimp ready, etc." Why should such a situation develop? Let us examine some specific example involving five fishes, viz., *Aphyosemion "calliurum ahli", Epiplatys sexfasciatus, Pachypanchax playfairii*, *Pachypanchax homalonotus* and the goldentail rivulus (these are the same species discussed in this month's Under the Cover Glass column, but the data to be presented is from an entirely different set of eggs … the species are the same because I breed five or six species at a time). More experienced fanciers will recognize these fishes as belonging to the family popularly called, "killifishes." Most of the fishes named could be considered "beginner's killies" and it could come to pass that you would like to breed them (this will be discussed in detail in a future column). One of the facts that you would like to know is how long their eggs take to hatch. Most handbooks will state a period of 2 weeks or, more bravely, 12 to 14 days.

Now take a look at Table I. This is actual data taken on the hatching times for these five species. The lower figure refers to the shortest observed development time, and the higher figure to the longest. Figures in parenthesis show the number of eggs upon which the observations were made.

What precise figure would you give for the hatching times of these fishes? Two weeks may be fairly close to the truth for the GTR, but it is apparently incorrect when applied to *Epiplatys sexfasciatus* where some fry hatched out in 1 week (recently, I had a set of *sexfasciatus* eggs hatch out in 5 days!). Bear in mind that all eggs were treated identically and conditions were "normal" as regards temperature and other important factors.

One might say at this point that it is desirable to examine the matter more closely, so let us look at the 102 eggs listed for *Pachypanchax playfairii* (Table II).

Since the total number of eggs" involved is 102, the percentage hatched out each day is approximately the number hatched. Note that about 58% of these eggs hatched within the 12-14 day interval. Begins to look like 12-14 days is a reasonable figure to quote, doesn't it? But then almost a third hatched out in the l6-18 day interval. Perhaps now you will begin to appreciate the problems involved in stating anything with certainty in this hobby. If, because of my own experiences in hatching our *Epiplatys sexfasciatus* within 5 days, I took other aquarists to task, then I should do them and the hobby injustice. Yet, this is exactly what we do when we grasp at the exceptions and the tails of the frequency distributions and use them to "prove our point." Remember, nothing is all-wrong; even a stopped clock is right twice a day!

Crapola in the Aquarium

[Aquarium Journal, September 1961]

In a recent issue of a Dutch aquarium magazine, I found this little paragraph tucked away at the bottom of one page: **"In the United**

States, there are those who are not satisfied with the natural colors provided to the sea anemone by Nature. Now it is possible to dye them! Magnificent color combinations of these animals — blue, orange, violet, green, and carmine — are available for your marine aquarium. One can even mix colors. How? Well, it appears that it is quite simple with the use of coloring materials dissolved in a little water, much in the same way as your wife transforms her drab sweaters into new glory. The anemone is immersed in the dye solution for about 20 minutes and is reported to emerge from the process in good condition. The whole idea again illustrates the heights to which the aquarium hobby has soared in America. In this same country, one can buy plastic underwater daisies, tulips and daffodils with which to adorn the aquarium. Such rubbish is even found in exhibition aquaria! And we grumble about the show rules over here . . ."

My first reaction to this paragraph was that of mild irritation. Further reflection, however, convinced me that the statement was to a large extent, justified and my pique should have been directed instead to my fellow hobbyists here in America. Perhaps our Dutch friends really were being kind as no mention was made of burping clams, belching hippopotami, and other underwater abominations that are unfortunately so easily purchased almost anywhere.

A while back, I asked several of my dealer friends why they stocked such trash. All of them had the same answer... "If they can't buy it here, they will just get it somewhere else." In this, I sympathize with the dealers. None of them really have any use for this junk but there is a living to consider. They do their level best to convince people that their money would be better spent on filters, pumps, and plants and (heavens forbid!) on fish.

That these "objects d'art" are sold for use in aquaria is a bit of an anomaly in itself, for American firms manufacture the finest aquarium equipment in the world. Our pumps, tanks, and filters are the best (European aquarists are still fiddling with painted-frame aquaria; we have stainless steel, epoxy-treated natural wood and sturdy plastic framed aquaria not just available, but widely used). Yet, we sort of ruin the picture by the mere presence of these other silly items. It is even rumored that one manufacturer is coming out with plastic "ick" spots, for use in healthy tanks! To be sure, I have seen some plastic plants that were authentic reproductions of true underwater plants that might find application under special circumstances . . . in tanks containing plant-eating fishes such as *Metynnis*, for instance. But to stretch things to include daffodils offends both aquarists and daffodil fanciers alike.

The beginner most assuredly can purchase plastic plants, fish and gravel with never a thought as to temperature, feeding, or fish diseases. Of course, since plastic water is not yet available, one does have to "top up" the tank from time to time. This, however, is not a hobby nor are its perpetrators hobbyists. There is much fun to be had in the aquarium fish hobby but this is not one of its routes.

The one thing that really bothers me about the Dutch comment, concerns the phrase, "again illustrates the heights to which the aquarium hobby has soared in America." The Dutch have the hobbyist sadly confused with the "goldfish in a bowl" type of piscatorial dilettante — but then it appears that we also have our terms confused. Time and time again, we hear that our hobby is one of the largest in the nation, boasting about 10,000,000 participants. This is sheer nonsense! One swallow doesn't make a summer and neither does one aquarium make a hobbyist, for if this was a valid criterion, then every person owning a dog would automatically become a dog fancier or, as the vernacular goes, "in the dog game."

The relationship between an aquarist and one who slowly murders a trio of 3-inch goldfish in a pint bowl, is no deeper than that between an ostrich egg and a weather balloon. If there are 10,000,000 "hobbyists" in this country, then the Greater Cincinnati area should have approximately 55,000 of them. Even if I distorted my definition of "hobbyist" beyond all proportion, I have only been able to find a thousand or so of them. Perhaps the other 50 some odd thousand "hobbyists" are out looking for daphnia in Crosley Stadium … in any event, they sure are a secretive bunch.

I trust that by this time, our friends overseas realize the true position and objectives of aquarium hobbyists in America and, as an afterthought, that our own citizens do likewise.

On Reading

[Aquarium Journal, October 1961]

One of the features of the aquarium hobby that has never failed to amaze me is the resistance on the part of the average hobbyist to read. Judging by the circulation figures of the various aquarium magazines, for example, only a minuscule number of hobbyists subscribe to them. If, as many sources state, there are "millions" of hobbyists involved in home aquaria, a monthly paid circulation for an aquarium magazine should easily reach 100,000. All aquarium magazine editors would drool at such a circulation if it were a reality!

The case for the handbooks is even more depressing. In my own aquarium society, but a few own even one booklet on fishes, let alone a reference text. Yet, 90% of the questions asked me are easily answered by such publications!

Why does this situation exist? True, handbooks are costly, but viewed in the light of the expense involved in setting up just one single tank complete with air pump, reflector, stand, etc., the cost of one handbook is but a small part of the total. As far as costs are concerned, a magazine subscription is even more a piddling amount, relatively speaking. Yet I have seen aquarists lose valuable fishes through ignorance of the knowledge contained in these aquarium publications. The losses far exceed the cost of the literature involved.

The larger handbooks generally consist of two sections:
(1) A number of chapters devoted to specific aquarium topics such as plants, diseases, etc., and
(2) A catalog of fishes with descriptions and remarks.

Now it is almost impossible for anyone to sit down and read such handbooks cover to cover at one sitting. In the first place, it would be ridiculous for anyone to read, one right after another, descriptions of 200 or more aquarium fishes. Therefore, most aquarists just file such handbooks away to be used when the occasion arises. Unfortunately, the "occasion" seldom seems to present itself. But what applies to the second part of handbooks, does not necessarily apply to the first. Those specific chapters on plants, foods, etc., should be read and re-read thoroughly. It wouldn't be a bad idea to re-read them, say, once a year or so. I frequently do this and find I never have wasted my time.
It certainly is true that not all the answers to hobbyist's problems are to be found in handbooks. However, it takes a certain basic aquarium education to be able to ask intelligent questions, and handbooks supply this background information.

I am always annoyed to find aquarists asking via the "letters to the editor" columns in the aquarium magazines, questions of the "How do I spawn zebra danios"-type. Obviously, this information is in the handbooks. I do, however, like to see questions of the "The book said one male to each female, but can I use two?”-type. This shows the editor that at least the aquarist has done some preliminary digging. Since many hobbyists don’t do this, “beginner’s corners” like this one are needed in our magazines (although they are also needed to correct handbook material and to bring it up to date).

In this respect, the purpose of an aquarium magazine should not be to rehash aquarium principles, but to represent these principles in the light of current activities in the hobby. For let us face it, all that is good and valid in aquarium magazines ultimately winds up in new or revised handbooks. Magazines bridge the time barrier. Thus, aquarists are behind the times without recourse to aquarium magazines. True, these magazines suffer from the fact that the hobbyist doesn’t choose their content in any one issue. Specific issues may be devoid of topics of immediate interest to the hobbyist (although who is to say that such material may not become of interest a year from now?) The point is, however, that such publications inform the beginner of new hobby developments, add to existing handbook information and, not the least important, provide a forum in which individual problems can be aired.

Like in any good cake, a proper “mix” must be obtained. By urging newcomers to the hobby to invest in a handbook and a subscription to an aquarium magazine, I am merely trying to redress a longstanding but traditional imbalance on the part of aquarium hobbyists everywhere.

On the Arrangement of an Aquarium

[Aquarium Journal, January 1962]

In the arrangement of an aquarium, one encounters the word, “taste” Thus we have those who think that the most enchanting touch to a tropical aquarium is something like a china pagoda or a lead diver. Leaving aside these esthetic aberrations, however, how is the aquarist to decorate his aquarium?

Several years ago, the Germans published a small book entitled, *So oder So?* This book was concerned entirely with this very same problem and the title, strange as it may seem, posed a question to the hobbyist, viz., “Do you want your aquarium to look this way or that way?” The “this way” turned out to be the all too common practice of displaying an aquarium with a flat, light-colored gravel bed and niggardly population of stringy plants. The “that way” showed aquaria that, even devoid of fishes altogether, were true objects of beauty.

It goes without saying that it is impossible to set down rules for producing works of art. Some of my British friends have made some excellent attempts, even going to the extreme of summarizing certain artist’s principles such as Aristotle’s “Golden Mean.” I should like to approach the subject a little differently, offering three of my own aquaria for critique by the reader. In all of them, I have tried for the second “So” without ever having obtained it completely.

Figure 1 shows a tank of 11 gallons capacity, built into a wall. The wall is gypsum board covered with white plastic, imitation brick. Although I could have cut the usual rectangle from the wall, I elected to cut a free-form shape, bordered in black. This simple step transformed this display tank into something special immediately. My next step was to paint the rear and sides solid black. The fish to be displayed in this aquarium were albino tiger barbs and this background flattered both these fishes and the plants very well.
Basically, only three plant species were used in this tank: ambulia (*Limnophila sessiliflora),* moneywort (*Lysimachia nummulara*) and hornwort (*Ceratophyllum demersum*). The last-named was not planted but was allowed to

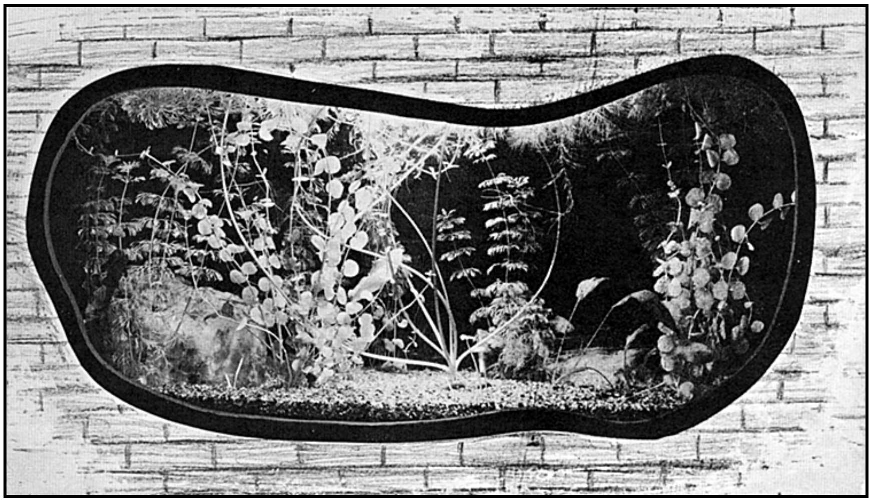


Figure 1. Only three species of plants were used for this well tank. Photo by A. J. Klee.

float at the surface. The light green, round leaves of the moneywort contrasted nicely with the dark-green, stringy leaves of the ambulia. Notice that I used these two plants in a rather asymmetrical arrangement. I didn't just bunch them together, yet there are decided groups of each plant.

I allowed myself the luxury of one crypt (*Cryptocoryne Beckettii*), and a banana plant (*Nymphoides aquatica*). The latter was placed about in the center and the former was planted to the right. Now it is true that it is not a good idea (esthetically) to plant "center plants" in the center, but the bulky piece of pink quartz on the left turned out to be the focal point and everything balanced out nicely. Another piece of quartz, much lower this time, was used on the right-hand side. The banana plant grew stringy but it contributed a horizontal movement to the tank and added to its beauty. Later on, this tank was used successfully to house a number of killifishes. The hornwort diffused the light to a considerable degree, much to the delight of these fishes.

Figure 2 is a very long tank (6 feet long!) of about 180 gallons capacity. The log shown in this picture is just that! At its base it is about 12" in diameter and in length is a bit under 5 feet. I had no container large enough to treat or "cure" a piece of wood this size, so I was forced to use the tank itself as the container. Other than water and about 300 pounds of gravel, nothing but the wood was placed in the tank during curing. I used several grams of pure methylene blue powder (this turned the water almost black!) and in three weeks, all slime bacteria and fungi were purged from the

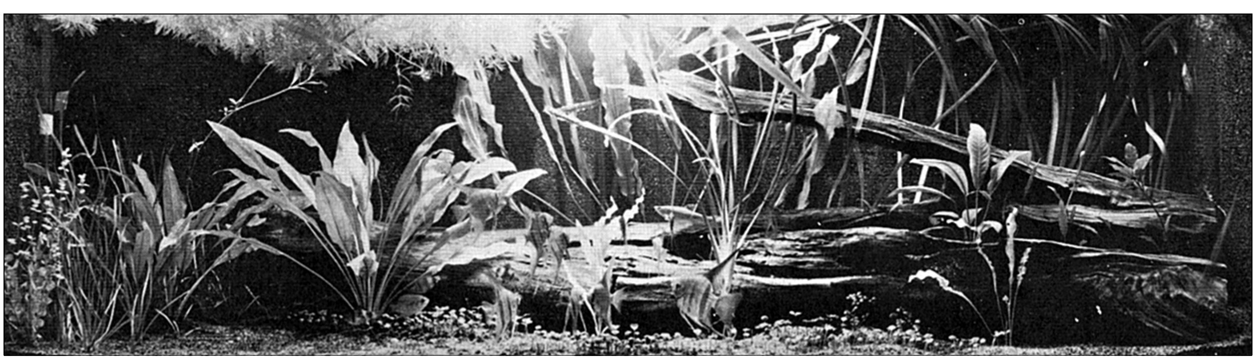


Figure 2. A 6-ft. long tank (about 180 gal. capacity), as photographed by the author.

wood. After three changes of water (no mean task for a tank this size!), the tank was ready for planting. Incidentally, both the log and the gravel were stained a dark blue from this treatment but this disappeared within six months. Everything is now its natural color. I sometimes wonder what those advocates of wood curing via boiling in salt water would have done about this situation!

Notice that the plant center of attraction is a very large Amazon sword plant (*Echinodorus martii*). Swordplants are used at the left and a medium-sized anubias (*Anubias lanceolata*) is planted in the log at the right. A very large ruffled leaf sword plant (Echinodorus martii) is planted behind the log about midway. Again, although in the center it does not form a focal point, the left end contains vallisneria (*Vallisneria spiralis*) and moneywort, and in the right behind the log there is a large stand of giant val (*Vallisneria gigantea*). Here and there are some small crypts, and floating at the top, a dense growth of hornwort. One of the interesting features of this aquarium is the carpet of underwater clover (*Marsilea quadrifolia*) in front of the log. Presently, although the aquarium won a "Best-In-Show" award, the tank still needs more in the way of background planting and planting to the right side. The sides and rear of this tank are made of plywood, covered with asphaltum varnish. While the varnish was still wet, gravel was pressed into the surface and so formed walls of pebbly, brown gravel. The log contains about 75 pounds of gravel to hold it down and there are two, 100-gallon-hour filters used to keep the water clear. The fish population is very varied including angels, gouramies, barbs, catfishes, and characins.

The Dutch have a rule of thumb that states that two-thirds of the aquarium should be occupied by plants. I have never achieved this in practice but as I get closer and closer to this ratio, I realize that this rule makes sense from an esthetic point of view. Unless one is willing to wait and grow ones own plants, it is an expensive axiom, however.

My last example is shown in figure 3. Here I was forced to do without rooted plants due to a population of cichlids and silver dollars (*Metynnis* species) that would not let plants be. However, I did use floating hornwort that had to be replaced at times. Again, the tank (23 gallons) is built in and the cutout is free form. The sides and rear are covered with plastic imitation stone of a natural color and I relied heavily on wood and stone for decoration. The contrasting colors of these materials somewhat made up for the missing plants. Notice that the

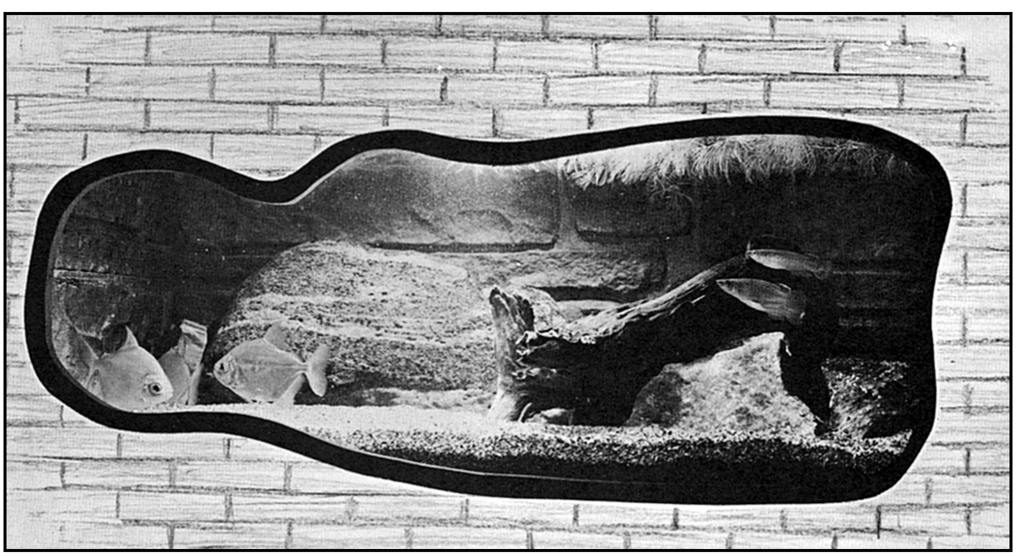


Figure 3. Here a population of *Metynnis* precluded rooted plants. Photo by A. J. Klee.

focal point is not at the center! The rocks at the right are medium-green; the background slab at the left rear is pink granite.

Notice also, how flat the gravel bed is. This was not the way I laid it down but the constant digging of the cichlids leveled it out quickly. One thing that aquarist are prone to forget … the fish must cooperate also!

On The Pronunciation Of Fish Names

[Aquarium Journal, February 1962]

Without a doubt, pronunciation of fish names is a minor stumbling block for the beginner, a source of irritation comparable to sand in one's spinach, hunting for your last cuff link in a somewhat untidy drawer, or being unable to work your son's simple fraction problems of the familiar form, "If a man had three apples ..." The hesitant and uncertain pronunciation of a fish name is bound to destroy the confidence of any aquarist, something the beginner can ill afford to sacrifice.

There has been little written in the aquarium literature on this subject, indeed. I have found only three such articles in the English language in my years in the hobby. It is an interesting subject, however, and one upon which I would like to touch from time to time. The point is, however, that the beginner should take it in small doses! Readers can consider this month's column as dose number one, with dose number two to follow only when I am sure that all have recovered from any nasty side effects that might ensue.

Hobbyists will be quick to discern that many fishes are named after persons, either living or dead, to commemorate patrons of science, eminent scholars, or discoverers, although I admit that occasionally, nepotism rears its ugly head resulting in fish being named for somebody's uncle, sister, wife, etc. If you ever see a scientific name like, "*Hyphessobrycon charliei*," chances are that "Charlie" was the brother of the wife of the man who named the fish. However, to emphasize the difficult conditions under which ichthyologists occasionally work, Charlie may very well have been the brother-in-law of the man who put up the maims to finance the expedition that discovered the fish in the first place. But since the vast majority of such names are deserved, every effort should be made to preserve in their pronunciation as nearly as possible, their original sounds. This is not only common sense, but courtesy as well.

Unfortunately, this is precisely the area in which aquarists botch up the job of pronunciation. More often than not, the name turns out unrecognizable. Be assured, however, that this sad state of affairs is not peculiar to aquarists alone. Gardeners, for instance, pronounce Camellia as, CAM-**MEEL'**-LEE-AH, even though this plant was named after and in honor of, George Joseph Kamel (Latinized form = Camelli) and should be pronounced, CAM-**MEL'**-LEE-A, with a short e.

The former pronunciation is careless and severs all connection between the plant and the man honored. Thus, one of the major reasons for bestowing the name in the first place is obscured.

To return to the fish world now, let us look at two fish names most often mangled, even in good company. Both happen to be popular dwarf cichlids. The first is Apistogramma agassizi, correctly pronounced, **AG'**-AS-SEE-EYE, but more often heard (ugh!) as, AG-AH-**SEE'**-ZEE. The second is Apistogramma ramirezi, correctly pronounced as, RAH-**MEER'**-EZ-EYE, but again mangled into something like, RAM-A-**REE'**-ZEE.

Note that the correct pronunciation closely follows the sounds and accents used by the persons so honored themselves. Thus, the great

French-American biologist, Louis Agassiz, and the Venezuelan fisheries biologist, Manuel Vicente Ramirez E., are clearly identified and the honor accorded them is preserved.

Because of the foreign languages involved, it may be difficult to get exact English sounds in a pronunciation. For example, consider the name, Aphyosemion schoutedeni, named after the Belgian, Dr. H. Schouteden. This is a Dutch name and as such, is all but impossible for an American to pronounce. A very close (and acceptable) approximation for the scientific name, however, is **SCOW'**-TE-DEN-EYE. Another example would be *Aphyosemion labarrei*, named after Mr. Cl. Labarre, a name of French root (although again, Mr. Labarre is a Belgian). We have no adequate way of sounding that "L" but at least we can avoid abominations such as **LAB'**-BER-EYE. The word should be pronounced, LA-**BAR'**-EYE.

This carelessness upon the part of hobbyists has led to mangling of even the easiest of names to pronounce. For example, recently I heard someone refer to the splashing tetra, Copeina arnoldi, as, AR-**NOLD'**-EYE, instead of the correct, **AR'**-NOLD-EYE, thus doing a disservice to Johann Arnold, the counterpart in Germany, to our own Dr. Innes. Even more distressing, I note that a few of our so-called "handbooks" contain egregious errors along this line. I would suggest that beginners study the pronunciations given in Innes', Exotic Aquarium Fishes or Jaeger's, The Biologist's Handbook of Pronunciations, for a firm foundation for developing acceptable pronunciations of aquarium fish names.

One word of caution, though. If one delves into this subject in detail, one finds that there is disagreement among experts here and there, upon the pronunciation of a scientific word. This should not bother anyone. The important thing is to develop consistency and confidence without doing violence to the laws of logic, Latin or Greek.

The "Perfect" Mix

[Aquarium Journal, March 1962]

One of the most frequently asked questions is, "What fishes can I place together in a community tank?" It would seem a simple thing merely to list groups of fishes that are compatible (and this would be an easy thing since most ordinary fishes found at your dealer's are compatible . . . it would be easier to list the incompatible ones!), but it isn't quite that simple. There are other factors in populating a community tank than just a mandate to keep the peace.

A friend of mine recently became interested in aquarium fishes and purchased a 15-gallon tank. In the process, he asked my assistance in choosing its inhabitants. Now this particular friend is of a scientific bent (he is a school teacher, teaching science courses in high school) and his interest in fishes is strictly for the fishes themselves. The esthetic aspects of his aquarium could concern him in no way whatsoever. His number one requirement was variety and lots of it. He will spend hours sitting in front of this tank, first watching one fish, then another. Between us, we worked out a rather unconventional community tank, one that I would not recommend to the average beginner.

For example, among others, there were some bumblebee gobies, *Brachygobius doriae*, a few young cichlids, *Aequidens portalegrensis*, and some killifishes, *Rivulus cylindraceus*. This is really a horrible combination but my friend was delighted and enjoyed the diversity (oh, go ahead and say it! Hodgepodge!) this varied fish population afforded. There was compatibility to the extent that each of these fishes kept to their own stratum of the aquarium, the gobies on the bottom, the cichlids in the middle, and the killifishes on the top. Thus, they kept to their own biotope, as the scientists say, and bothered no one. Unfortunately, my friend happened to mention this combination to some of my fellow members of my aquarium society, and. I had to take a merciless ribbing over my "selections."

Another friend had a restaurant with two 50-gallon tanks built into the back of a bar. His number one requirement was that his customers should be able to see the fish. Now a peaceful combination of pristellas, zebra danios, cherry barbs, etc. could have been worked out, but the viewing distance, a matter of some 8 feet (to this we have to add an intangible distance to account for the fact that bar patrons are not noted for the sharpest vision in town) would have precluded anyone seeing them. We finally decided on 200 neon tetras for the first tank, and 12 very large angelfish plus some large pearl gouramies for the second. For entirely different reasons (color in the first tank, size in the other) the fish in both tanks were quite visible. Here is a case where any attempt to combine many species would have backfired, for in general, it is only by massing one or two species in a large tank that they are visible at a distance.

Admittedly, however, the more usual case is that of the beginner who wants to combine angelfish, tiger barbs, leeris, swordtails, Jack Dempseys and other mismatched combinations. Here is where one has to utilize all powers of persuasion to talk such aquarists out of their ambitious but ill fated plans. Some experience in this hobby has taught me that the fish one should feel sorry for in all this is the angelfish for everyone wants to include it in a collection without realizing that (a), they are larger than most other aquarium fishes and so need more room for growth and peace of mind, (b) they are rather shy, slow-moving fishes, easily frightened and bullied and (c), they have elongated ventral fins which attract every fin-nipping fish within a three county radius. Angelfishes do best in the company of less aggressive fishes such as pearl and dwarf gouramies or pencil fishes.

In planning a community tank, it is best to prevent any one element from dominating another. For example, 3 pearl gouramies will dominate 3 pencil fishes, even though the former are not ordinarily thought of as domineering fishes. A better combination would be 3 pearl gouramies and 12 pencil fishes, a combination where neither species will dominate the other. What we have done is to make allowances for differences in size.

There are some troublemakers that are popular among beginners, viz. male swordtails and tiger barbs, both of which are bullies of sorts. The amount of harm they do depends mostly on the vigor of the other tank inhabitants. The characteristic of fin nipping, the major source of trouble in the ill-advised community tank, is not easy to resolve in some cases. True, there are some fishes that are always suspect, such as the blind cave characin and the ones already mentioned but other normally peaceful fishes can learn fin nipping. Thus, isolated individuals of black tetras and zebra danios can evolve into troublemakers over a period of time. The usually harmless plecostomus catfish can turn into a mass murderer upon occasion. (I have had this happen so often that I am almost willing to classify it as a killer regardless of size, although it is mostly the larger specimens that are mean).

The same thing applies to plant eating, the second source of irritation in the community aquarium. Again, some fishes can be cataloged as habitual plant-eaters, viz., silver tetras, *Ctenobrycon spirulus*, and silver dollars (*Metynnis* et al), but I have found that certain species, black ruby barbs for example, can learn to eat plants with gusto.

If one plans a community aquarium from an esthetic point of view, care should be taken in the choice of fishes re color. For example, the following fishes all have a reddish base and tend to detract from each other: *Barbus tetrazona, Barbus nigrofasciatus, Rasbora heteromorpha* and *Rasbora maculata*. On the other hand, I have seen dramatic color combinations involving just two kinds of fishes, for instance, black mollies and red platies. One tank that was especially exciting contained silver and gold, the latter in the form of gold barbs (the Schubert variety of *Barbus semifasciolatus* and the former as *Barbus ticto*. The frame of this tank as well as and the tank itself contained large pieces of translucent white gypsum and some pieces of white finger coral … there were no plants present at all. With its white sand bottom, the whole tank installation blended in with its surroundings perfectly.

For best results, the community tank should be carefully planned with a view towards the final objective. No one should criticize (constructively, that is) any particular combination of fishes without knowing the desired goals. That aquarist with her "silver and gold" community tank is just as happy with her choice as is my friend with the improbable combination of gobies, cichlids, and killifishes.

On Odds and Ends

[Aquarium Journal, April 1962]

Although admittedly not quite as bad as the electronic hobby, the keeping of aquarium fishes can tend to become a bit untidy if things aren't kept in proper order. For years I have had an aquarist's counterpart of Fibber Mc-Gee's closet, containing bits of airline tubing, corks, valves, small plastic dishes, old peat moss, crystal paint, etc. There seems to be a propensity on the part of aquarists everywhere to abhor throwing anything away. For example, it just seems a crime to throw away those trimmings when one is cutting cover glasses. Result? I have a beautiful collection of pieces of glass with such odd dimensions as 14" x 3/4", 2-1/2" x 5-1/2", etc. The same goes for tubing. If it's under six inches long, I've got it! Unfortunately, six inches doesn't take a filter very far and somehow ten or fifteen pieces of such tubing strung together with rigid plastic gives the impression of a highly shaky financial position or a miserly nature, especially if the pieces are randomly chosen in green and clear. Ditto for old filters. Filters have the unfortunate habit of losing their inwards over the years, thus the aquarist accumulates row after row of plastic shells. Unlike pop bottles, however, there is no deposit on them and no future in holding them for posterity.

In an attempt to forestall future doom (in which I pictured myself drowning in a sea of years of accumulation of small parts), I took a firm stand and tossed everything not really needed, into the trash basket. In this, I surprised myself, my wife, and our garbage collector (who had to return a second time with an empty truck to cart everything away).
For those items I could not bear to part with (such as an air stone from the late Devonian Period), I purchased a number of plastic tackle containers, labeled, and filled them with the objects in question. Now when I grab for a handful of peat moss, it is all peat . . . no surprises such as air valves, old scissors, or eeyedroppers Even my dry fishfood (which I buy in bulk) is stored in these plastic containers with the advantages of (1), being able to indicate immediately how much food is left and (2), being all of one size and shape. To indicate different kinds and sizes of food, the containers are of different colors.

Even my "topping" water is stored in plastic. I have one 20-gallon plastic garbage pail (colored yellow) that holds rainwater, and another (colored green) which holds aged tap water. Even on New Year's Day, I was able to "tap the right keg," due to the prominent color-coding.

The hardest part of my cleanup campaign was in the net department. Aquarists tend to become quite fond of certain nets and refuse to give them up regardless of the fact that they do wear out. Most of my nets had large holes in them with the result that it was about as difficult to net a large cichlid as it would have been to try netting infusoria. With a heart these trusty (and rusty) veterans were retired and replaced, with the happy result of cutting my fish-catching time down from 1-1/2 hours per fish to only 12 seconds per fish.

Perhaps the cruelest area of all is in the medicine department. After a while, aquarists learn that all labels sold for use on aquarium products are specially made with water-soluble glue, thus insuring that they fall off in quick order. There is an interesting game that old-time aquarists play called, "What's in the bottle?" This is a fascinating game suitable for ages seven through 70, and one never knows whether the answer will be ick remedy, quinine tablets, pH test solution, sodium bicarbonate, etc. It is best to get rid of this material quickly. Don't, however, pour everything down the kitchen sink for the combination of some of these interesting chemicals is unpredictable and plumbing bills being what they are, it is best to leave the pyrotechnics to your garbage man (poor fellow!). To avoid all this, use clear cellophane tape on all bottles, jars, etc., immediately after purchase. Thus protected, the labels should last as long as the aquarist!

On Growth and Survival of Fishes in Aquaria

[Aquarium Journal, June 1962]

It is perhaps trite to say that hobbyists have observed that some fishes live longer than others and that some grow larger than others. There are, of course, important differences among species and few aquarists are oblivious to the fact that, for example, an angelfish is likely to outlive a betta, or that the former will most probably exceed the latter in size. The principles of fishkeeping, however, are not so concerned with such uncontrollable factors as they are with those upon which aquarists do exert some measure of discipline. A good many aquarium fishes die as the result of "accidents," and the word is placed in quotes because the vast majority of fish deaths don't really belong in that category at all. If a fish jumps from a tank and dies a dusty death on the floor, the classification of the event as an "accident" is merely a sop to the conscience of the aquarist who neglected to insure, through adequate

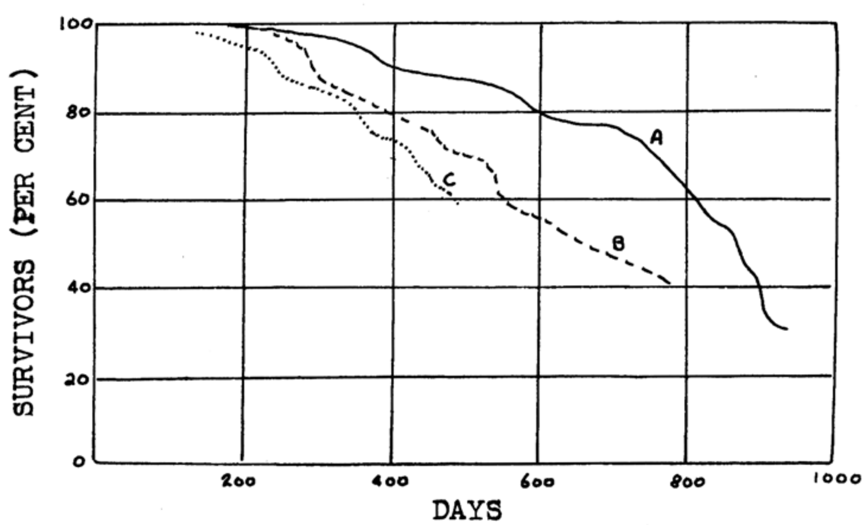


Figure 1.
Curve A: Guppies in ordinary tanks.
Curve B: Guppies in 2000 milliliter bottles.
Curve C: Guppies in 300 Milliliter bottles (after Comfort).

tank covering, that such an event could not take place. True accidents in the hobby are really few and far between.

There are some fish deaths that are spectacular in nature as, for example, when a large cichlid gobbles up a neon tetra or some other small fish. Once this is observed, the beginner is not likely to make the same mistake twice for it is too vividly etched in the memory. But what of the more subtle aspects of growth and survival? All too frequently, the lives of fishes are shortened through neglect and/or unsuitable environment, and because the ravages of these causes do not present themselves as dramatically to the aquarist, they are often overlooked.

Let's consider, for a moment, a group of guppies. Let our interest be directed to the effect of tank space upon their longevity. The often-quoted "2-year life span" of the guppy is a poor target to shoot at, for under ideal conditions, the maximum may be stretched to 5 years. Dr. Alex Comfort, an English biologist specializing in the senescence (aging) of animals, has experimented with guppies in order to determine how restrictions on tank space affect longevity. Figure 1 shows the results of these experiments (which are still going on, hence the curves are not yet completed). One group of guppies was housed in ordinary tanks; the second in 2000 milliliter (about 2 quarts) and the third in 300 milliliter bottles (about 10 ounces). All of these guppies were fully fed and well cared for. The graph shows that despite this, survival was lowered as the container size was decreased.

Figure 2 shows the effects of neglect on the survival of guppies. Both groups were kept in 600 milliliter bottles (about 20 ounces) but one group was neglected. The curves tell the whole story, that neglect too, takes its toll.

Aquarists know that the growth of fishes is related to many variables but are sometimes in doubt as to the relationship between growth and longevity. Figure 3 shows the exact sizes of sister female guppies, 266 days old. Both had balanced diets but one had a restricted (but still adequate) caloric intake, the other a full intake. But even more remarkable is the fact that when fully fed, the smaller will quickly reach the size of her sister and will probably outlive her! The point is, that the optimum level of feeding for growth results in a much shorter life span than a diet that checks growth without causing specific vitamin deficiencies.

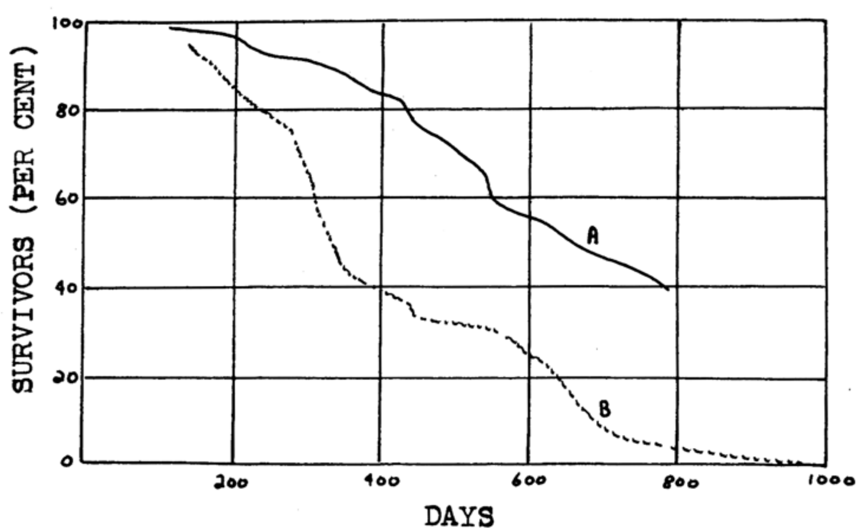


Figure 2. Guppies raised in 600 milliliter bottles. Curve A: Well cared for. Curve B: Relatively neglected (after Comfort).

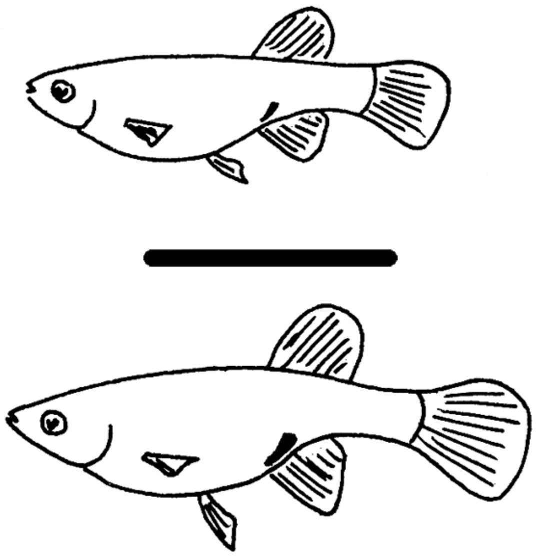


Figure 3. Relative size between guppies fed restricted and unrestricted diets. UPPER FISH: Female guppy 266 days old, raised on adequate but restricted diet. LOWER FISH: Female guppy 266 days old, raised on same food but with unrestricted intake. Line is one inch long (after Comfort).

It seems this principle is not widely known among fish fanciers, especially those breeding for size in selected groups of fishes. Thus between two fishes brought to the same size, one slowly, the other much faster, the former will outlive the latter. Note that this does not mean that to restrict growth, one must provide a diet deficient in one or more nutrients. Slow growth for longer life span is achieved by restriction of caloric intake and not by an inadequate diet.

One of the unfortunate things is that one cannot, merely by looking at a fish, tell whether it was brought to size quickly or slowly. In this, the hobbyist has to rely on the integrity and reputation of the breeder or dealer.

The Floccinaucinihilipilificator

[Aquarium Journal, July 1962]

There is a tendency on the part of far too many hobbyists today in habitually judging this or that aquarium fish as being practically worthless. In some groups whose object of admiration is a single fish such as the guppy, the betta, or the angelfish, or whose object is a cluster of species or a single family such as the killifishes or the cichlids, the habit refines itself into a sort of piscatorial snobbery. Thus, we hear statements which although in print seem harmless enough, cast sinister implications through the way the words are pronounced, e.g., "Oh him! He's a guppy man!" or, "Yes, 'but he's interested in those `panchax' things!" Pity the poor beginner who falls into the hands of one of these floccinaucinihilipilificators!

It now becomes necessary to digress a moment for a definition, a statement which no doubt holds the record for understatements ever appearing in the JOURNAL. That word above appears in the Oxford English Dictionary along with the remark that it has only been used three times in the history of the language: in 1741, 1816 and 1829. In view of this vigorous usage, it is surprising not to find the word in Webster's! Nevertheless, it is defined as, "the action or habit of estimating as worthless." We are confident that this word will immediately take the aquarium world by storm since by using just one word, we replace eight! *[Editor's note: We take no responsibility for pronunciation of Al Klee's "eight in one step to obscurity."]*

One of the strangest results of floccinaucinihilipilification is that members of the same aquarium society take turns sleeping through lectures, slide shows, panel discussions, etc., only to awaken and show signs of life when their own pet subject is announced. It is even more amazing when one considers that, in general, all of our fishes suffer from the same diseases, eat approximately the same foods, and inhabit approximately the same rectangular, glass-sided containers. At one time this writer overheard a hobbyist who was a specialist in angelfish, remark to his crony upon a lecture on velvet disease, “Yes, but he was talking about velvet on bettas!” How silly can you get?

But this is organized floccinaucinihilipilifcation where aquarists huddle together in groups… it should be mentioned that there are isolated practitioners of the art, as well. Take, for example, the aquarist who has just finished comparing his spawn of neon tetras to his friend’s of the lemon tetra. “Well,” he says, “You can’t compare the two . . . those lemon tetras are worthless.” Here the judgment goes against the lemon tets because they don’t possess the brilliance of coloration of the neons. No one denies that the latter won’t show up well even under photographer’s lights, while the former must be carefully illuminated to show their delicate colors. But to condemn as worthless? “Gaudy” can be used as a synonym for “brilliant coloration,” as can “ostentatious.” This writer frequently prefers the delicate beauty of such an unjustly maligned fish to the aurora borealis of the over-emphasized popularity leaders.

A major difficulty in the hobby today is that aquarists quickly become bored with it all. They soon run down the list of our showy popular aquarium fishes, leaving themselves ill-equipped to enjoy the many interesting fishes that remain. Thus, after having bred bettas, angelfishes and fancy guppies, they have “done all, seen all,” and so drop out of the hobby. The main objection to the fioccinaucinihilipilificator is that he tends to discourage those who are willing to experiment with our less popular fishes. “You’re playing with seven-spot livebearers? Get rid of them and start breeding a really pretty fish, the cardinal!”

In the early days of our hobby in this country, there never seemed to be a halt to the procession of interesting fishes with which to keep and breed. Those were the days when barbs, rasboras and catfishes, and anything else that was new, strange or bizarre, received a welcome to our shores. Each one received a little attention and it added something to the hobby. Some time ago, hobbyists in the author’s city broke away, to their great credit, from floccinaucinihilipilification. Out of nowhere, a craze began for zebra cichlids. A little while later, interest developed in halfbeaks. Hobbyists were so busy trying new techniques and adapting their old techniques to these radically different fishes, that they didn’t have time to get bored. Sure, the floccinaucinihilipilificator said, “Why fuss with those things? They aren’t worth anything!”

On a sloping, winding street in Cincinnati, in a small hip-roofed house, in a basement fish room, in a 15-gallon tank . . . this author keeps a 10-inch eel, originally obtained from the waters off Boston harbor. His name is “Charlie” and he takes pieces of canned shrimp from my fingers every day. Should any floccinaucinihilipilificator ask me, “Why do you keep that thing?” Lord help him!

On Heroes

[Aquarium Journal, August 1962]

In early spring of 1959, I received a letter from a friend at ALL-PETS MAGAZINE, a publication highly regarded in its field, which I would like to quote in part:

“I would like to compile a list of ‘key breeders’ or key hobbyists, in the fish field. Several things come to mind, but I’m not too sure how to go about it. This must be a prime list, of only the most active and successful breeders in the hobby.

“With cats and dogs it is relatively easier … you pick out the ones who breed the champi-

ons, grand champions and best in show animals.

"Can you suggest some way I might go about compiling such a list for the fish hobby?
"Am I safe in assuming that the officers of the aquarium clubs would be logical people? Or at least the president and secretary? Any suggestions you can send along will be greatly appreciated."

Recently, I again looked over my reply to his request and was struck by the thought that the comments therein might, even today, serve to orient the beginning aquarist somewhat within his newfound hobby. Again in part, here is my answer:

"For years now, I have preached the philosophy that the aquarium hobby is rather distinct from the other pet 'hobbies.' When I was a youngster my folks raised Boston Terriers and Pugs. They were members and in some cases, officers, of five kennel clubs. At no time were their activities referred to as the 'dog hobby'; it almost always was the 'dog game.'

"In the dog game, the key personnel were easy to spot. There were, as you suggest, the owners of the champions, group winners, etc. In addition, there were the professional and semi-professional handlers and judges. Although there existed many dog magazines, the writers of articles in these magazines were hardly noticed. If the authors had any claim to fame (with few exceptions), it was a result of their dog show successes and not their writing.

"The point is, in the aquarium hobby the situation is quite reversed. It is true that fish shows are held but due to the lack of national standards (except in the case, perhaps, of the guppy), these are mostly local affairs. My folks would travel 600 miles to attend a dog show ... very few aquarists would go so far a distance to attend a fish show. In any kennel club, the monthly puppy matches and planning for future specialty shows (or other shows) takes most of the monthly meeting time, this is not true in an aquarium society. In most fish clubs, the number of members interested in shows on an active basis forms considerably less than a majority. An aquarium society meeting is primarily taken up with lectures, films or discussions pertinent to fish, plants, diseases or equipment.

"Since there are prominent persons in the aquarium hobby, the question is, 'Who are these people?' My answer (and not facetiously by any means) is that they are:

(a) Writers for aquarium magazines and
(b) Friends of writers for aquarium magazines.

"However, if writing for an aquarium magazine is the only criterion for hobby prominence, then it can easily be seen how shaky a foundation this prominence rests upon. Let me briefly classify writers for such magazines.

"Class 1. Professional scientists associated in a field pertinent to the hobby.
This class contains professionals such as botanists, ichthyologists, geneticists, etc., who are not aquarists per se, necessarily. They render service by providing opinions upon classification of fishes and plants, and highly technical aspects such as physiology, pathology, etc.

Class II. Professionals associated with the hobby vocationally.
Here we include retail and wholesale dealers, personnel of public aquaria, operators of fish farms and collectors. Since this group is in a position to receive new fish and plants before anyone else, their articles are frequently introductions to these new importations. Natural habitat data is also supplied by these professionals. All of them have a commercial interest in the aquarium hobby. Occasionally, the publishers of aquarium hobby material are included here also.

Class III. The Non-professionals.
Although somewhat of a catchall, many fine aquarists are represented here, more so than in any other class. There are two subclasses here (considering now the extremes):

(a) Those who know what they are talking about and who have a passable to excellent writing style, and
(b) Those who are stumbling along but have an excellent writing style and are used because of the shortage of those above.
"This breakdown is crude, I know, for some can only be classified if placed in one or more groups, and I say nothing about hobbyists whose main claim to fame is fine photography.

"So you see, your question is not an easy one to answer. Under no circumstances should such a list include as a matter of course, the officers of aquarium societies! Many officers are pleasant, easy to get along with chaps, elected upon the basis of a popularity contest or as a salve to warring factions within a club. Many fine officers have been aquarists for but a short while. There are, of course, excellent aquarists among club officers but one is no guarantee of the other.

"If you are interested primarily in well-known people in the hobby, then your problem is easy to solve. Merely canvas the magazines and list the names most frequently encountered. If you desire a list of competent (and excellent) aquarists, the job is harder. It could be done as follows:

"Contact every aquarium society and also every well-known aquarist, and ask them to compile a list of prominent hobbyists in their immediate vicinity. Then ask them to state upon what basis the persons named were chosen. In large metropolitan areas, the multiple society organizations should serve as a check on the answers to some extent. There is no one person in this country that could supply the list you want although I have no doubt that some would offer some such list. I might possibly be competent to judge articles appearing in the magazines, but how could I possibly pass judgment upon the countless excellent aquarists who, for one reason or another, never appear in print? Some of the non-writers are publicized in print through friendships with regular writers. There is nothing wrong in this; it is in the omissions where the other many deserving hobbyists miss out. Now that I have hopelessly confused the issues, I will close for now."

Three years ago, that was my answer and I stand by it even today. We all choose our heroes in this hobby but it should be borne in mind that a suitable "hero" might be living right next door, unsung perhaps, but a candidate still. Arguments about who is the "greatest" aquarist here or there are nonsense indeed.

President's Guide to Aquarium Society Meetings

[Aquarium Journal, November 1962]

More than once I have urged a beginner to join a local aquarium society only to have him return from his first meeting disappointed and fed up with the whole idea. More often than not the chief complaint is in the conduct of the meeting, the rampant disorganization of its business and the lack of preparation of its leaders. Much of the blame can be placed upon the chief officer of the society, the President himself. The very word, President, is derived from the Latin words that mean, "to sit before." Unfortunately, many society Presidents do only just that. They fail to recognize the two great responsibilities of a presiding officer; that of guiding the meeting and that of impartial umpiring. To carry out these responsibilities successfully, the President must combine careful preparation with self-control. Actually, careful preparation is half the battle won for nothing inspires self-confidence more than the realization that one knows what he is doing. Self-control is a necessary quality for without it, a President can hardly hope to be impartial nor can he avoid being dictatorial and undemocratic.

The guide to a regular society meeting is aptly summed up in the phrase, "order of business." It is the outline that brings order to the meeting. A typical and useful order of business for an aquarium society (but by no means the only one) is as follows:

1. Calling of the meeting to order.
2. Reading, correction and approval of the minutes.
3. Reports of officers, boards, and standing committees.
4. Reports of special committees.
5. Unfinished business.
6. New business.
7. Program.
8. Adjournment.

Although some of the steps in the order of business are routine and require little or no preparation, quite a few require advance knowledge. The President should determine before the meeting what reports will be made and who will give them. He should also familiarize himself with any unfinished business remaining from previous meetings in order that he may intelligently answer the questions that usually arise when reintroducing old business. Finally, the President should familiarize himself with the evening's program. In the absence of the program chairman, he may be expected to introduce the speaker or otherwise fill in. Let's look at the steps in the order of business, one by one.

1. Calling of the meeting to order.

This is the first step in the meeting procedure. After obtaining the attention of his audience, either by voice alone or with the use of the gavel, the President can simply say, "The meeting will please come to order." Allow a few moments for all members and guests to be seated.

2. Reading, correction and approval of the minutes of the previous meeting.

After the meeting has been called to order, the President can say, "The secretary will please read the, minutes of the previous meeting." When the secretary has finished reading the minutes and after a few moments have elapsed to allow the audience time to entertain any corrections, the President can say, "Are there any additions or corrections to the minutes?" If none are offered, he may then say, "The minutes are approved as read." When additions or corrections are suggested, the President should determine whether there is general acceptance of them. If objections are made, the alterations should be made in the form of a motion and a vote taken. If there is general approval of the corrections evidenced either by lack of objection or by favorable vote, the President concludes this section by saying, "The minutes will stand as corrected."

3. Reports of officers, boards, and standing committees.

Societies will differ in their treatment of reports from these sources. Some societies require monthly reports from their treasurers, for example, others do not Generally speaking, if reports do not carry with them recommendations for action, it is not necessary to have a motion to adopt it and place it in the society's records. It is sufficient to say, "The report is received and will be placed in the records." Reports that contain specific motions or recommendations for action should, of course, be voted upon by the membership. As can be seen from this discussion, the usual type of treasurer's report does not require a vote.

4. Reports of special committees.

The preceding remarks hold also for this section. Since special committees are appointed for specific projects, they should always be discharged when their work is completed. If their work is unfinished, the President may say, "The report is received and the committee continued."

5. Unfinished and new business.

Unfinished business as opposed to new business consists of business from previous meetings that has been delayed, postponed, or tabled for lack of time, and business mentioned in the minutes of the previous meeting. It is important to distinguish between the two.

A good President will always determine, to a certain degree, what a great part of the new business will be. Unfortunately, very few presidents do this. He will be informed of the activities of the society's executive board and its committees, and should be prepared as to the recommendations that will be made. Advance preparation on the part of the President can facilitate and speed up the business session so that it will not become tiresome to the membership who have attended mainly for the program of the evening.

6. The program.

In some societies, it may be the duty of the President to introduce the program or the speaker. Under such circumstances, the President should obtain detailed information about the program beforehand and prepare his introduction. If the meeting is to be turned over to a program chairman, this should not be cause for neglecting such preparations as the President may be required to substitute for the program chairman in his absence. When things don't go according to plan, everyone looks to the President for a solution. Be prepared . . . have one in hand.

7. Adjournment.

If there are announcements to be made before adjourning the meeting, this fact should be made known and the announcements given. After such action the President can say, "Will someone move to adjourn?" A second, and a favorable majority vote completes the meeting.

Here are a few tips for presiding club officers to remember:

(a) Do not dictate to the membership. The president's duty is to guide the membership, not tell it what to do.

(b) At all times strive to be courteous and tactful.

(c) Know your own society's Constitution and By-laws as well as the parliamentary authority for your organization.

(d) The art of presiding may not come automatically to every president, but careful preparation before each meeting is a great equalizer.

On Environment

[Aquarium Journal, December 1962]

Nothing is more discouraging to the beginner trying to keep up with his hobby by reading all the articles on aquarium topics he can get his hands upon, than to encounter a word the meaning of which is a bit hazy. An example would be "rainforest," seemingly a simple combination of two elementary words but perhaps not making much sense upon analysis. After all, don't all forests receive rain? ' Yet we see this word often, particularly when egg layers are discussed and even more particularly when consideration is being made of providing an aquarium environment close to that of a fish's natural habitat, or else when the question is one of breeding a so-called "problem fish" (e.g., the neon tetra).

When an area receives over 100 inches of rain a year and the temperature is such to permit year-round growing (and we also stipulate that the resultant forest is undisturbed by man or fire), what is called a rainforest develops. It is characterized by many different kinds of plants growing together, each adapted to a different stratum, from the very lowest ground cover to the tallest trees. The rainforest is the typical movie "jungle" and is what we usually think of when we hear the term, "darkest Africa," for example. There are other characteristics of rainforests, one of which is that vegetable debris rapidly decays and intense leaching from heavy rains continually occurs. Most rainforests are, perforce, tropical but we have one outstanding example in our own country. On the westward coast of the Olympic Peninsula in Washington, westerly winds take up a tremendous amount of moisture from the warm Pacific. Subsequently, they release this load when they are suddenly cooled by the Olympic Mountains. The result is a truly lush rainforest.

Many of our aquarium fishes come from similar rainforests, albeit in tropical countries. As far as fishes are concerned, the term rainforest conjures in the mind a vision of clear, shaded waters that are low in certain dissolved minerals and have rather acid waters. We are not speaking of large streams that sometimes flow through these rainforests, for this is an entirely different environment, and the differences are reflected in the sort of fishes to be found. River fishes are often large and many are adapted to swift currents. Nor must me confuse rainforest waters with those of streams having their origins high in the mountains but emptying into rainforests. Such streams are usually cool, rocky, and swift, and their fish fauna are specialized to these conditions.

When we think of tropical countries, it would be a mistake to believe that everything is rainforest. A good portion of a given tropical country might simply be desert, but even if we exclude this possibility there is another characteristic land type often found in such countries. The name used for this feature often varies with the country concerned but a general term would be "savanna." The savanna also provides the movies with scenery and typically, these are the grasslands of the rhinoceros and the giraffe, poor in both water and trees. Where the rainforest is well watered the year round, and where its rainy season is more or less all throughout the year, the savanna has decided wet and dry periods. There is, therefore, little leaching here. Its waters are turbid, unshaded and its dissolved mineral content often is high, especially in the dry periods. As might be expected, living conditions for fishes in the savanna are quite different from those in the rainforest.

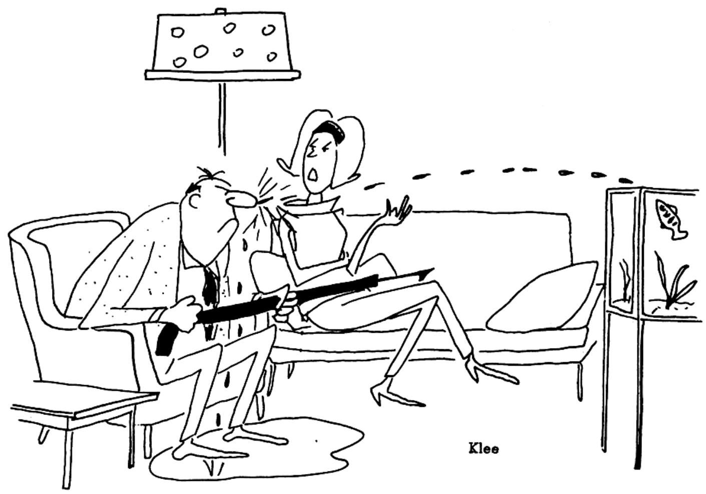
These do not exhaust the characteristic environments of our aquarium fishes. The influence of salt waters through the action of tides provides another environment, the environment of several of our livebearers, certain native fishes, silversides, and gobies. When we reflect upon these different environments, it is difficult to reconcile many of the so-called "community tank" arrangements found in the homes of most aquarists. No matter what the aquarium conditions are, at least some fishes are enjoying less than optimum conditions. This fact alone should be prima facie reason for learning more about the natural habitat of our fishes.

Another reason for learning more about these natural habitats is self defense against would be "experts" who neatly classify every fish into perhaps two simple groups on an environmental basis. As an example, recall to mind those who point out that killifishes are delicate and that they need clear, soft and acid water. It turns out that most of the annual killifishes come from savanna regions, however, and from what we have already said about such regions, we must conclude that fishes from these areas must be among the toughest and hardiest fishes that aquarists keep in the aquarium! How many other fishes can survive a change in water hardness from 0 DH to somewhere in the vicinity of 20 DH? Yet, these are the sorts of changes the annuals go through in nature.

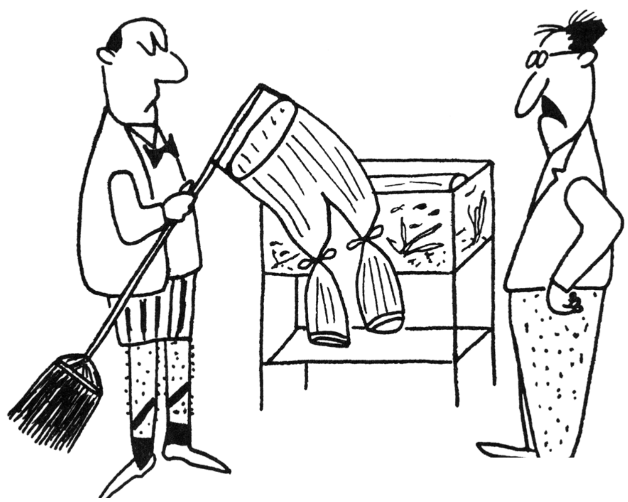
One must be informed on environmental matters also because occasionally the very popular names we give to our fishes may lead us to the wrong conclusions. For example, both the neon tetra and the characins contained within the genus Alestes are referred to as “tetras” by aquarists (the species of Alestes are usually labeled some sort of African tetra). Yet, these two types do not come from the same kind of environment. About the only thing their respective environments do share is that they are both soft and acid waters. There is more to keeping and breeding fishes, however, than just the degree of hardness and acidity of the water. If this were all that was involved, aquarists who were also chemists would reign supreme … this is not the case, by any means.

An excellent introduction to the study of the natural habitat of fishes is contained in Robert Erdtisck’s series of three articles on the black tetra which appeared in the JOURNAL starting with the February 1961 issue, Upon reading articles such as these, one soon learns that water isn’t necessarily “water,” at least so far as aquarium fishes are concerned!

CARTOONS



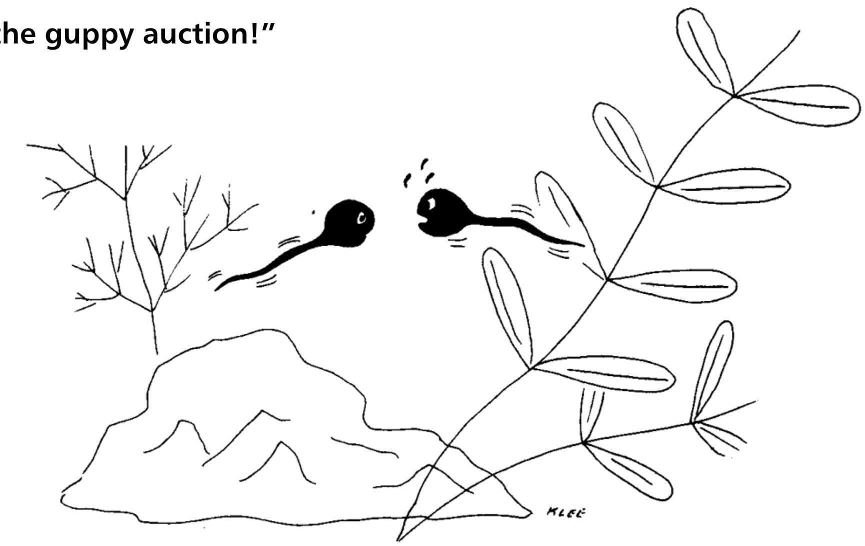
"Henry…why don't you and the archer fish stop this silly feud?"



"When are you going to break down and buy yourself a decent net?"

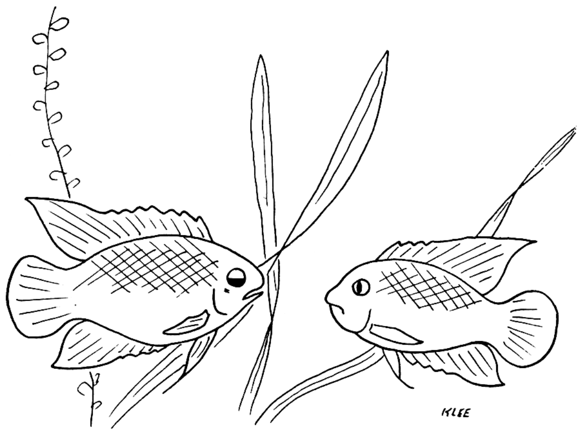
"Now if Madam is looking for economy in an air pump…"

"I decided to stay for the guppy auction!"



"Call me 'small fry' again and I'll punch you one in the nose!"

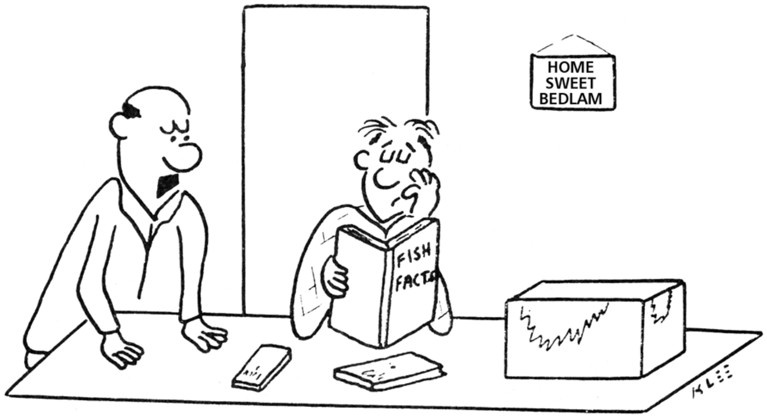
"Stop mumbling, Gromley, and finish unloading the rest of that saltwater shipment!"



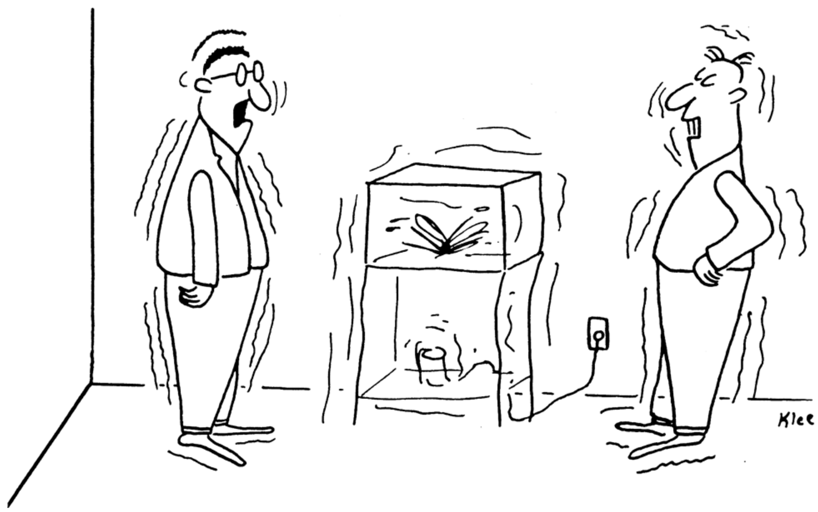
"Things are going so badly with me nowa-
days that it's all I can do to keep my head
below water!"

"How do you like my fighting fish?"

"No, Polly doesn't want a cracker, Polly
wants a worm! Fishy can eat the @#$%^!
cracker!"



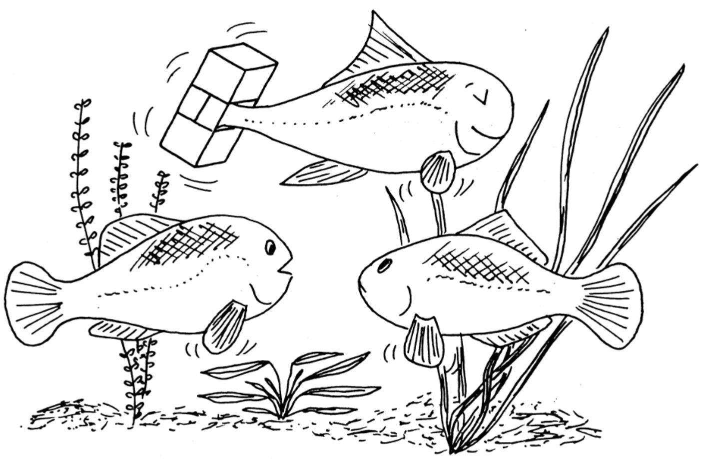
"I still don't think it's your glass catfish that's been nibbling at that tank!"



"I think that vibrator pump needs a little adjusting!"

"Looks like something went a little wrong with your order for a vial of brine shrimp!"

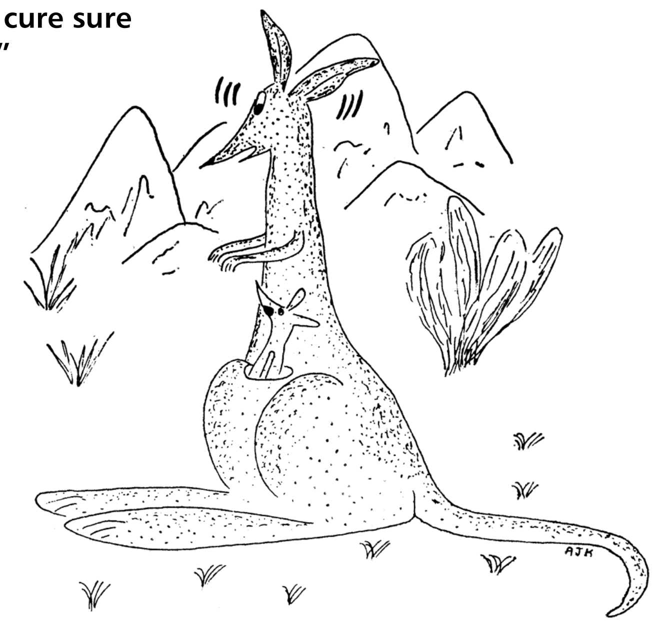
"Don't you think we could cut down a little on the light in this reflector?"



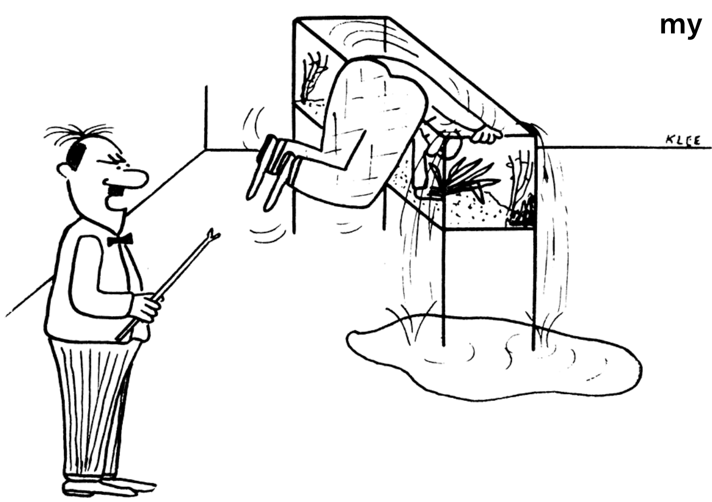
"He says it gives him more lift!"

"There are other ways to top up an aquarium, Digby!"

"I don't mind the 'Ick" so much but the cure sure makes these plants taste salty!"

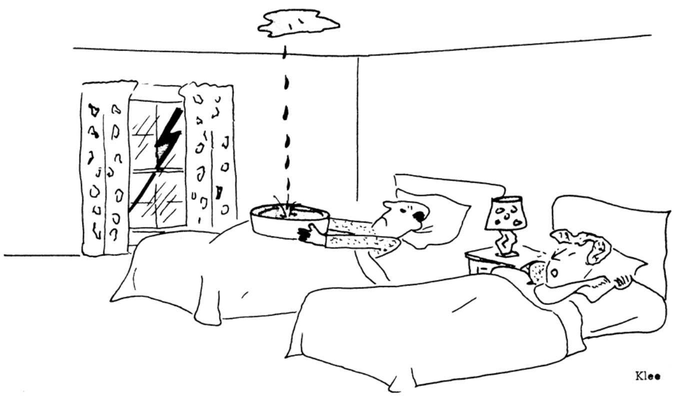


"No Ma'am… it's not what you think. One of my 5-gallon tanks sprung a leak!"

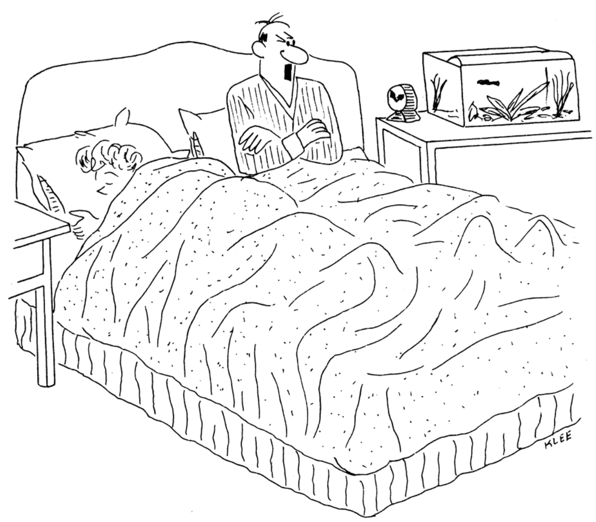


"Care for a planting stick?"

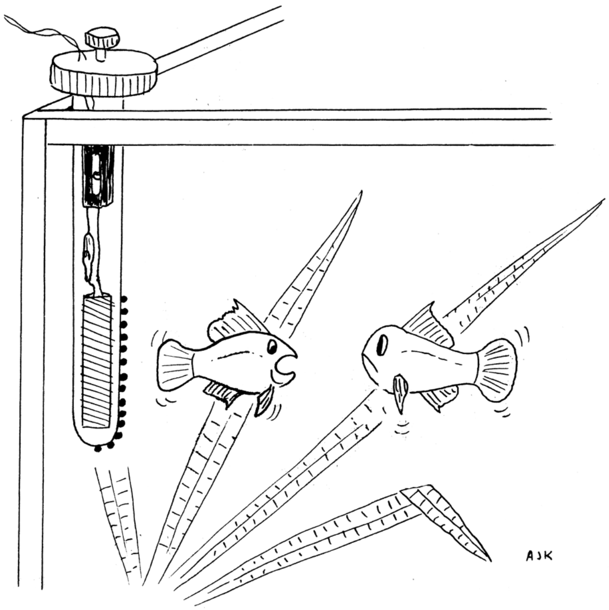
"Sam has a bit of a hard water problem!"



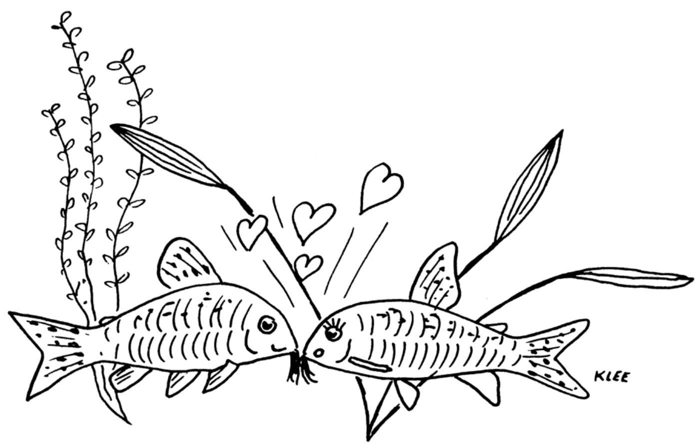
"I still don't think that's the right way to get rainwater!"



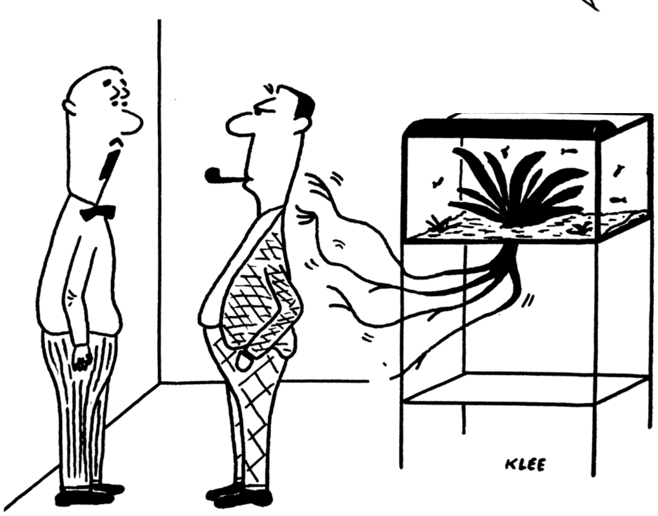
"For the last time, Martha, if you don't shut up that fool talking catfish...!"



"I prefer my eggs hard-boiled!"



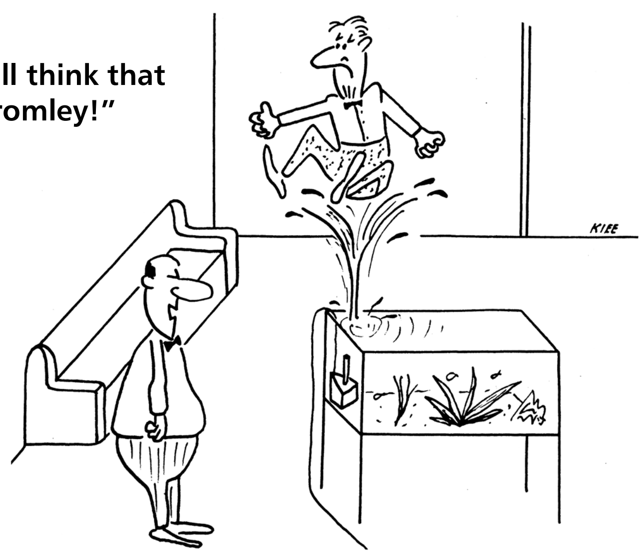
"Oh Charlie! You tickle!"



"Aren't you using just a bit too much plant food?"

"I've noticed that these archer fish will eat practically anything!"

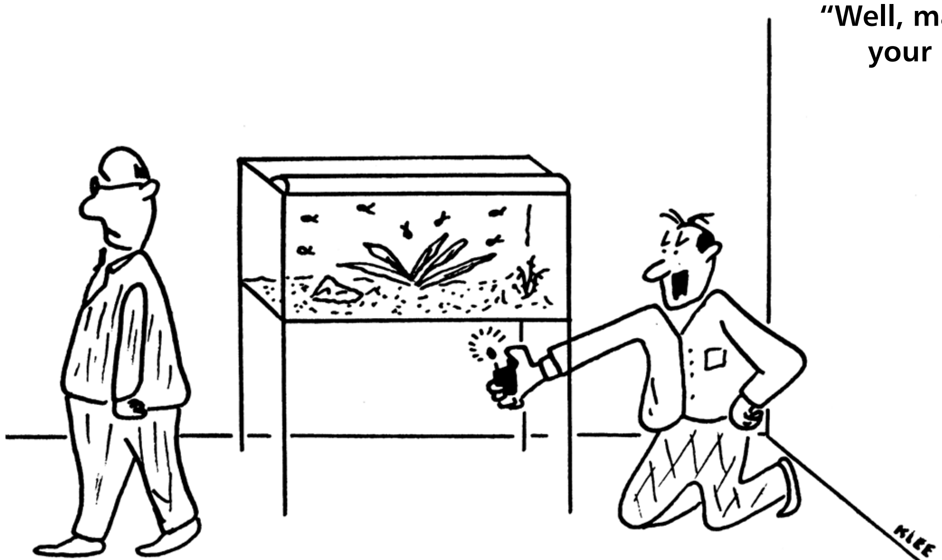
"Crepe soles or no crepe soles, I still think that electric eel is getting to you, Gromley!"



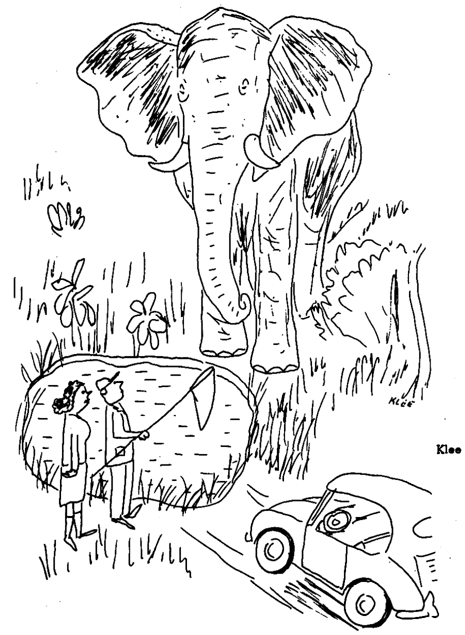
"Oh, all right – I'll turn down the air a little!"

"I'll give you two minutes to get that wa-
ter off the floor!"

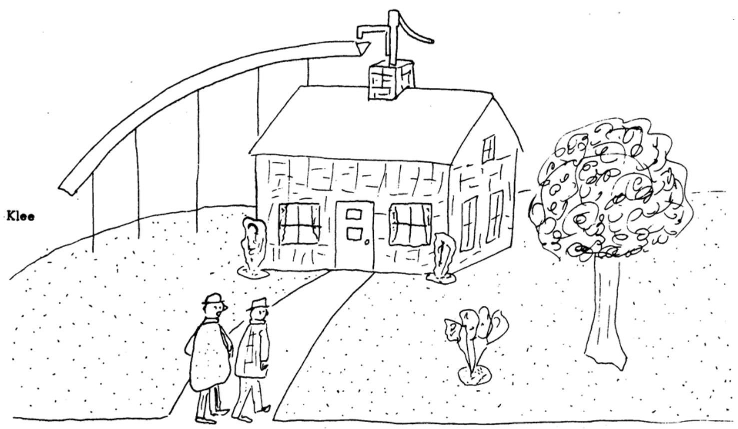
"Well, maybe you better put
your hands down...!"



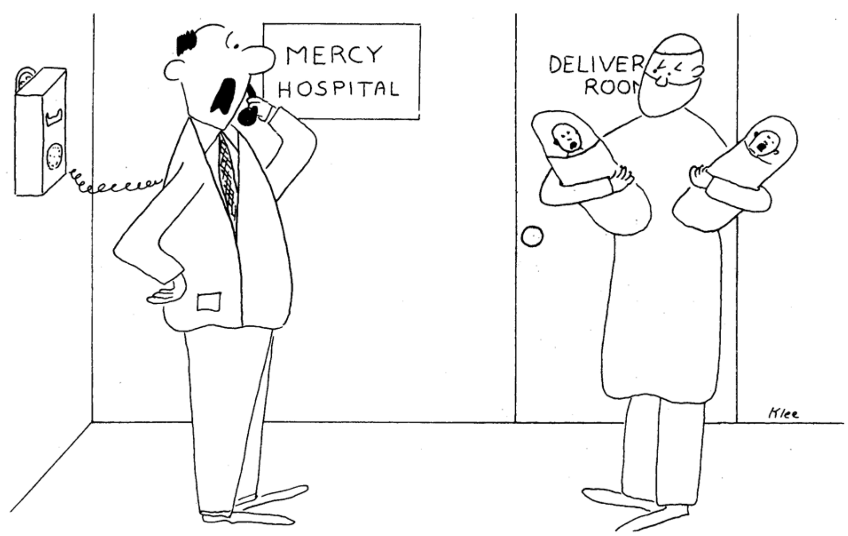
"While you're downtown, how about getting
me a 75-watt heater?"



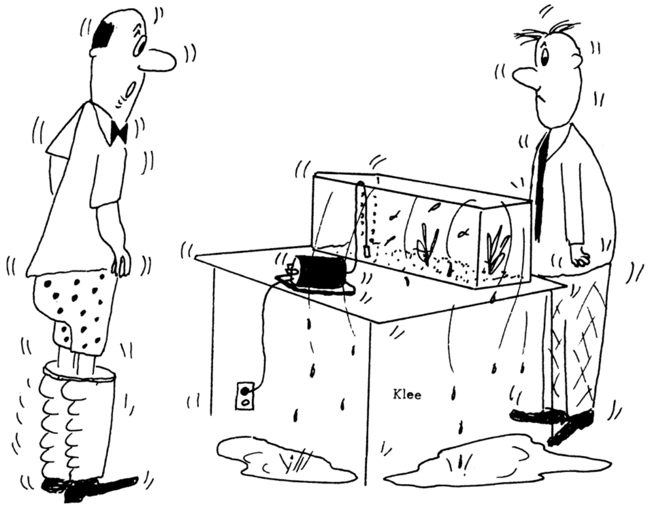
"*Nothobranchius* or no *Nothobranchius*, I still think you better let him take a drink!"



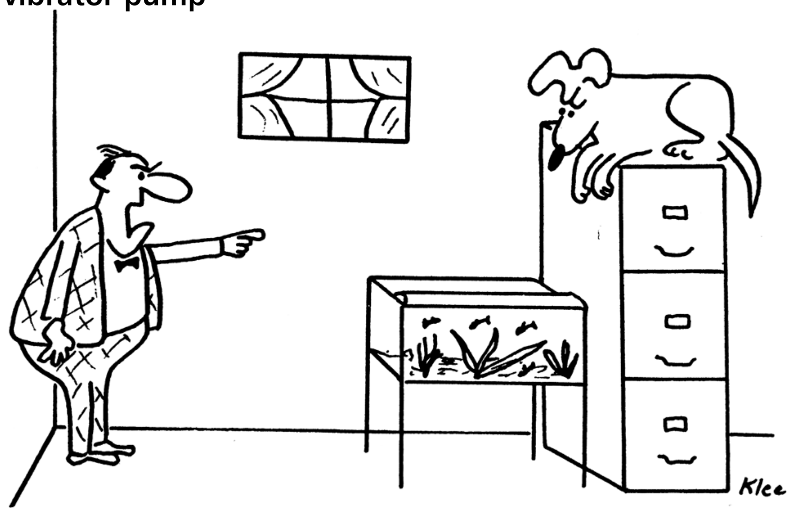
"Sam finally has the problem of that leaky tank in his basement solved!"



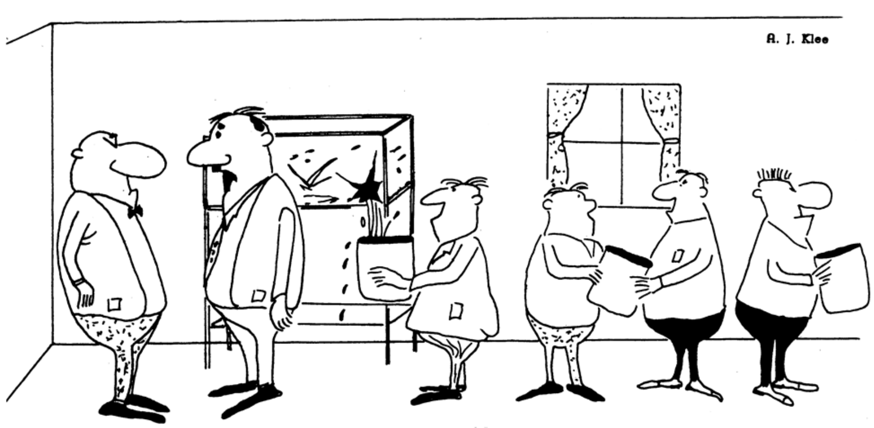
"Hello, Sam? About that expedition up the Amazon we planned this spring…"



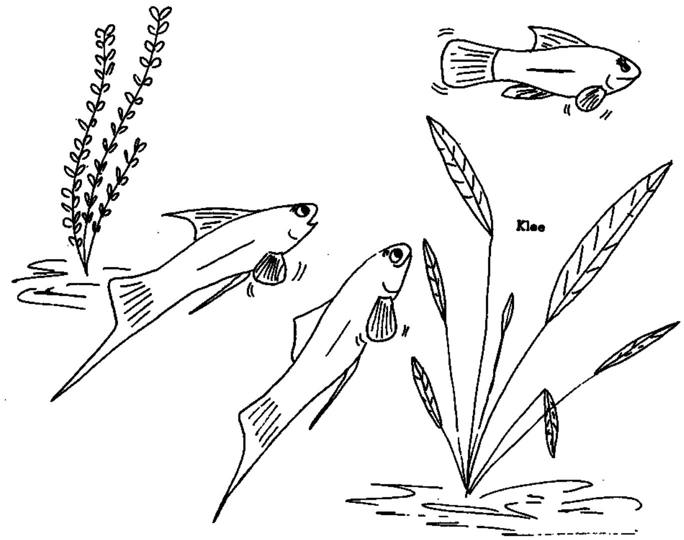
"I think you should turn that vibrator pump down a little!"



"S'help me Roscoe, if you touch any of those catfish…"

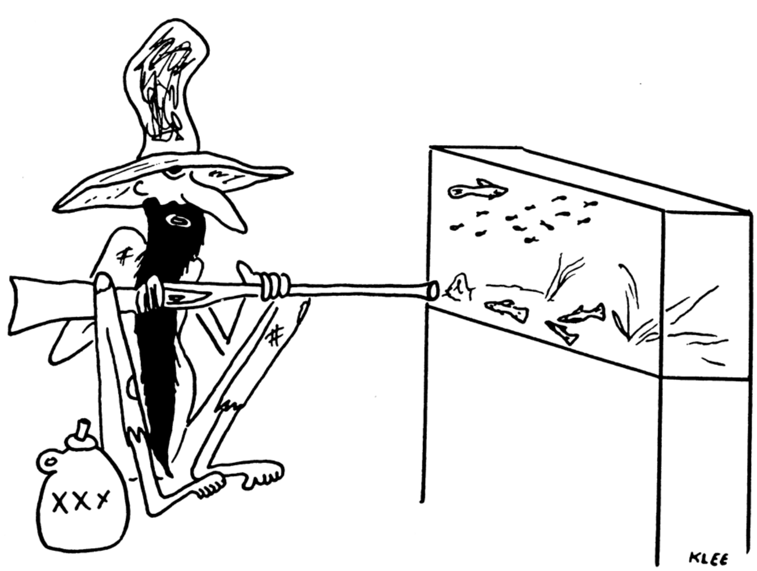


"That's not what I meant when I said to take care of that leak!"

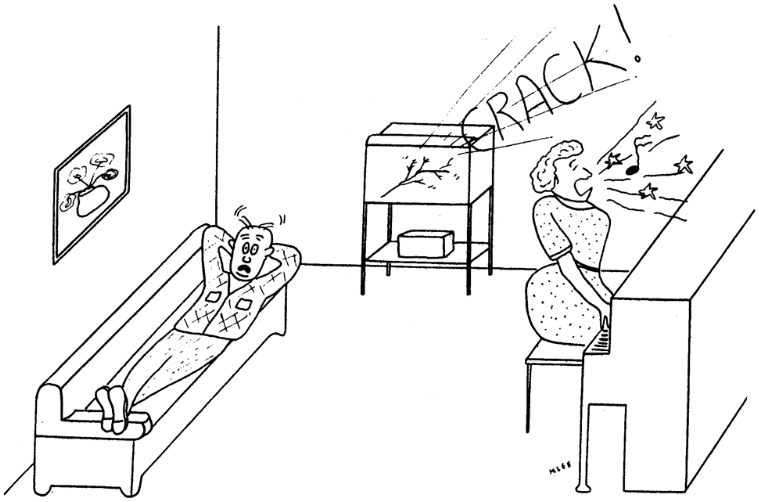


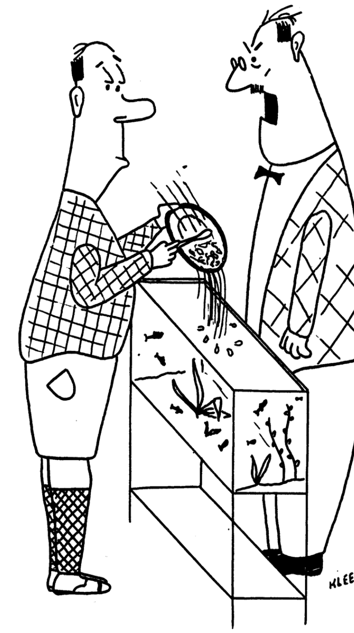
"All systems are go!"

"Sam here has found a real acid peat moss for spawning killies!"

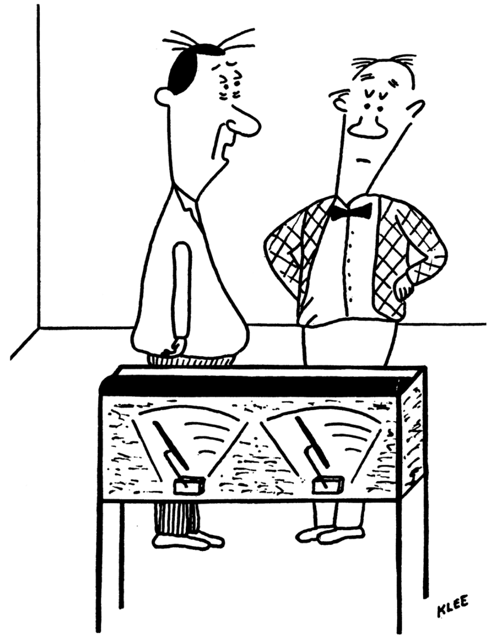


"One uh you boys gotta marry her!"

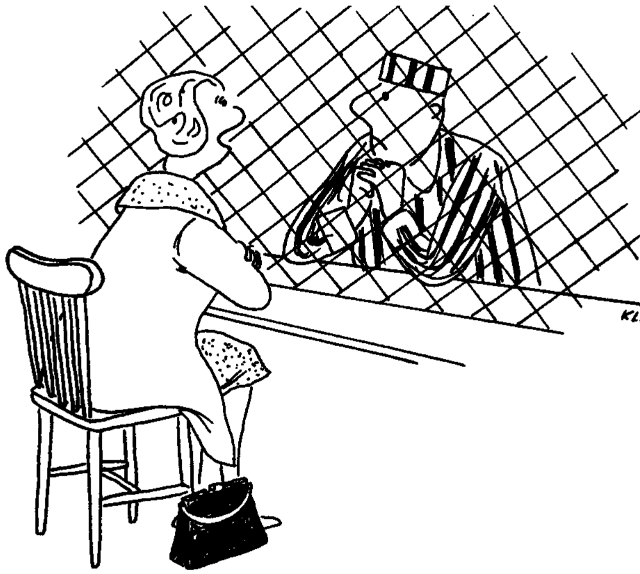




"I know catfish are scavengers
but they still won't
eat leftovers!"

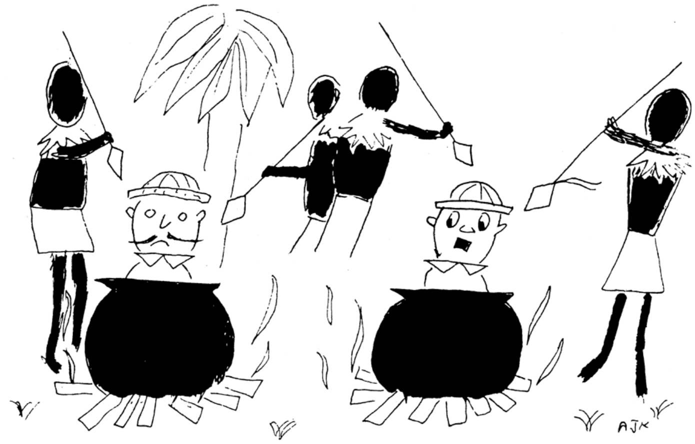


"I've finally solved my algae problem!"

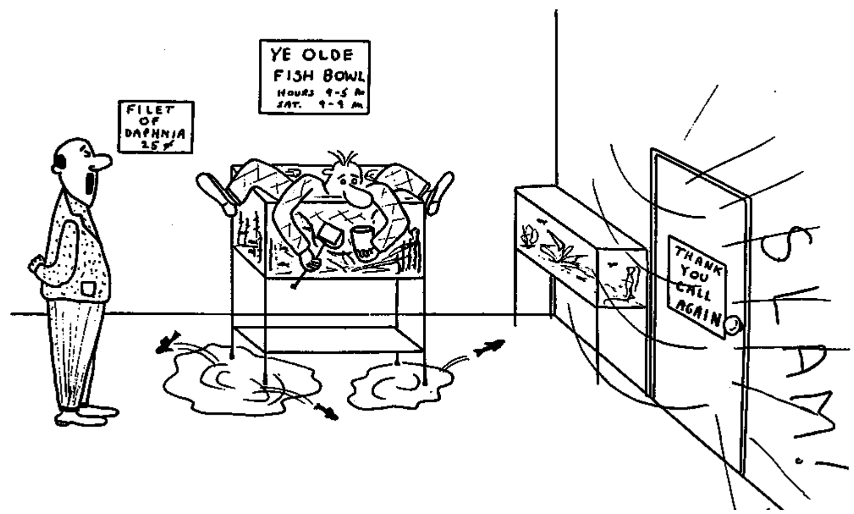


"And your lawyer says you can hold onto your cichlids but you better get rid of all your annual fishes…"

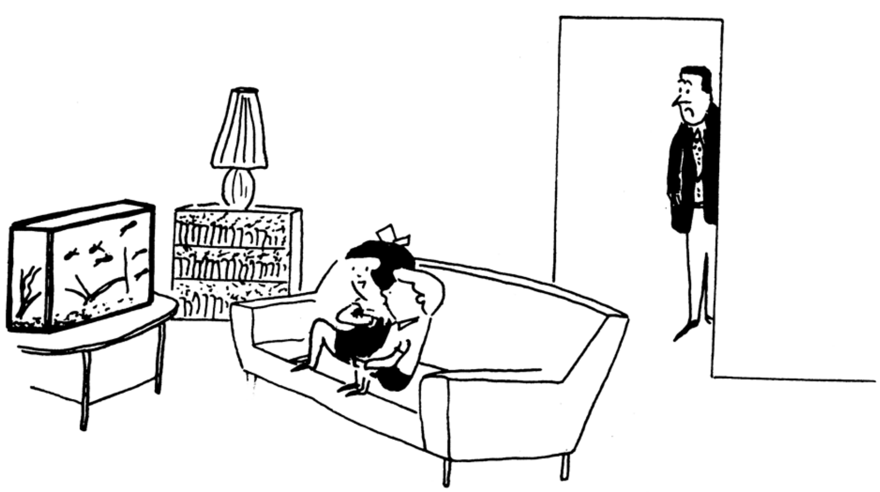
"I was caught putting snail eggs in my instant fish kits!"



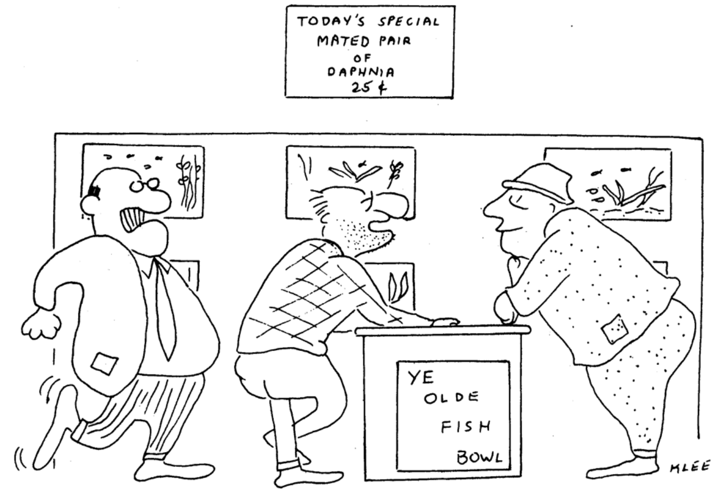
"Don't blame me! You're the one who wanted to collect his own discus!"



"Another satisfied customer, Gromley?"

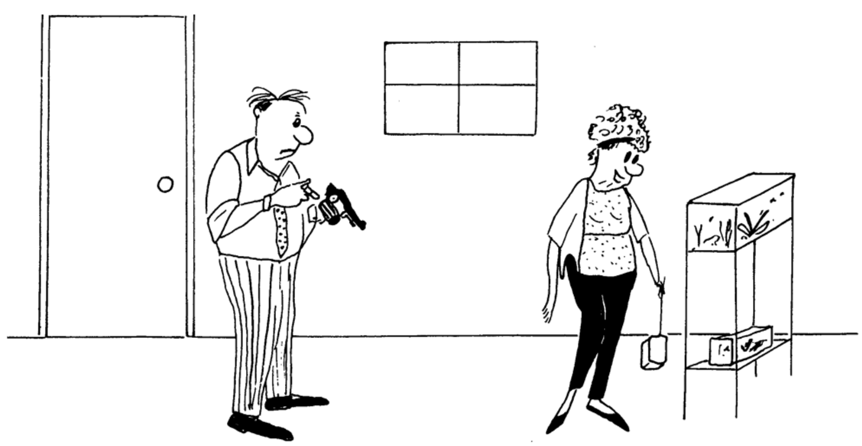


"They're called 'guppies.' Wait 'til you see that they're up to!"



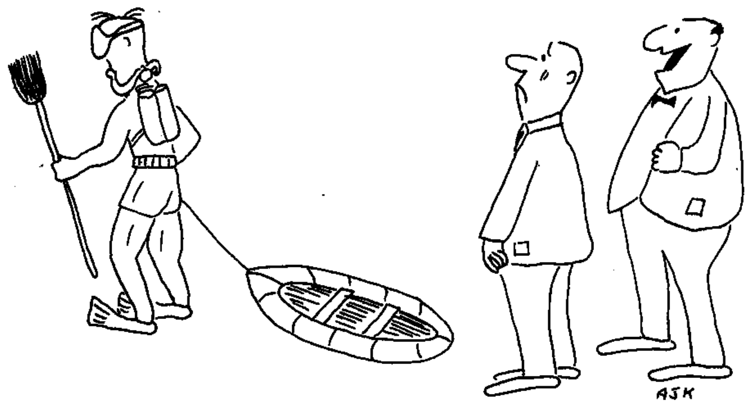
"I need a boost in this business!"

"Now this, Madam, is the latest in aquarium cleaning equipment!"

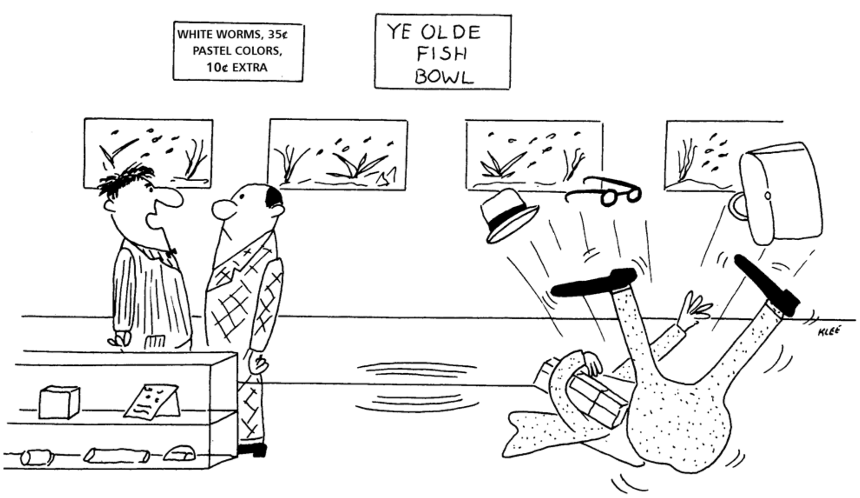


"Darling, I accidentally mixed the virgin females with the young male guppies today. I hope you're not angry…"

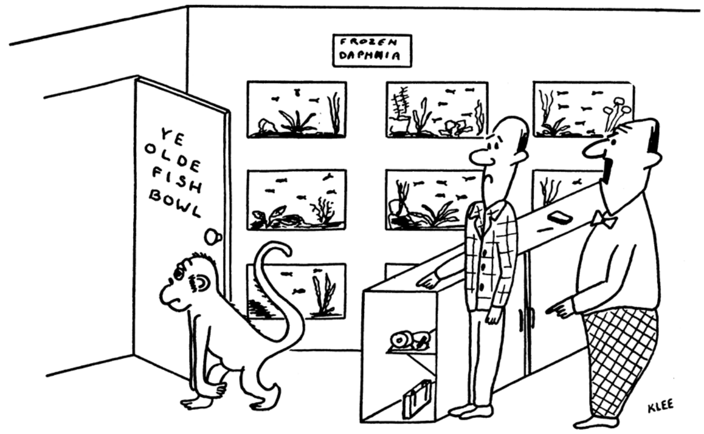
"I'll see your discus and raise you 12 angelfish!"



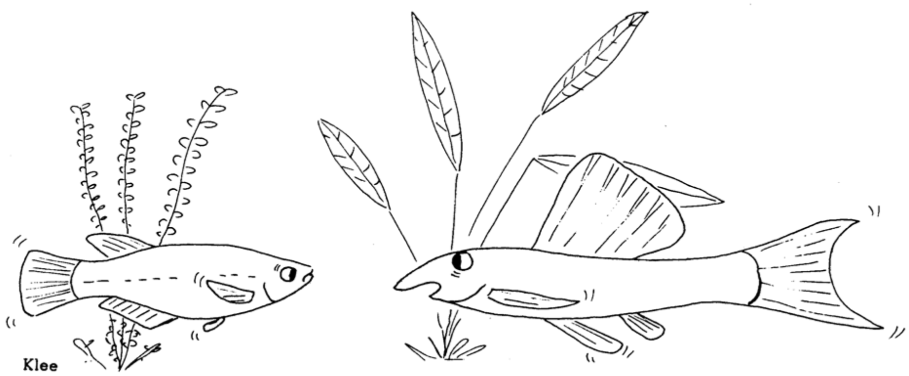
"He sure puts on a pretty good show on having the biggest tank in town!"



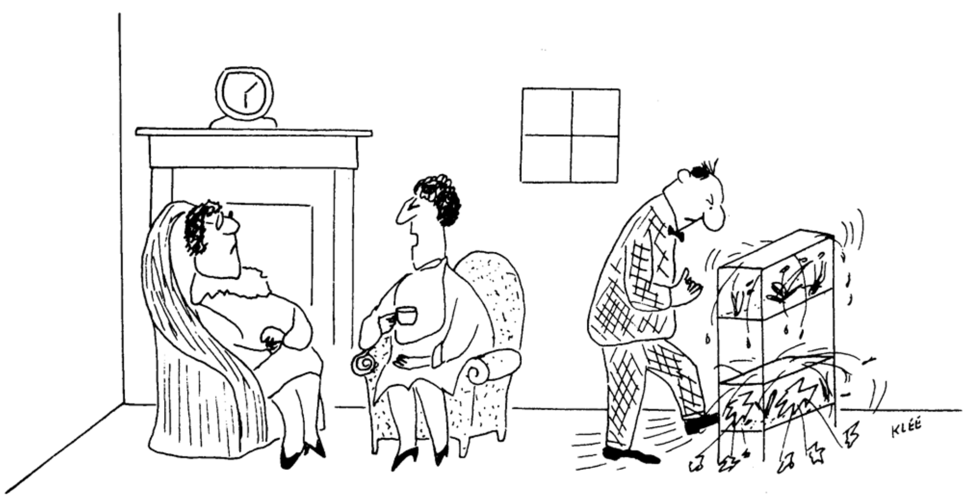
"The next time you sell a reflector, unplug it!"



"He keeps coming in asking for banana plants!"

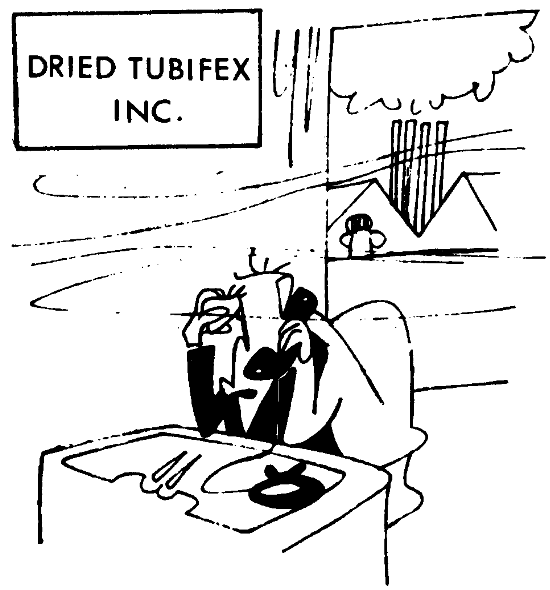


"I know what I am… I just can't pronounce it!"

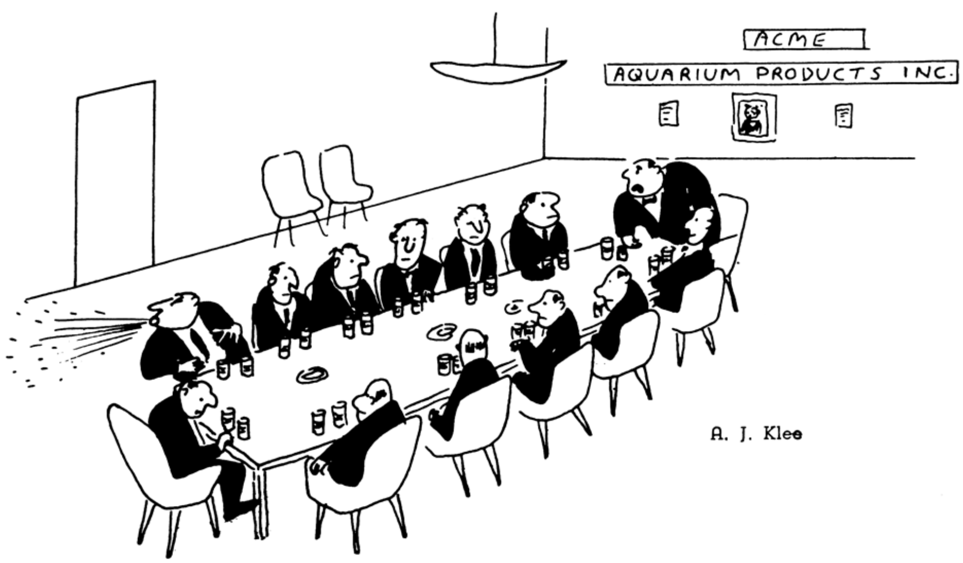


"If things get much worse at the office, we may have to drop out of the hobby!"

"I know fish are cheaper in Hong Kong, Henry, but don't you think this is carrying things a bit too far?"

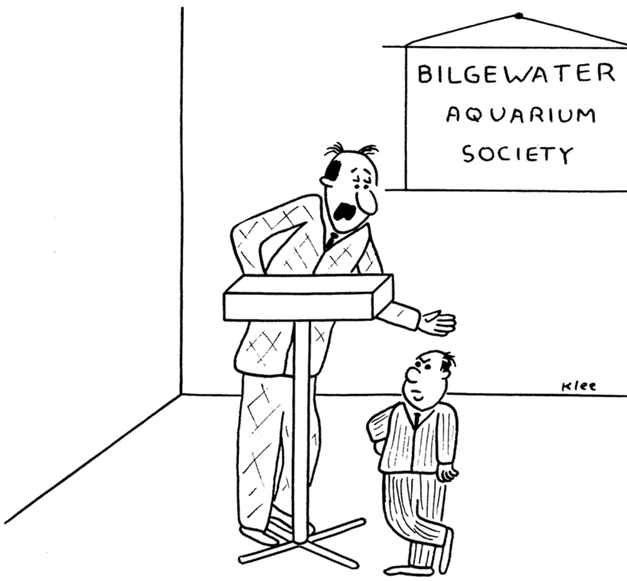


"Business is so good I can hardly stand it!"



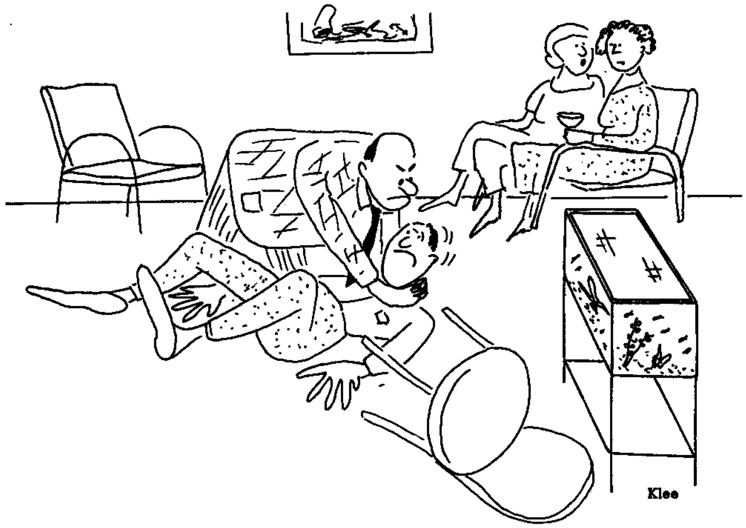
"I gather that you don't think we've quite got the right flavor for our new fish food, Gromley?"

"Another complaint on our
No. 407-1/2 filter!"



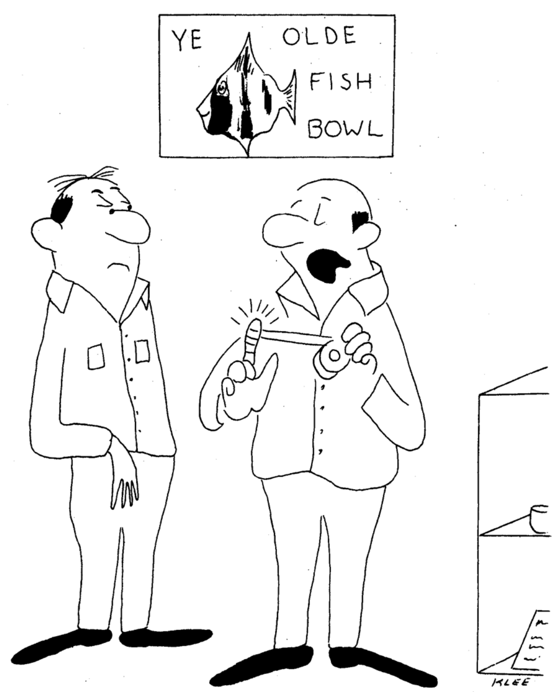
"… and our next speaker will talk about
dwarf gouramies!"

"For Heaven's sake, Lillian, you're not going to send
a card to the damned fish?"

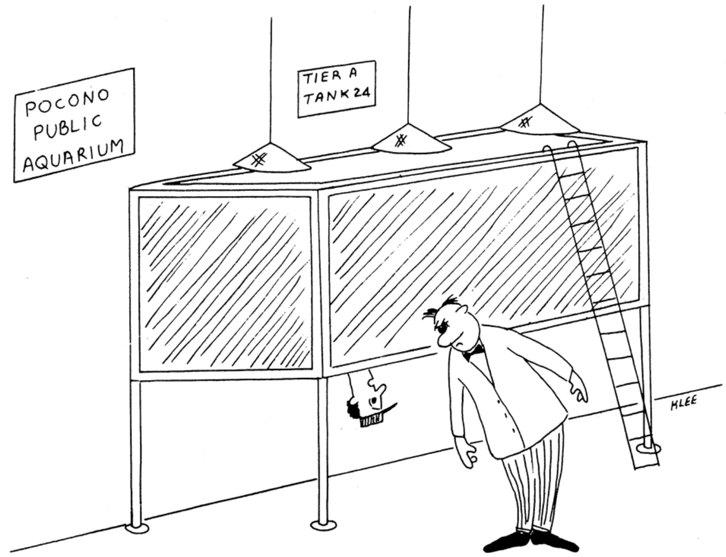


"Don't you think this discussion of how to raise brine shrimp has gone a bit too far?"

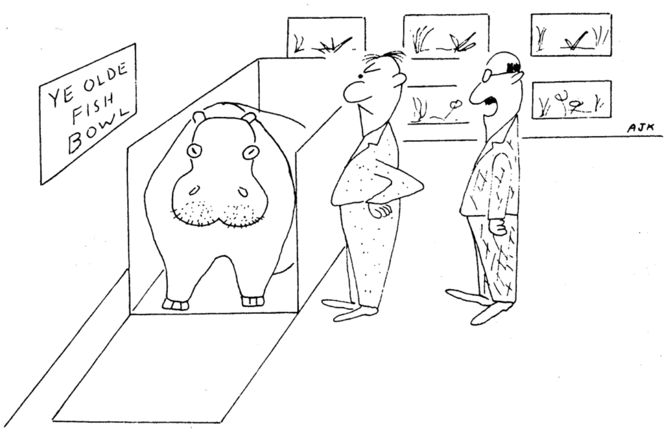
"There are other ways to register your complaints about the judging, Smedley!"



"Why yes, I just happen to have a piranha I can let you have cheap!"

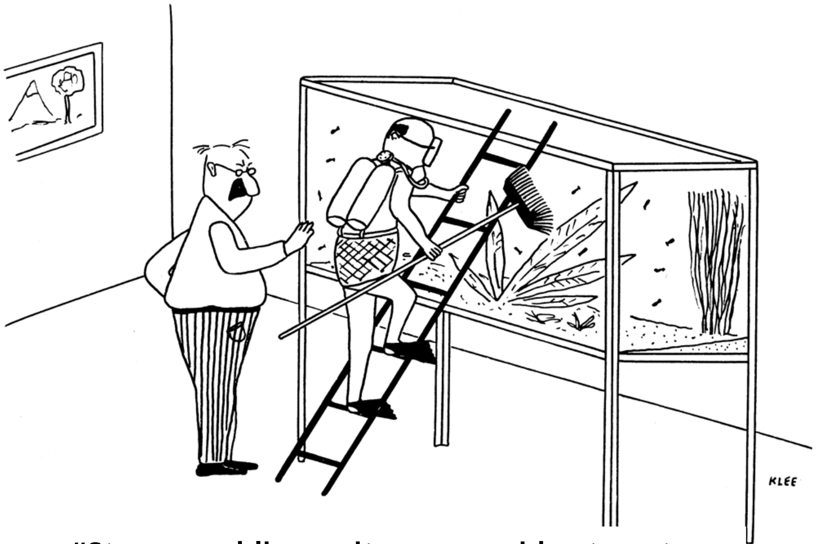


"I think I found the leak, Chief!"

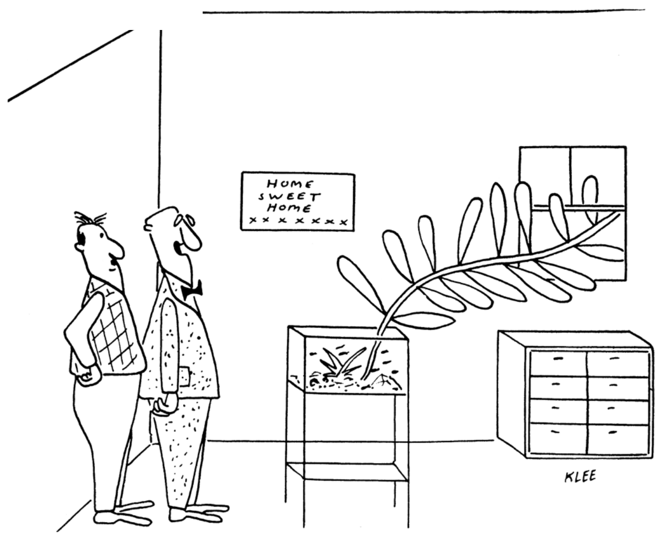


"I warned you about those !@#$%! Scientific names! The next time you order seahorses, don't ask for Hippocampus!"

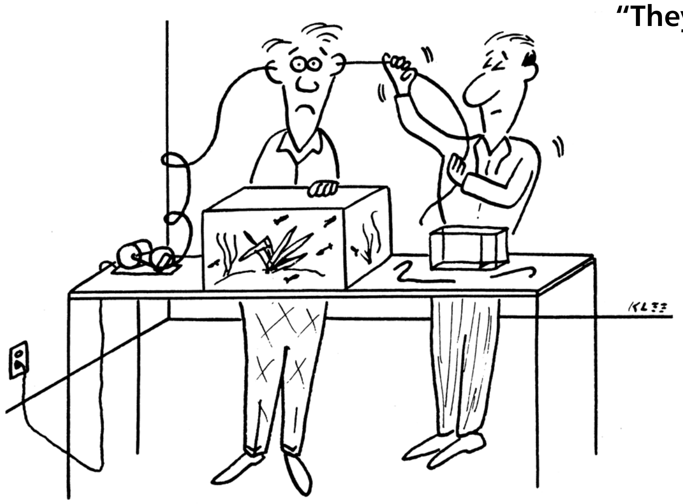
"And now we hear from our speaker who has just returned from a collecting trip in Viet Nam."



"Stop grumbling … it was your idea to get a 500-gallon tank!"



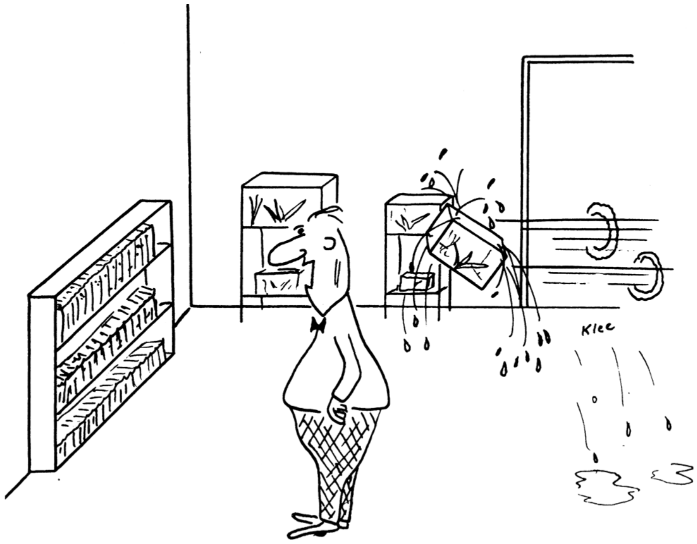
"They sold it to me as Giant Hygrophila!"



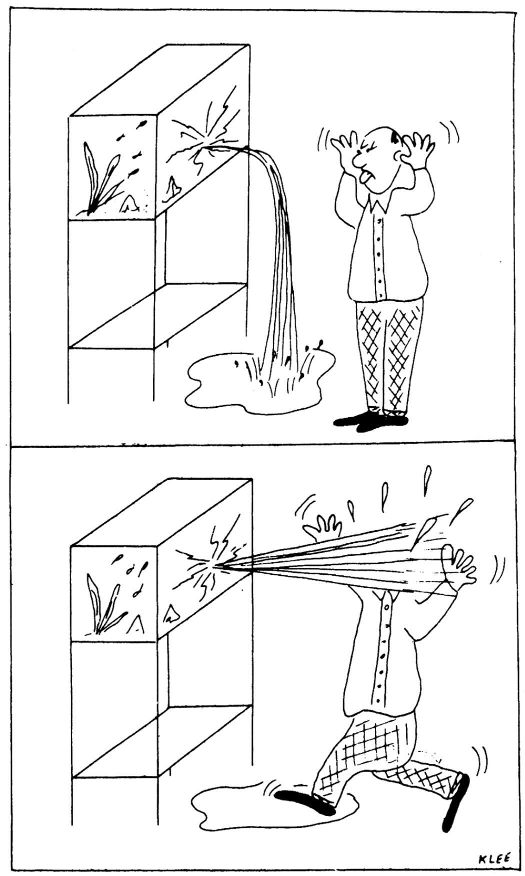
"Discus or no discus, next year we leave the fish home!"

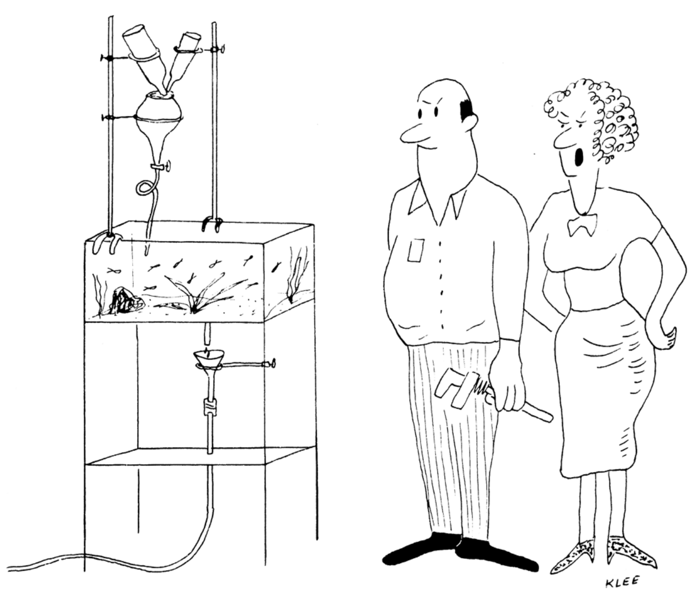
"I think that you're going to have to give up the hobby!"

"It's a cinch that there's more action going on in that tank than there is here!"



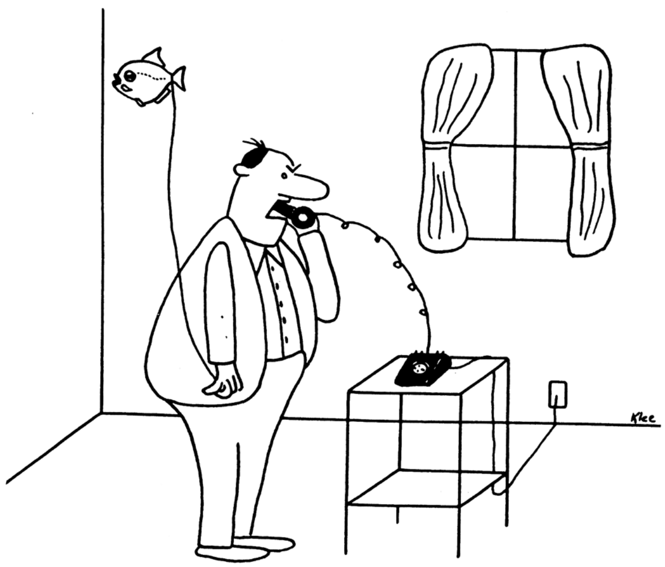
"Martha, if we get rid of this bookcase, I think we can fit in a couple of fifteens!"



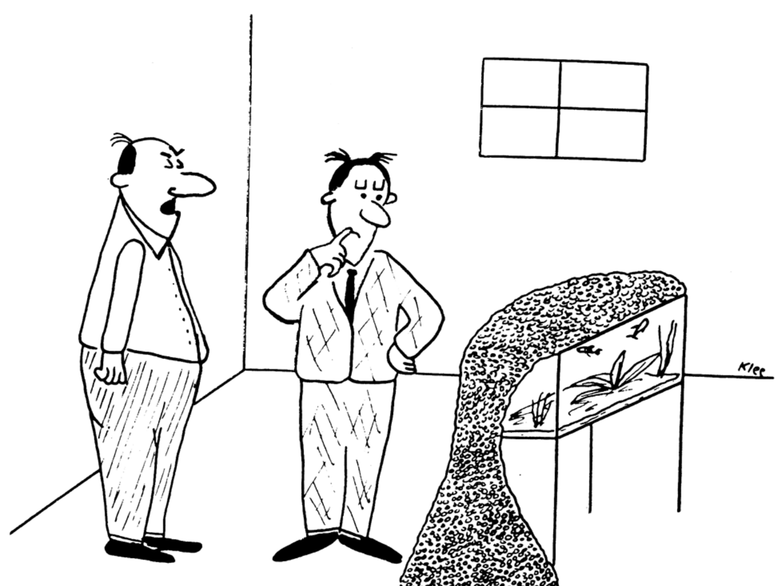


"Why don't you break down and buy yourself an automatic fish feeder?"

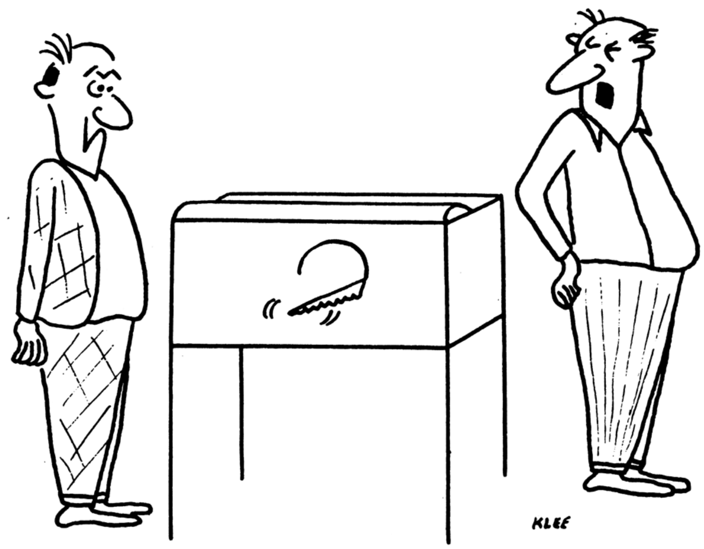
"You and your !@#$% climbing perch!"



"Say, Paul, what do you do for swimbladder disease?"

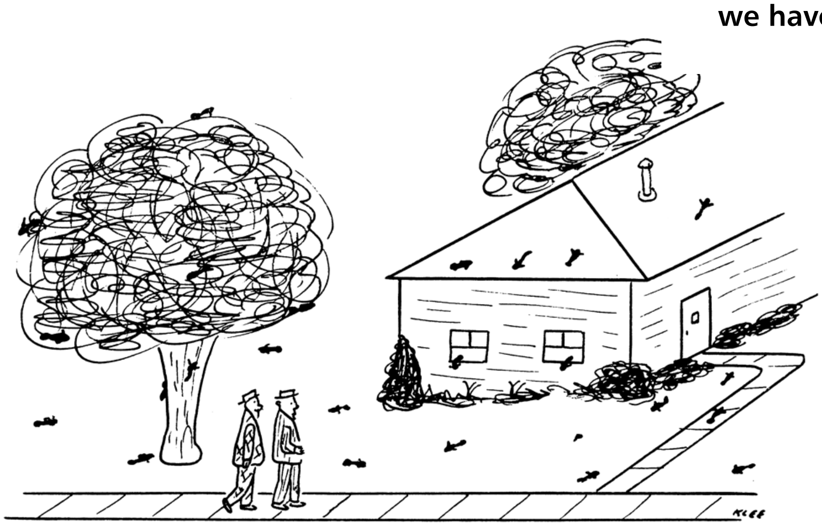


"Of course you know that bettas build bubblenests!"

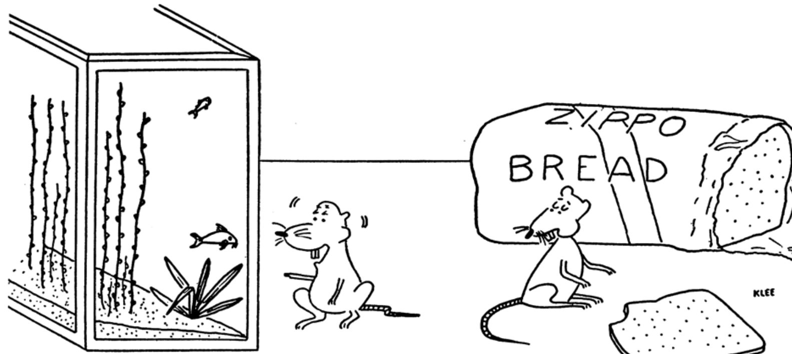


"I've got the only sawfish in Cincinnati!"?

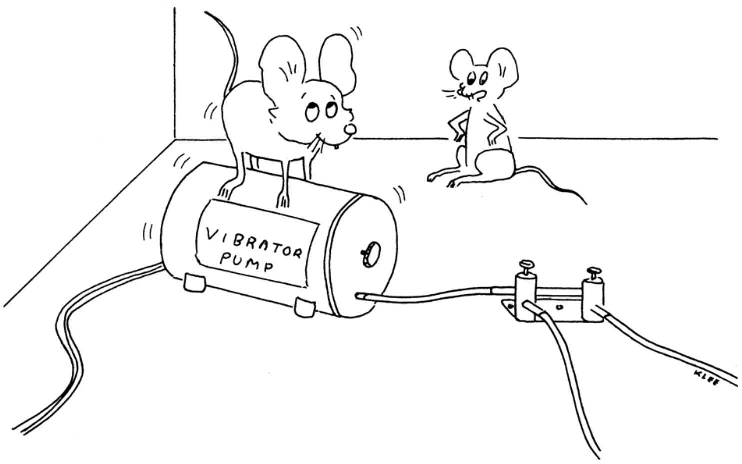
"Fan them? Do you mean to tell me that we have to fan these damn things?"



"I see Tyson's spawned his climbing perch again!"

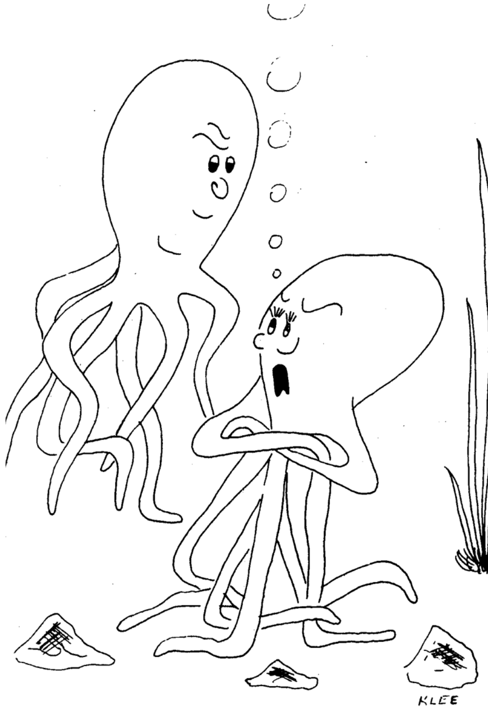


"Alright already! So it is a catfish! So what!"

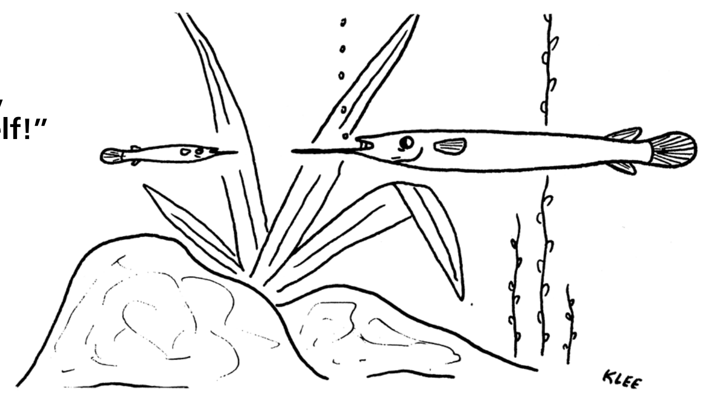


"Alright already! So it relaxes your poor tired feet!"

"Oh, Mr. Gridley, I could watch all night!"



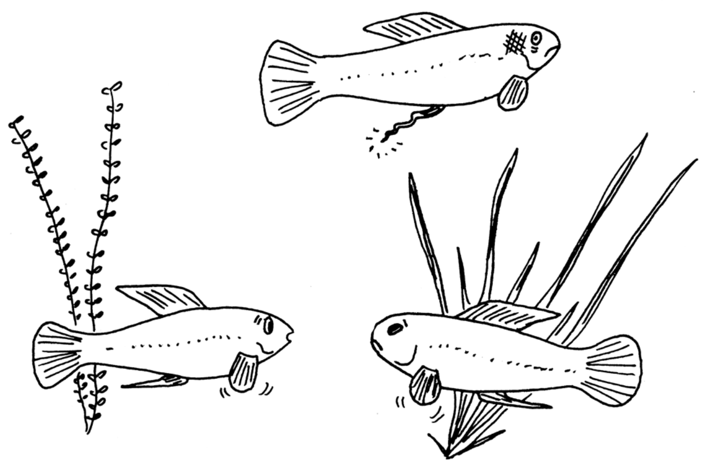
"I'm telling you for the last time,
Charlie – keep your hands to yourself!"



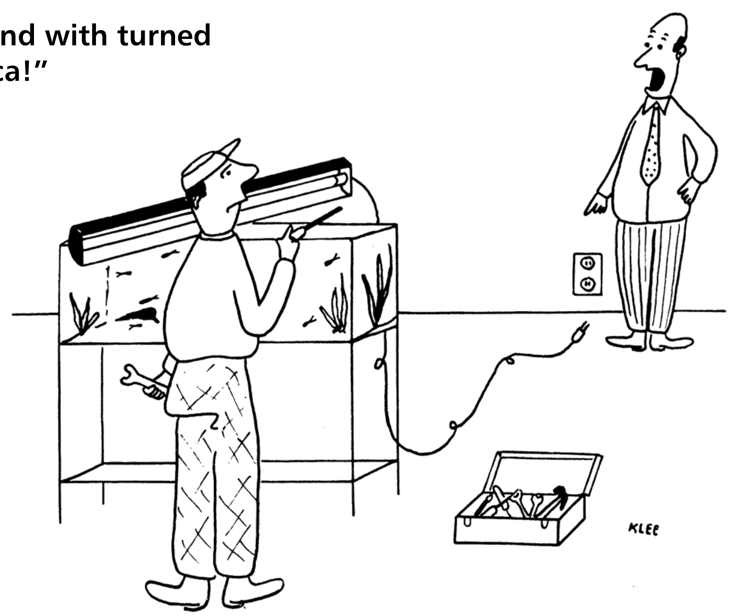
"Don't give me any of your lip, young man!"

"You have to hand it to old Gromley… he sure come up
with some authentic speakers for these conventions!"

"Quigley, I understand you've got an aquarium upstairs..."



"That babe Charlie was foolin' around with turned out to be a plastic replica!"



"I think I've found your 'short-circuit,' Simpson!"

LIST OF ARTICLES IN THIS VOLUME, CHRONOLOGICALLY BY MAGAZINE

THE AQUARIUM, Feature Articles

AQUARIUM JOURNAL, Feature Articles

ALL-PETS MAGAZINE, Feature Articles

1956

1957

1958

1959

AQUARIUM JOURNAL, Beginner's Corner

CARTOONS