Fig. 81. Enclosed Aqua-Terrarium, Awarded First Prize by the Triton Society

Tropical terraria, whether moist or dry, are heated artificially from below, the heating device being concealed in a false bottom. The heat may be applied either to a pan of sand or water or used in the form of a miniature hot-water heating system as indicated in figure 75 for heating tropical aquaria. The pipes are not carried over the top, but through or around the bottom.

The forms of terraria are quite diverse, according to requirements or fancy. Quite a number are divided into two halves, one side containing a shallow pool with tall bog plants, the other side being for dry terrestrial plants, the two sometimes being connected by a sloping ladder over the division, so that the animals may cross at will. The same arrangement is further developed into the aqua-terrarium by having the moist side in regular aquarium form and filling about two-thirds deep with water. Where tree frogs or other climbing animals are kept there should be a ladder or other arrangement to enable them to seek varying levels at different times, as this desire seems to be an important part of their nature. Tree frogs in some parts of the world are better known as "weather frogs." They are kept where they may either remain in water or climb to different levels at will, and are regarded as good barometers to foretell approaching weather conditions. Undoubtedly the state of the atmosphere has something to do with their movements in this respect.

Terraria for moths and insects usually have three sides of screen and one side of glass for clear observation.

Aqua-terraria may be considered a higher development of terraria, since their possibilities are so much enhanced on account of accommodating both terrestrial and aquatic animals and plants. One of the most interesting kinds is devoted to the observation of aquatic insects. These only contain a few inches of water, in which is planted bog plants, so that the leaves stand well out of water. Very few of the aquatic insects spend their entire lives in the water and some such provision is needed for them. It is important that stones or other creeping-out places be provided for turtles, frogs, newts and other amphibians, for it is a great cruelty to oblige them to remain constantly in the water.

Quite artistic effects can be obtained in the arrangement and planting of the terrarium and the aqua-terrarium. Natural bridges, lakes, waterfalls, archways, ledges, hollows, cliffs, caves, and other details may be used to good purpose, but care should be exercised not to combine the incongruous nor introduce objects out of keeping with the general scheme. Stones cemented together are capable of good pictorial effects. For moist terraria, pumice or other porous stone will be found useful, as it retains so much moisture and makes a good foothold for ferns and creeping plants.

An aqua-terrarium constructed for pictorial effect is made in the form of an ordinary aquarium with terrestrial plants arranged in the rear corners, thus giving the effect of a complete bit of landscape. The great possibilities of this treatment are shown in the illustration on page 122. This has the earth in slate containers reaching all the way to the bottom, but in a form devised later the soil is in cement pans 6 inches deep which are hung by hooks on the top edge of the aquarium proper, thus giving more light at the bottom of the aquarium.

Swamp aquaria have received little attention, although they can be made very picturesque, as will be seen in Fig. 82.

Plants. Most of the plants flourishing in greenhouses will prosper in the moist terrarium, so that the selection is very large. The dry terrarium is much more limited in this respect, the possibilities being confined practically to cacti, agaves, aloes, houseleeks and certain hardy ferns which have come from dry situations.

Planting. The main point in planting the terrarium is to procure proper drainage by the use of pebbles. Plants can be set either directly in soil above the pebbles or in pots. Fertilizer may be used in the lower part of soil but very sparingly in moist terraria. In planting it is well to keep in mind the natural surroundings of the animals and to provide, so far as possible, those conditions which are agreeable to their natures. For instance, the reptiles like to sun themselves in open, dry spots and in planting for them this can easily be arranged. Amphibious animals like to secrete themselves and hide from the light at times in thick vegetation, a provision easily made in the moist terrarium. These same considerations will present themselves when it comes to selecting a place for the terrarium. The snakes delight to sun themselves for hours, so in planting it is well to use only such plants that will stand plenty of direct sunlight. Terraria have one important advantage over aquaria in that at least the smaller sizes may be shifted from one place to another with very little effort, so that light conditions may be changed at will and hours of sunshine increased as opportunity offers.

Occupants for Terraria. The large majority of cold-blooded animals of suitable sizes may be introduced. In the moist terrarium the principal animals used are young alligators, newts, salamanders, tadpoles, frogs, water snakes, turtles, aquatic insects and their larvæ. For the dry terrarium we have tree toads, hop toads, horned toads, beetles, spiders, lizards, chameleons, tortoises, snakes, butterflies, moths and other insects.

Feeding in the Terrarium. The different occupants of the terrarium naturally require a varying range of foods. Those containing chameleons, frogs, toads, tree toads, do well on flies. It is a good plan to have a fly trap which can be emptied into the terrarium. It is quite an amusing thing to see the animals waiting for the flys to emerge after they have learned that they are fed in this manner. The dexterity with which they are caught and eaten is a never-ending marvel. While these animals can live on little, they ought to be well fed in warm weather, giving them

FIG. 82 SWAMP AQUARIUM

once daily all the flies they can consume which will be found to be a considerable number. In winter when flies are scarce they may be fed on meal worms and meal bugs, which are easily cultivated in bran flour, once a small stock is started. Particular care should be taken not to allow any of the meal breeding stock to escape into the house, as it is liable to become a pest in the kitchen.

Newts and salamanders are fed on bits of meat, fish, oysters, fish eggs and worms.

Snakes and lizards require large and small insects, worms, small live fish and animals.

Alligators and carnivorous turtles want live fish, tadpoles, crayfish, small animals. In the absence of living food they can sometimes be induced to take chopped oysters, fish, etc.

Box tortoises and land turtles are largely vegetarians and should be supplied with berries, garden vegetables, mushrooms, cooked cereals, snails and worms.

As with the aquarium, particular care should be exercised not to allow any excess of food which is liable to decay, all such surplus being removed immediately after the feeding hour.

Chapter Eleven

Fishfoods

PREPARED FISHFOODS

Nearly all aquarium fishes naturally desire a variety of foods, and the nearer we can approximate Nature in this matter, the better will be our results. Whatever foods we employ we should always keep in mind the necessary balance of vegetable, animal and mineral content required. One of the poorest fishfoods obtainable is the white wafer usually sold in pet shops and drug stores. Of recent years many better foods have been placed on the market, most pet stores keeping at least one of them. They are granular in form, usually of a dark color and are composed of a mixture of dried insects, meat, fish roe, flour, codfish and other ingredients. Unless one needs a large quantity of fishfood it is better to purchase a prepared article of the sort described.

An extremely good fishfood is puppy biscuit broken up and ground in a coffee mill to small sizes. This is cheaper than regular fishfood and is very satisfactory. It is used as a base by some manufacturers to add a few ingredients to and then place it on the market under their own label.

A food used with considerable success is oatmeal prepared exactly as it comes to the breakfast table, containing the same amount of salt. This is especially recommended for feeding young fish when daphnia have become scarce. The shape of a fish is permanently influenced by its body development in the first few months, and different methods of feeding produce, to a certain extent, different shapes. The effect of oatmeal, fed plentifully, is to build the short, round body so generally desired. For fish under ten weeks old the oatmeal should be squeezed through cheesecloth to take out the kernels. Let the young fish have as much as they can eat all day, but let none remain over night. This does not apply to fish in their second year or over, although oatmeal in much smaller quantity is good for them also. Large fish may be allowed to eat uncooked rolled oats.

An improvement on boiled oatmeal is secured by adding a moderate portion of powdered shrimp, dried fish roe or powdered shredded codfish. For preparation of these ingredients see page 129.

A cereal known as Cream of Barley when cooked is a good fishfood and may be used in conjunction with oatmeal.

Dried bread crumbs make good food for goldfishes, especially if Graham or whole wheat bread is used.

In feeding any kind of dried granular food it is best to use small sizes. Water causes the grains to swell considerably. This sometimes

produces indigestion when the food swells after being swallowed. Many fanciers in Germany scald food just before feeding, which is no doubt a good practise.

For those wishing to make a general fishfood suitable for all except strictly carnivorous fishes, the following recipe will be found to be very good:

Quarter tumbler powdered cod
Half tumbler powdered liver
Three-quarters tumbler powdered shrimp
Three tumblers flour
One teaspoonful Epsom salts
Three teaspoonfuls baking powder
Three teaspoonfuls powdered chalk

Add two raw eggs and sufficient water to make the mixture into the usual consistency of bread dough. Place in pan and bake in oven. When properly baked allow to cool and cut into thin slices. After thoroughly drying grind in coffee mill and sift into desired sizes. *Keep all dry fishfoods well secured in bottles or other actually tight receptacles.* Moths and other insects gain a foothold and soon turn the food into a mass of worms and refuse.

In above recipe the cod is prepared by purchasing a package of shredded cod, drying over slow fire and grinding fine in coffee mill. The liver should be parboiled, cut into thin strips, dried and ground. Dried shrimp may be had at Chinese grocery stores. It needs to be broken in pieces, put through a coarse setting of the mill, then well dried for a few days and lastly ground fine.

Whole wheat flour is preferable to white flour.

Powdered cuttlebone or eggshell may be used instead of chalk.

Those desiring to experiment on a food according to their own ideas of ingredients and proportions may safely use any of the following items, in addition to those already mentioned: Pea flour, rice flour, rye flour, vermicelli, boiled fish, boiled yellow of egg, fine corn meal, ant eggs, chopped earthworms, water crackers, dried bread, chopped meal worms, dried and powdered lettuce leaves, dried fish roe and dried daphnia. In preparing the latter two ingredients they should be parboiled with a moderate amount of salt, then placed in cheesecloth; water squeezed out, spread out thin on tin plates and dried quickly in the sun or slow oven. The drying must be thorough and quick. In drying it will be found that the shrinkage in volume will be very great. It should, therefore, be remembered that these ingredients are highly concentrated and be used accordingly.

When fish have been without fresh or living food for some time it is well to occasionally give them a small quantity of scraped raw beef (scraped crosswise to grain) or the dark, soft part of oysters, chopped and slightly rinsed. Fresh shrimp, obtainable in most fish markets in Winter, if passed through a fine meat chopper, makes an excellent change of diet.

LIVING FISHFOODS

Living fishfoods are divided mainly into larvæ and crustacea, the latter on the whole being the more important and the more generally

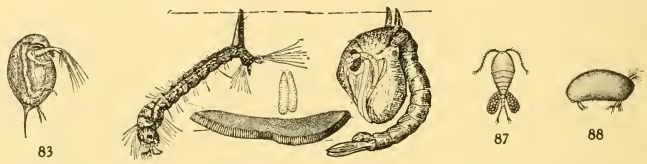


Fig. 83. Daphnia (*Greatly enlarged*)
Fig. 84. Mosquito Larva (*Greatly enlarged*)
Fig. 85. Egg Raft and Individual Eggs (*Greatly enlarged*)
Fig. 86. Pupa Before Transforming to Mosquito (*Greatly enlarged*)
Fig. 87. Cyclops (*Greatly enlarged*)
Fig. 88. Cypris (*Greatly enlarged*)

obtainable. Those which are of practical value to the breeder of fancy aquarium fishes are few in number. Like the insect enemies of fishes, four is the number of really important kinds.

Daphnia. Undoubtedly the best food for aquarium fishes is living daphnia and this should be used at all times in preference to prepared foods if obtainable. The fish will consume great quantities of these crustaceans without suffering the usual effects of being overfed. A certain degree of care must be exercised not to place so much daphnia into the aquarium as to suffocate the fish. Daphnia breathe the free oxygen in water the same as do fish and therefore too many will soon exhaust oxygen from water. The fish will die of suffocation sooner than the daphnia. Many fanciers have lost fish in this way. A good practise is to give the fish all they can eat in about a quarter of an hour and still leave some few daphnia swimming about.

A popular name for daphnia is "ditch fleas." This will give a key to their appearance, as they are approximately the size and shape of a flea, except that they have two rather long, branched swimming arms which are always in motion and which gives the animal a sort of hopping motion through the water. Without this perpetual swimming the daphnia

would sink to the bottom, as they are heavier than water and have no air bladder. A greatly magnified illustration is shown in Fig. 83.

Daphnia (incorrectly pronounced "daffney") are known among fish breeders as "insects," but they are really not such, being perfect fresh-water crustaceans as much as a crayfish. The shell though soft contains mineral elements which are very desirable, while the flesh itself is easily digested and nutritious. This little creature is found nearly all over the world, principally in still pools where there are no fish. For the practical purpose of catching daphnia in sufficient quantities to feed fish the collector should hunt pools in which there is considerable animal or vegetable decomposition in process. This decomposition favors the growth of infusoria, small members of the animal kingdom on which daphnia feed. Such conditions are found to perfection in the pools on the grounds where city refuse is dumped. When the conditions are favorable the daphnia rise to the surface in such quantities as to color the water, the usual color being a rusty red. The color varies from this to olive and gray. Fish breeders like to see the daphnia as bright a red as possible, although it is an open question as to whether the red ones are better food. The same individuals will alternate in color, probably due to a difference in food. Usually these crustaceans are not so plentiful as to color the water and we have to use our eyes more closely to locate them. The collector should provide himself with a cheesecloth net about 12 inches in diameter and 15 inches deep, fastened on a pole or jointed handle not less than 6 feet long. If an examination of the water does not at first reveal any daphnia, the net should be tried anyhow, using a gentle stirring motion back and forth, to stir up the bottom water. Daphnia have very peculiar habits and one can never tell from day to day just how they are to be found, so that the collector will always have to depend somewhat on his own resources. If an examination of the net after dipping for a few minutes shows nothing, try elsewhere. If a colony has been located do not take too many into the net at one time, as the weight of the top ones crushes those beneath. A mass that would bulk about equivalent to an orange should not be exceeded. Reverse the net into carrying pail and repeat until the water is thick with daphnia. In cool weather the pail may be carried in this crowded condition for about an hour. If the day is hot, a piece of ice should be added to the water—enough to keep temperature down until home is reached. Newspaper wrapped about the can helps the ice melt more slowly. As soon as home is reached, add fresh water to the pail and transfer the daphnia to tubs or tanks kept for the purpose. Like fish, the water they are in should have as much air surface as possible. Do not try to keep too many in stock, as overcrowding suffocates a number and these in turn decomposing kill the living ones. The cooler they are kept, the longer

they will last. In hot weather they can be kept about three days and in October about two weeks.

A method of carrying live food which is growing in favor is to crate them (without water) in layers in a box. Frames about 10 x 12 inches, made of ⅞-inch square wood, are covered on one side with cheesecloth. These are floated in the water, the daphnia dropped in, spread out evenly and placed in carrying box which, of course, needs to be airtight. The number of layers are only limited by the depth of the box. Daphnia may be spread to a depth of about ¼ inch, but mosquito larvæ may be piled to ½ inch without injury.

In transferring from carrying pails to stock tanks it is well to first pour in small portions to a white enamel basin which enables one to carefully go over the catch and remove any insect enemies. (See page 156.) If the daphnia are too thick to be readily examined, some water should be added. A little care in keeping out the enemies at the start is energy well invested. Most of the enemies and the dirt may be sifted out (under water) by using a screen just large enough for the daphnia to pass through.

A beginner will do well to make the acquaintance of an experienced daphnia collector and go along with him on a trip. There are now aquarium societies in many of the large cities, part of their activities being the dissemination of such knowledge. All those interested in aquaria should have either active or corresponding membership in one of these organizations. If return stamps are enclosed the publishers of this work will always be glad to put the beginner in touch with the nearest society.

All beginners seem to have the idea that sufficient daphnia can be raised in a tub or trough to feed with. This has been tried many times but never with any degree of success. If the daphnia pools are too far distant to make collecting practicable it is best to try to inoculate some suitable pond nearby, but there should be no fish in the pond. Daphnia if not crowded may be shipped quite a distance. There are several Philadelphia collectors constantly making shipments in season.

The practical way to raise daphnia for food purposes is described in the chapter on Wholesale Breeding (page 62).

Cyclops. Wherever Daphnia are found, Cyclops is pretty sure to be, and also in a great many places where the former does not exist. They are crustacea of about the same size and color as Daphnia, but under close examination are of entirely different structure and also of different action, going rapidly through the water in straight lines with a jumping movement. Like Daphnia they are divided into many species and are

practically worldwide in distribution. The two tabs seen near the lower portion of the illustration are the egg-pouches of the female. These develop in warm weather every two days, become detached and fall to the bottom with 16 to 32 eggs which arrive at maturity in 30 days. They are called Cyclops because, like the giant of mythology, they have but one eye.

Mosquito Larvæ. These are often known as wrigglers and are familiar to those who have looked in rain barrels. Their bodies are straight and about a quarter of an inch long. They rest at an angle to the surface of the water as shown in Fig. 84, with head down, and are always ready to "wriggle" to the bottom at the first sign of danger. From midsummer on they may be found in still water where there are no fish. They are taken in the same manner as daphnia, except that one has to get them with a quick sweep before they can get down into the water. They can usually be seen floating together in black masses. The city entomologist anywhere will give information as to where they may be obtained and will be glad to have his burdens lightened by the fish breeder.

Mosquito Larvæ may be termed a special food. It can only be had in large quantities towards the middle and end of Summer, and is only suited to the fish large enough to easily swallow it. As a food for putting growth on fish an inch long or over it has no equal. The main drawback to these larvæ is that those not eaten quickly by the fish are liable to turn to mosquitoes. This difficulty can be discounted by proper management. Keep the stock of larvæ in a tank covered by a sheet of glass, leaving about two inches at one end not covered. Over this open space place a piece of mosquito netting, drawing it up several inches over the opening into a sort of inverted bag. Then draw a string around top edge of tank to fasten netting down. As the mosquitoes hatch they will fly upward into the netting bag, where they may be killed before lifting the lid to get larvæ for the fish. The larvæ should be kept out of the sun and as cool as possible so as to retard hatching. They will stand great crowding, their only requirement being that there is room for them all to get to the surface at one time, for they breathe air. This is one advantage in placing larvæ with fish, for, unlike daphnia, they extract no oxygen from the water. By feeding them to the fish we not only do well for the fish, but serve the interests of humanity by cutting down the mosquito pest. In open pools goldfishes are one of the best agents in keeping the neighborhood free of mosquitoes. Unfortunately the mosquito larvæ can live and hatch in temporary pools and in water too foul for any fish to survive in.

Cypris. Incorrectly known as "hardshell daphnia," Cypris forms an important article of fish diet. These crustacea inhabit stagnant pools, particularly those well stocked with decomposing vegetal matter. Although capable of swimming freely they are more apt to remain close to the bottom, but more especially to decaying wood. They are of a dull, purplish black color about twice the size of an ordinary pin-head. Inexperienced observers frequently mistake them for Daphnia. Fishes do not appear to be quite so fond of them as of Daphnia but they are a good second choice. They are extremely hardy and will withstand dense overcrowding in the foulest of water. Under favorable conditions Cypris multiplies with astounding rapidity. They have been known to attack newly hatched fishes.

Blood Worms. In freshwater pools nearly everywhere can be found deep-red, jointed worms about half an inch long. See figure 89. They usually stay at the bottom, living chiefly on decomposing vegetal matter. Often they will writhe their way awkwardly through the water in

FIG. 89. BLOODWORM (*Larva of Chironomus*) (*Enlarged four times*)

a series of figure eights. They are the larvæ of midges and form an important article of diet for our native fishes. They are often found in large numbers in daphnia pools and should always be taken when possible. If too large for the young fish, they make choice morsels for the older ones.

Tubifex Worms. These are small thread-like worms living in mud and sand. They form a tube or case below the surface, extending the upper ends of their bodies from this in search of small organic food, causing a circulation of water about themselves by a constant weaving

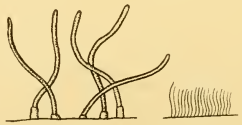


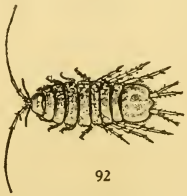
FIG. 90. TUBIFEX WORMS MAGNIFIED AND AS THE ENDS APPEAR ABOVE THE BOTTOM

motion. When alarmed they draw back into the case. They are extensively cultivated in Europe as a food for tropical fishes. A similar variety is often introduced into goldfish aquaria when feeding daphnia, where they become an unsightly nuisance, for goldfishes do not eat them. To

get rid of them it is necessary to boil or renew the sand or else keep other fishes in the aquarium for a long time. The worms have to be eaten off many times before the stock dies. Germicides strong enough to kill them will also destroy the plants, as they can withdraw into the sand. Along the edges of ditches they are often so numerous as to make a solid rusty red color. If they are scraped up together with the dirt and then washed free they are greatly enjoyed by small tropical fishes.

Fairy Shrimp (*Gammarus*). While freshwater shrimp is not plentiful enough anywhere to feed in large quantities, it is a delicate morsel for grown fishes and should be taken as opportunity offers. They are found principally in small streams, under stones and around decaying wood. Placed in a large aquarium or tank with plenty of vegetation they will multiply rapidly.

91



92

Fig. 91. Fairy Shrimp (*Enlarged 3 times*)
Fig. 92. Water-Asel (*Enlarged 3 times*)

Water-Asel (*Asellopus*) is found in still or slowly moving water, usually in the mud or clinging to vegetation. It cannot move rapidly like Fairy Shrimp, but both are enemies of very small fry and both are greedily taken as food by larger aquarium fishes, although the shrimp move so rapidly that highly developed fishes have trouble in catching them.

Fig. 93
Asplanchnopus myrmelco

Fig. 94
Pterodina patina

Fig. 95
Noteus quadracornis

Three Typical Rotifiers (*Greatly magnified*)

Infusoria and Rotifera. Of prime importance as food for very small fishes are the Infusoria and other microscopic creatures of still water. Some idea of their minuteness may be had when it is pointed out that they are the natural food of Daphnia, Cyclops and other small crustaceans. All except the very largest of the infusorians will pass through ordinary cheesecloth nets, but silk bolting-cloth of fine texture will hold those

which are large enough to be of real use. Further information on this point is contained on page 140. Other infusoria are shown in Fig. 96.

Enchytrae. These are thread-like small white worms usually bred in winter as a substitute for daphnia for feeding to tropical fishes. Goldfishes are also very fond of them, but it is a difficult matter to cultivate a sufficiently large quantity to satisfy the appetite of several goldfish. For some of the smaller fishes requiring living food they are almost indispensable in winter.

The culture of these worms is quite easy and requires very little attention after the start is made. Many of the dealers and fanciers in New York and vicinity have a stock of enchytrae, from whom a stock can be procured. These are placed in ordinary garden soil from which all worms and larvae have been carefully removed. Wooden or earthenware boxes about 15 inches long, 7 inches wide and six inches deep may be filled with the earth to a depth of 4 inches. A cover glass must be provided, this setting directly on the soil. Proper feeding is the principal keynote to success. They like milk, white bread, boiled potato, cheese rinds, etc. In a box of this size, four or five small holes are dug out with a spoon, the food placed therein and the earth replaced. This is done as often as the food is consumed and in three or four weeks the harvest of worms will be ready. Care should be taken not to overfeed, as this will sour the soil. The soil should be removed from the box about every two weeks, broken up, loosened and returned. This is considerably facilitated if about half the soil is composed of leaf mold. The breeding box does best in an average temperature of about 60 degrees Fahrenheit.

The worms are separated from the earth in a number of ways. If but a few are desired the simplest way is to remove two or three spoons full of soil and place same in water just deep enough to cover. In a very short time the worms will come out of the soil and entangle themselves in a bunch near the surface of the water, when they may easily be collected.

Another much quicker method is to take a piece of cardboard (the cover of a shoe-box answers nicely) spreading a quantity of soil thereon and holding over a heat; this soon causes the worms to crawl to the top of the earth, from which they are removed. However, great care must be exercised that they are not injured by the heat, which would destroy them, for the fish prefer the live worms at all times. As soon as they appear and bunch on the surface of the earth, the heat should be removed.

Another method of separating the worms from soil is to place a portion of the earth in an enameled dish, pouring sufficient water over same to cover and placing thereupon a sheet of glass, which should rest above and free from the moist earth. Because this will prevent sufficient

oxygen from penetrating the dirt or water, the Enchytrae will promptly leave the soil, crawl up the sides of the dish and on the underside of the glass cover, clinging to same in a variety of entanglements. The cover can then be removed and the worms washed or scraped off and fed to the fish. This of course is a slow process, but by preparing an hour or so before it is desired to obtain same, an ample supply may be procured.

It is not advisable to feed all of the worms thus obtained as when a considerable number are placed in a tank at a single time, some are bound to escape from the bunch and, burying themselves in the gravel or sand, die and pollute the water. It is said that they can exist under water for about forty-eight hours and it has been noted that the larger specimens are usually the first to succumb.

Still another way to remove them from the soil is to take a section of blotting paper, placing the earth on it, and in a short time it will be noticed that they will have gathered in a ring around the outer edge of the soil, free from the dirt.

Chapter Twelve

The Microscope In Aquarium Work

THE MICROSCOPE IN AQUARIUM WORK

Aquarium work in general and fish breeding in particular can be made both more interesting and more successful by the use of a microscope. For most purposes a very cheap instrument is satisfactory. In fact, a low power lens is preferable to a high in examining water for infusorian food.

All aquaria contain various beautiful and highly interesting forms of microscopic life, some harmful, some negative, but mostly beneficial to fishes. The constant changing of varieties and quantities presents a vast field for new study, but we are here mostly concerned with the practical points of raising young fish. On page 135 we refer to the use of infusoria as food for young fish. To determine the presence of this food, touch the tip of the finger lightly to the surface of the water, preferably to the side nearest the source of light. This is because they are mostly at the surface and they seek the light. Place this drop on a glass slide and observe under a good magnifying glass or a low power microscope. The latter is rather preferable, as the focus can be changed as required, and it is fitted with a mirror to facilitate observation. In the absence of a microscope the small pocket folding lens known as a "thread counter" will do. This costs about twenty-five cents. In using this the frame of the counter should be laid directly on the glass containing the drop of water, and the whole placed over a mirror held at the proper angle to reflect light upwards, but too strong a light should not be used. A little experimenting will soon show the best light to work by.

The creatures which are of value as food to newly hatched fishes are generally of a size just too small to be detected by the naked eye, or at most they look like specks of dust. At the same time they are plainly observable under a good magnifying glass or low-power microscope. There is a great deal of life in the water of a smaller size than will be shown in this way and which probably has no food value to fishes. The high-power microscope would show many of these organisms and thus be apt to deceive the observer as to the actual food value contained in the water. Also with high magnification the field of vision and the area of sharp focus are smaller, while movements are apparently much more rapid, making observation difficult.

The majority of the valuable organisms are rotifers. These move in a steady, revolving or rotating manner. On page 57 will be found instructions for propagating these organisms for purposes of feeding young fish. Most rotifers can be readily identified as such because they

swim through the water by means of circlets of hairs or cilia arising from the front of their heads, by the vibratile action of which they swim and disport themselves through the water. In fact, rotifers derive their name from the wheel-like appearance produced by the motion of the circlets of cilia while feeding and swimming. For culture water to have practical food value a single drop should contain at least half a dozen living objects that can be seen in the manner suggested. Water rich in life will show rotifers so thickly that they almost touch one another—probably two hundred in a small drop. In taking water from the culture tank to feed the fish it should be skimmed from the surface,

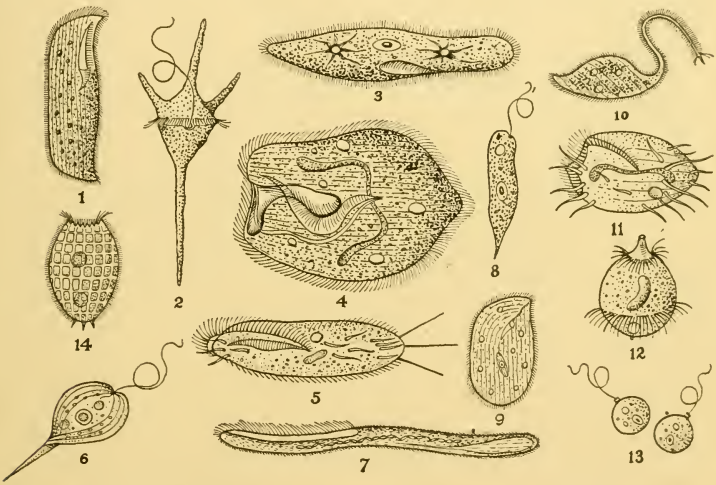


FIG. 96. COMMON FORMS OF MICROSCOPIC ANIMAL LIFE IN FRESHWATER (*Greatly magnified*)

1. LOXODES, a very common form.
2. CERATIUM, a very common form, especially in ponds and lakes.
3. PARAMAECIUM, a very common form, the slipper animalcule.
4. BURSARIA, a very common form, one of the largest.
5. STYLONYCHA, a very common form, found everywhere.
6. PHACUS, not so common as the above numbers.
7. SPIROSTOMUM, common everywhere.
8. EUGLENA, common everywhere.
9. CHILODON, common everywhere.
10. TRACHELOCERCA, common everywhere, the swan animalcule.
11. EUPOLOTES, not an aquarium in America without examples.
12. DIDINIUM, predacous, feeds on paramaecium and others.
13. TRACHELOCERCA, small but plentiful.
14. COLEPS, the barrel animalcule, common.

or the animals extracted from the water by a plankton net, which is nothing more than a small net of the finest bolting cloth.

Besides the examination of water for living food there are many other interesting possibilities for the microscope in aquarium work. Diseases, the development of eggs, plant structure, algae, the structure of daphnia, cyclops and other crustacean foods are a few of the subjects which may be taken up with profitable interest.

A study of the microscopic world within the aquarium will prove a most fascinating pursuit. Good microscopes for the purpose can be purchased very cheaply now compared with former prices. An instrument equipped with a 24 m. m. (1 inch) objective and a times 5 or 6 eyepiece will show everything needed, giving a magnification of 60 diameters.

Those wishing to explore this field a little further will find the following works to be helpful: "Aquatic Microscopy for Beginners," by Stokes; "Marvels of Pond Life," by Slack; "Evenings at the Microscope," by Gosse.

Chapter Thirteen

Diseases of Aquarium Fishes and Their Treatment

DISEASES AND AILMENTS OF AQUARIUM FISHES AND THEIR TREATMENT

Even in a state of Nature fishes are sometimes attacked by disease and parasitic enemies. It is little wonder, then, that aquarium fishes, weakened by inbreeding and kept under artificial conditions should be subject to a number of maladies. The wonder is that the majority of the diseases can be so successfully treated, under the circumstances.

Half the battle is won by taking the trouble in time. The aquarist should always be on the alert to detect when his pets are a little out of condition. As elsewhere stated, this is shown by listless movements, loss of appetite, drooping dorsal fin (when the fish is in the habit of holding it erect), congested or frayed fins, white slime on body and bubbles in excrement. When a fish is even suspected of being in doubtful condition it should be observed carefully for a day or two, and, if improvement is not noted, given the required treatment—*promptly*.

Affected fishes should be immediately removed from their fellows. There is always the possibility that they are suffering from a contagious disease which may quickly spread. Great care should be exercised not to use the same nets in handling sick and well fishes unless they are sterilized after exposure to disease germs.

Salt Treatment. In Nature the sick fish seeks brackish water or saline earths, and we cannot do better than to follow this hint. Most of the disease-producing bacteria of fresh water are unable to live in moderate salt solutions. The point, then, is to find the strength of solution that will kill the bacteria without injuring he fish. As the salt treatment is the main one for curable diseases, we shall go into this at some length.

Kind of Salt. Ordinary table salt is likely to contain chemicals to prevent caking in damp weather. These are injurious to fishes. However, if no other salt is obtainable, this can be made to do. The very best medicine is real sea water, properly diluted. The next best is Turk's Island salt, which is the residue from evaporated sea water. Where the fish shows a tendency to constipation, one-quarter of the salt content may be Epsom salts. Some writers recommend this addition in all cases.

Strength of Salt Solution. Common practice among the uninformed is to throw a sick fish into a strong brine solution, leaving it there a few minutes until it shows signs of expiring. This treatment is usually

better than none at all, but is unnecessarily severe and is not so successful as milder solutions. In fact, the strong salt takes the protective slime off the fish and leaves it in a condition where it is liable to be quickly again infected, and in a weakened condition where treatment is not likely to again be effectual. The usual practice of the author is to make a solution in which salt is just easily discernable to the taste. As the sense of taste varies in individuals, this is not a very accurate rule to give others. A suitable proportion is one ounce of salt (approximately two heaping teaspoonfuls) to each gallon of water.

Methods of Treatment. Nearly all sick fishes do best in shallow water and out of bright light. An enamel tray four inches deep by twenty inches square is very good, or a well-seasoned tub filled to a few inches is suitable. In placing the patient in the medicated water, see that there is no considerable change in temperature. In warm weather a change to very slightly cooler water is stimulating and probably does no harm. Except for the air-breathing species (Paradise fish, etc.) a change to several degrees warmer water is liable to produce suffocation, warm water holding less free oxygen than cool. Aquarium fishes can live indefinitely in the solution described, but in two days a salt solution begins to smell stale and needs to be changed. A daily change is better. Should the patient not show signs of improvement in four days, gradually increase the strength of salt solution for two or three days until it is up to two ounces (four heaping teaspoonfuls) to each gallon of water. After remaining in this for two days the salt proportion is slowly weakened down again to the first formula.

Ammonia Treatment. A popular treatment among European fish culturists for fungoid diseases is the ammonia method. This has not been generally accepted in the United States, but has been tried with remarkable success in some instances where other treatments have failed. We feel, however, that it should only be tried as a last resort. To one gallon of clean water add ten drops of ordinary household ammonia. (Unfortunately, this varies somewhat in strength.) Place the fish in this for five minutes, but take out sooner, should it turn over. Remove to plain water and then back to its tank. The treatment may be repeated at intervals of three days if necessary.

Special Attention. All fish should, if possible, be placed, after any chemical treatment, in a healthy tank containing green water. Sometimes this is, indeed, the only treatment required.

Another very good after-treatment which may be used in summer is to place the hospital tank under a small stream or drip. In making the

final change from salt back to fresh water, this is a very good way to accomplish it. Dripping water may do all that is necessary, especially if a fish is only on the doubtful line, which is more often the case than not.

Summer offers one more treatment when all others fail—place the affected fish in a shallow mud-bottom tank or pool. This is especially beneficial to goldfishes.

In winter when a skilled aquarist finds a fish a little out of condition, but with apparently nothing radically wrong, his first treatment is to remove the fish to another tank if he has one available. This often has the stimulating effect of a change of climate and usually wards off more serious trouble that might be developing. *As with ourselves and all animals, it is much better to cure an ailment, if possible, by improved conditions, rather than by recourse to drugs or chemicals.*

In treating sick goldfishes it is important to give some attention to temperature, especially in winter. Best results can be had at about 68°, which is a little warmer than fishes are usually kept in the cool season.

Another point to bear in mind for those having air-pumps, is that in the majority of ailments a cure is accelerated by a gentle flow of air liberated in the hospital tank, but not agitating the water enough to worry the fish. If no pump is at hand an occasional spraying is of value.

The foregoing is general in character but will be found useful in most of the diseases that can be cured. We will now deal specifically with the diseases and ailments.

Fin Congestion. This is the commonest of all fish troubles, and is especially liable to attack the highly developed fins of fancy goldfishes. Their long fins are no doubt deficient in circulation, causing low powers of resistance. As soon as the fish is slightly indisposed through overfeeding, sudden chill, protracted low temperature or other causes, fin congestion is usually the first symptom. The fins of fancy goldfishes may be considered very good barometers of the condition of the fish. The appearance produced is well indicated by the name. The fins are more or less red and streaked with veins. In advanced cases the fins commence to split and fray, particularly the tails.

Treatment. Fin congestion, as well as being the commonest of goldfish diseases, is also the most easily cured. The salt-water treatment described on page 144 is without a superior. When the trouble is confined to the tail, it may be dipped in a 10-per cent. solution of peroxide of hydrogen. Another method is to paint the fish with coal oil, keeping the head and gills wrapped in a moist cloth. Usually lighter feeding and plenty of room in fresh water will be all that is necessary if taken in time. Two grains of permanganate of potash to the gallon of water is a suc-

cessful treatment. It is best to use this in an enamel or a glass receptacle. Organic substances, such as wood or floating particles of dirt, quickly decompose the chemical. The fish may be given the treatment several hours at a time, but a fresh solution should be made daily.

An entirely different kind of fin congestion is sometimes prevalent in the Fall, especially when the fishes are first taken in, young fishes being more liable to attacks. The base of the tail and other fins becomes suddenly blood-red, the color sometimes extending to the body immediately adjoining. If allowed to continue this form of the disease is rapidly disastrous. Fortunately, it yields with surprising quickness to either salt water or permanganate of potash treatment. When alternatives to salt-water treatment are suggested, the fancier will certainly be on the safe side by giving the salt the first trial, particularly if carefully followed out as we have directed.

White Fungus. This is next to the most common disease among goldfishes, and is responsible for the majority of deaths, except among very young fry. It begins on the tail and other fins, extending over the body and into the gills. When it reaches this stage it is usually fatal.

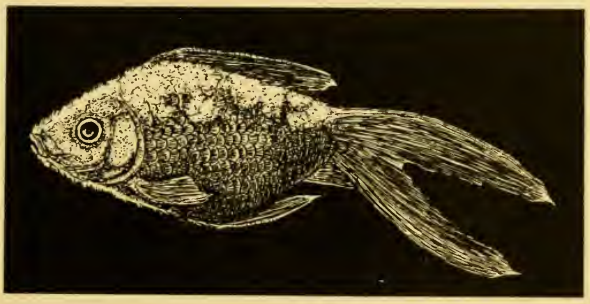


FIG. 97. FISH AFFECTED WITH WHITE FUNGUS
This illustration is characteristic of sick fishes in general. The fins are folded and drawn together and the general appearance is one of listlessness.

The progress of the disease is marked by the development of a white scum which destroys the fins, prevents the natural functions of the skin, and when the parasite enters the gills causes death by suffocation. The latter stage is not always reached, the fish often becoming so emaciated as to die in the second stage of the malady. The bacteria causing this disease are present in virtually all water, but can make no inroads on a fish in good condition. A weakened fish once infected will breed so many bacteria that

they can successfully attack the remaining well fish. White fungus, therefore, is contagious, and the sufferer should be removed from its fellows at once. This disease is caused by overcrowding, overfeeding, lack of proper plant life, transferring to water of different temperature and by bruises in shipment.

Treatment. Fishes suffering from white fungus should be treated exactly the same as those having fin congestion. If the fins have become very much frayed and it is necessary to trim them, this can best be done by a sharp knife, using a board to cut on. Scissors make a very poor result. It is well to treat the new cut edges with a permanganate solution of one grain to a glass of water. By grain we of course always mean a certain quantity of weight, and not simply a small particle.

Sometimes raw spots are left after the fungus has been removed. These or similar spots from other causes can be greatly helped by the following method: Wrap the head and gills of the fish in a moist rag, dry the affected spot and apply some Turlington's Balsam with a small piece of absorbent cotton. Allow to dry for three or four minutes. This will not endanger the life of the fish so long as the gills are kept moist.

Black Fungus. Many have supposed this disease to be invariably fatal, but this is not the case. If taken in time, the majority of cases can be cured. The great trouble is that the fish is in a run-down condition before contracting the disease and has little power to withstand the necessarily severe treatment. This disease manifests itself more on the body than the fins, at first presenting a dark gray appearance, later turning black and peeling off, leaving raw spots. A common place for the first appearance is the center of the gill plates, and also on the sides of the fish where they would be most likely to rub, for the parasites are conveyed principally by contact. The Protozoans causing this serious complaint are animal parasites which soon lodge themselves so deeply in the skin of the fish as to make treatment difficult. If they get into the gills the case is considered hopeless.

Treatment. Start at once on the increasing salt method described on page 144, only carrying it further. Over a period of from three to four days the strength of solution should be carried to two and one-half ounces to the gallon. Goldfishes can stand a great deal of salt if brought to it gradually. As before noted, the strength should be slowly reduced before returning to normal water. (The same is true of most other aquarium fishes.) After the maximum strength of solution is reached the fish should be pencilled on the affected spots with a 50 per cent. solution of peroxide of hydrogen for a few moments (being careful not to slop over on the healthy parts). The next day the spots may be treated with

Turlington's Balsam as described for White Fungus. Feed on good nutritious substances, such as daphnia or chopped earthworms. If the fish seems to be standing it satisfactorily, keep in the strong salt for about one week, changing the water daily and relying on accurate measurements for salt quantities. A progressive permanganate of potassium treatment may also be used, but should not be continued as long, five days being about the maximum for a fish in poor condition. Start at one grain to the gallon and go up to three. With this chemical there is no need of gradually reducing the strength, but a new solution should be mixed daily, and twice daily is better, always remembering not to change temperature of water. Happily Black Fungus is not as prevalent as formerly, owing probably to the fact that we now have many more American wholesale breeders, thus doing away with the necessity of purchasing so many fishes that are in a thoroughly bad condition from hard trips across the Pacific Ocean, and shorter but equally hard travels across the American Continent.

Itch. The itch is one of the more common complaints in the aquarium. The fishes are observed to quickly rub their sides against the firmer objects in the aquarium, often against pebbles on the bottom. The affection is caused by different fish parasites.

TREATMENT. Although this trouble is caused by different organisms, they all yield to the progressive salt treatment (page 144). The aquarium should be cleaned out before fish are returned, and care exercised to keep it in a cleaner condition, paying particular attention to seeing that no uneaten particles of food are left lying about. The introduction of more snails and a small Weatherfish or two (see page 13) will help to avoid a recurrence. It is not improbable that mussels consume a large number of suspended parasites and bacteria of various kinds.

Constipation. Among the highly-bred, short-bodied fishes, constipation, as well as other mechanical disorders, is naturally common. The much shortened bodies throw the internal organs out of position, give rise to swimming bladder troubles and tie up the muscles which must discharge eggs and also the excrement of the fishes. Lack of proper exercise in the cramped confines of the aquarium and too highly concentrated foods are other causes leading to constipation. The excrement should be of a brown color and free from bubbles or any slimy appearance. In health it usually is seen in long sections.

TREATMENT. An equal mixture of sea salt and Epsom salts, made to a strength of one ounce of salts to the gallon, will usually prove beneficial. It is better not to feed the fish during the period of treatment—about two days. The trouble may be due to overfeeding, and in any case a short fast will probably do good.

Goldfishes readily eat Epsom salts. A pinch dropped in the aquarium once weekly is beneficial to the fishes, and at the same time replaces some of the mineral content of the water depleted by the plants and fishes drawing constantly upon it for the chemicals necessary to sustain life. This practice has a tendency to prevent constipation.

Chopped earthworms will be found a mild laxative. In severe cases some fanciers place a drop of castor oil well down the throat of the fish by means of a dropper. The author has never been convinced that the fish swallows any medication administered in this way, but it does no harm to try, and may do good.

Tailrot. This disease first affects the end of the tail and other fins; the appearance is one of being frayed and split. If allowed to continue until the base of the tail is affected, the fish will die. Taken in time the trouble is easily corrected. It must not be supposed that every case of split and ragged tails is one of tailrot. This is often a manifestation of a generally run-down condition, and in addition to the regular treatment for tailrot, also requires a general building-up under improved environment.

Treatment. The same treatment as that for white fungus is indicated. Dipping the tail in a 10% solution of peroxide of hydrogen is beneficial. Should the ends be hopelessly frayed, they may be eaten off by a 50% peroxide solution. On returning to the water the treated parts will be full of bubbles and will slough off in a few days, leaving a less sharp line than when cut with a knife.

Consumption. It is doubtful whether this is a real form of tuberculosis, but the wasted appearance of the suffering fish is such as to suggest it. The body becomes thin and so shrunken that the head appears to stand out from the body. Listlessness and loss of appetite are accompanying symptoms.

Treatment. This trouble seems to be deeply seated and is difficult to treat successfully. Unless the fish is a particularly valued one, it had best be destroyed. Place fish in an ample supply of green water or fresh water containing ½ ounce of sea salt to the gallon. Feed well on daphnia, chopped earthworms and soft bits of oyster. Unless living daphnia can be secured, a cure is scarcely worth attempting. Placing fish in a shallow muddy pond or tank may be beneficial.

Dropsy. The cause for this distressing complaint is not known, but it is considered to be due to a disordered liver. It is more apt to attack fancy fishes, and does so without apparent reference to the general health of the individual or the conditions under which it is kept. The manifesta-

tions are a swelling of the body and the scales standing out at an angle, producing a ruffled appearance.

TREATMENT. No cure is known for dropsy in fishes. They have been known to improve in an outdoor pool in summer, but on the approach of cool weather the symptoms returned with increased severity, death following as usual. There is a current belief that a few drops of digitalis in the water sometimes effects a cure. The author has never been able to verify a single such case. If the fish is valuable, its life may be prolonged by "tapping" it. This is done by inserting a fine needle beneath the skin, holding needle nearly flat to the body so that it again emerges in about a quarter inch. After repeating this at a number of points, enough liquid can be drawn off to relieve the fish, whose health and spirits do not seem to be particularly affected until shortly before death. The operation can be repeated when necessary.

Swimming Bladder Trouble. As before stated, highly bred, short bodied fishes are the more susceptible to this not uncommon disorder. Sometimes the victims are unable to rise from the bottom except by a violent effort, or again they may lie at the top of water at an angle, or even upside down. Scaleless varieties are the more susceptible, particularly the light colors. Reduced temperatures, even when brought about slowly, are responsible for most cases.

TREATMENT. No cure for swimming bladder trouble is known, but it is sometimes relieved by placing in very shallow, slightly salt warm water. If the fish is benefited it will always have to be kept in temperate water, preferably shallow.

It should be borne in mind that not all cases of loss of equilibrium are due to bladder trouble, but may be caused by accumulated gases resulting from indigestion. Treatment for constipation will relieve these cases, but such fishes will have to always be watched carefully thereafter.

Gill Congestion. There are two forms of gill congestion. The most important, generally known as "gill fever," is that attacking fry from two to five weeks old, and is easily responsible for more losses among goldfishes than all other causes combined. The gills become inflamed and swollen, presenting a distended appearance. Owing to the minuteness of the fish at this period a further observation is difficult except with a magnifying glass, which shows white threads like bristles sticking from the gill plates and openings. The disease is highly contagious, so that if one affected fish is found in a thousand, it is very difficult to save any of them, even though the sick fish be removed at once.

The other form affects mainly young fishes about 2 inches long. The gills swell rapidly, the infection spreading to the throat and producing a

gray or whitish appearance. Without treatment, death is sure to come quickly. This was formerly a common disease among fancy fishes, but for some unknown reason has largely subsided, we hope permanently.

Treatment in Fry. Innumerable experiments have been tried to cure this devastating disease, but without consistent results. So fatal is it considered by many expert fanciers that when they find a few affected fishes they destroy them, together with perhaps thousands of their fellows in the same tank without attempting a cure, throwing out bad and apparently good alike. The tank is then disinfected with strong salt water or more powerful germicides. The great trouble is that any chemical which will kill the vegetal parasites is also very apt to kill the delicate fry. However, it is almost certain a cure can be found, and it is a great pity to neglect an opportunity for experimenting. Cases have been cured, but exact data is lacking. Nevertheless we have two experimental points to start from. The first and more likely is with permanganate of potash. A well-known and thoroughly reliable breeder claims to have cured over one thousand fry by making the water a "pale purple" with this chemical, leaving the fish in it. To gauge a permanganate solution by color is most difficult. If one looks through 12 inches of water, the color will be 12 times as deep as through 1 inch. We would suggest trying ½ grain by weight to the gallon. This just flavors the water. (Tasting without swallowing will do no harm.) If fishes not yet affected are removed from their diseased companions and placed in such a solution for half a day, it is reasonably sure that many if not all could be saved, taking care, of course, not to return to an infected tank. Here it might be repeated to advantage that small fry should be lifted with a spoon and transferred carefully, avoiding pouring or any violent movements.

The other basis for experiment is with sulphate of copper in extremely diluted form—about 1 to 10,000 or weaker. Copper is fatal to all forms of life and therefore the treatment should only be temporary. We would suggest finding a strength that would kill the fry in an hour, then use that strength for 15-minute treatments for remaining fishes. Reports of cures by copper are current, but details are entirely lacking.

Treatment Larger Fishes. This form of gill congestion has also been considered necessarily fatal, but such is not the case. The fish should be placed in strong salt water (3½ ounces to the gallon) until it rolls over from exhaustion. It is then transferred to a tank of gently running water which overflows. It appears as though the salt loosens the disease-germs and the running water carries them off while they are weakened. If this is a correct theory the cure could no doubt be hastened by pouring fresh water in the under side of the gills after the salt treatment, thus also helping to revive the fish. Treatment is repeated daily until improvement is noticed.

Eye Inflammation. The protruding eyes of telescope fishes are quite subject to injury, especially against the sides of cans in travel. Painstaking

treatment can go far to relieve this condition and ward off permanent blindness.

TREATMENT. Make a saturated solution of boracic acid in tepid water. This is gently applied daily to the affected parts by a bit of absorbent cotton. The fish should be placed, if possible, in a large tank free from obstructions, that the injured eyes may not be further irritated.

Ichthyopthirius. This parasitic disease causes small whitish dots all over the fish. It is more apt to affect tropical fishes and has killed many fine specimens. Until recently it has been considered incurable, but two cures are now positively known. The fish should be placed in a plain glass jar and have the water changed (keeping temperature even) every eight hours, *disinfecting jar each time.* This takes a few days. It is claimed that plain water is as good as salt for this treatment, but the writer has had better success with brackish water, gradually increasing the strength and then as gradually reducing.

The second method of treatment is only suited to goldfishes. This consists of treatment in water in which two grains to the gallon of permanganate of potash have been dissolved. In a few days the old mucous coating of the fish peels off and leaves a new, healthy surface.

Animal Parasites. There are only three of these of sufficient importance to keepers of aquarium fishes to require mention. Food fishes and all wild species are more or less subject to numerous parasites, many of them serious or fatal. No doubt aquarium conditions are not favorable to their propagation; otherwise we would have more trouble in this direction on account of the large numbers of wild fishes being imported for aquarium purposes from all temperate and tropical parts of the earth.

Leeches. There is a small white leech about ¼ inch long occasionally introduced with living food (daphnia), more particularly in the spring. This attacks the bodies and gills, and if the fish is only a few weeks old the results are fatal. In an aquarium it is easily possible to see them on the glass and the breeder should be on the lookout for them. If any are discovered the fishes should be carefully removed to an aquarium where they can be kept under observation. The affected aquarium should be disinfected and the plant destroyed. These and larger leeches can be removed from the gills of larger fishes by the injection of strong salt water, or by the progressive salt water treatment previously described (page 144).

Fish Lice. While not very common, and seldom fatal, this crustacean parasite is very annoying. It is about ⅛ inch in diameter, very flat, of a nearly rounded outline and is quite translucent, but distinctly showing handsome iridescent colors under a good magnifying glass. They are free swimmers and are able to hold most tenaciously to their hosts. So tight is their hold that even after death by poisoning they still adhere where fastened. Owing to their translucent quality they are difficult to see. The fishes will scratch themselves much the same as in cases of the

"Itch," but one can notice small irritated spots, particularly on the tail and fins. The body, however, is not free from attack. The only treatment is to take the fish out of the water and scrape off the pests, for no chemical has been discovered that will cause them to let go, and no doubt if it would it would also kill the fish.

FIG. 98. FISH LOUSE (*Enlarged four diameters*)

Flukes. The detection of flukes is not easy without the aid of a miscroscope, the cause being a small parasite worm (*Gyrodactylus elegans*), chiefly infesting the gills. The fish breathes unnaturally fast, frequently coming to the surface of the water for air. The fins twitch and occasionally the fish will dash wildly and aimlessly about the tank, coming to a rest after exhaustion. Before death the body becomes thin and emaciated.

If the fish is not too far gone it will stand the formaldehyde treatment, which will usually effect a cure. Place the fish in a solution of 5 drops of formaldehyde to the quart of water. Add one drop per minute (per quart) until there are ten drops to each quart. Allow the fish to remain in this for ten minutes unless it shows signs of exhaustion sooner. Return to a thoroughly disinfected tank and repeat the operation next day. Two or three treatments will usually be sufficient. As a rule, all the fishes in a tank are affected, so if this parasite is positively identified, it will be well to treat every fish that has been exposed.

We can see no reason why the formaldehyde treatment should not be applied to any of the parasitic ailments. If carefully used it will at least cause no trouble.

Diseases of Tropical Fishes. Tropical fishes cannot stand the different chemicals and treatments recommended for goldfishes. The principal cause for their lack of condition is too low a temperature. If placed in a uniform warmer temperature, with one ounce of sea salt to each gallon of water, and fed up on daphnia or white worms (described on page 136) they will usually improve rapidly.

The most common disease among them is Ichthyopthirius, caused by an infusorian parasite burrowing into the skin, producing numberless white raised spots. This requires special and prompt treatment, carried out to the letter as described on page 153. The treatment is worthless unless the changes of water are made on time. Aside from chill this epidemic kills more tropical fishes than any other cause. It has long been considered incurable, but recent careful study by European scientists of the life history of the parasite has evolved the very simple treatment described, and there is no reason for further serious losses in this direction. This has been proven by the author and other American experimenters.

Chapter Fourteen

Enemies of Aquarium Fishes

INSECT ENEMIES OF FISHES

Among the troubles that beset the fish culturists, not the least are caused by insects and their larvæ. This applies both to the propagators of food fishes and those interested in fancy aquarium pets. We use the term "insect" here in its popular sense and not according to exact scientific definition.

Some of these enemies are much more readily detected than others, but most of them may enter the rearing tanks when so small that detection is practically impossible. Wire screen or netting will keep out those that fly, or a large enemy in the water can be separated from daphnia or other living food by passing the "catch" through a fine wire gauze under water, but despite these precautions it is essential in the summer season to be ever on the lookout for any of the pests which may have gotten by our keenest observation. Fortunately for the aquarist there are not many kinds of insect enemies with which he is actively concerned. There are only four, three of these being larvæ. While the others are none the less savage or fatal they are not so often met with, or else are so easily detected that they are not such serious factors with which to reckon. With the aid of illustrations made from specimens, mostly living, we will proceed to give descriptions of the four arch-enemies in the order of their destructiveness, and follow on with the others, adhering to the same plan as far as possible.

Water Tiger. This is the larva of the Predaceous Diving Beetle (*Dytiscus*), itself also a very powerful but easily detected enemy. The Water Tiger is easily the most rapacious, savage and insatiable enemy of

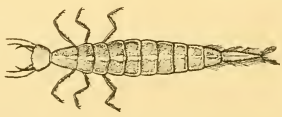


FIG. 99. WATER TIGER (*Life size*)

young fishes. It does not wait for its prey to pass nearby, but adopts business-like methods of going after its unwary victims. The flat head is furnished with a strong pair of hollow mandibles, through which it sucks enough blood to kill its victim and then wantonly goes after another. In this way a single individual may kill an entire hatching of fish over night. This larva can usually be recognized by its spindle-shaped body,

flat, strong head, pale translucent brown color and a steady progress through the water, coming to the surface frequently to breath a moment through the rear end. Although growing to a length of 2½ inches, at which time it attacks larger fishes and any small aquatic animals, it is the smaller sizes with which we are principally concerned. From a length of ¼ to 1 inch they are not so easily seen but are capable of doing great mischief.

Spearmouth. While not quite so common as the Water Tiger its habits are similar and it grows to an even larger size, reaching 3 inches.

FIG. 100. SPEARMOUTH (*Life size*)

The body is thicker and the mandibles are shorter. From the aquarist's standpoint both these larvæ could be classed as one. The Spearmouth is the larva of the large Water Scavenger Beetle (*Hydrophilus*).

Dragon-Fly Larvæ. Almost everyone who raises fish outdoors is familiar with these unpleasant individuals. There are two reasons why they are difficult to altogether avoid. When newly hatched they are very small and will go through the same strainer as daphnia; furthermore the

FIGS. 101 AND 102. NYMPH OF DRAGON FLY AND LARVA CATCHING YOUNG FISH (*Life size*)

mother Dragon Fly (*Odonata*) is an excellent flier and may deposit her eggs in any body of water that provides proper facilities for her needs. These larvæ live more by their cunning than by any agility as swimmers. Waiting on a dirty pond-bottom or attached to sticks, aquatic grass or other object they mark time until a victim comes within close reach. Then they quickly pounce forward, extending a vicious, pincer-like organ called the "mask," rarely missing the object of attack. The method of propulsion through the water is peculiar, being brought about by a series of expulsions of water from the hinder end. This enables them to

make a very sudden leap towards a victim. The "mask" shown in Figure 102 when not in use is folded before and under the head. Dragon Fly larvæ are strictly carnivorous at all periods and will attack any pond creature reasonably near its own size. If given enough time a single individual will destroy an entire hatching of fishes, growing by what it feeds upon so as to be able to devour the remaining fishes which are also becoming larger.

Water Boatmen and Back Swimmers (*Corixidæ* and *Notonectidæ*) are found everywhere in still or slow-moving water. They are especially plentiful in ponds containing vegetal decomposition and filth, not because

FIG. 103. WATER BOATMAN (*Slightly enlarged*)

they like these, but because such conditions are favorable to the growth of other creatures making good food for themselves. In daphnia pools from midsummer until the end of the season Water Boatmen are frequently found. Care should be exercised in picking them out of a net, as their bite is very severe, the sensation being described as akin to the sting of a hornet. Young fishes fall easy prey to these predatory insects. They are usually easy to see on account of their jerky, jumping movements, which are produced by use of their oar-like swimming legs. They are obliged to occasionally come to the surface of the water to take air, which gives an opportunity of seeing them. Both Water Boatmen and Back Swimmers fly clumsily at night, and are often attracted to electric lights. In some Southern climates they occur in enormous numbers. They are gathered by the natives, dried and sold as fishfood under the name of "African Flies."

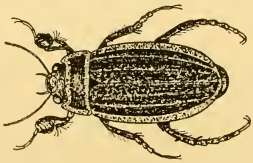


FIG. 104. PREDACEOUS DIVING BEETLE (*Life size*)

Predaceous Diving Beetle (*Dytiscus*). Fortunately this beetle is of such size that it can scarcely escape notice, especially as it is obliged to come to the surface for air, which it takes at the end of the abdomen.

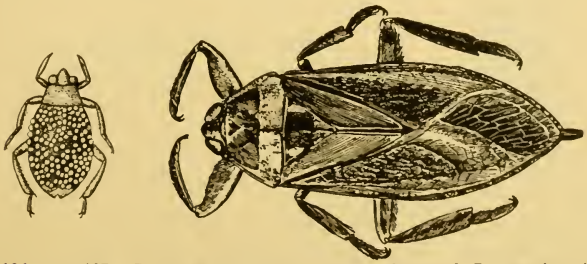
It is rapacious in extreme degree and is a good swimmer. A large specimen was once placed in an aquarium for observation. It so quickly attacked a goldfish that the scales fell in a small shower and the fish died before it could be rescued. The males may be distinguished by the ball-like development on the forelegs. They are usually of such a dark brown as to appear black, but are sometimes marked or bordered with yellow.

Water Scavenger Beetle (*Hydrophilidæ*). We mention this beetle here because of its resemblance to the large predaceous diving beetle. It swims differently, using its legs alternately, while the diving beetle moves opposite pairs together. The Scavenger Beetle is also different in that

FIG. 105. WATER SCAVENGER BEETLE (*Life size*)

it breathes at the surface from the mouth. Instead of long antennæ they have palpi looking like club-shaped antennæ. This beetle lives chiefly on decomposing vegetal and animal matter, although taking soft living plants such as Nitella. It has been claimed to be predaceous but there is doubt about their attacking fishes. They have been kept in aquaria with them without doing damage. On general principles, however, it is best to exclude all beetles, large or small.

Giant Water Bug (*Belostomatidæ*) also known as the Electric Light Bug is one of our common bugs both on land and in water. Flying clumsily but strongly before electric lights, or patiently awaiting a victim at the bottom of a pond, the bug is one and the same. They are fiercely



FIGS. 106 AND 107. GIANT WATER BUGS (*B. serphus and B. americana*) THE SMALLER A MALE WITH EGGS ON BACK (*Life size*)

predaceous and very powerful. The smaller sizes are the more to be feared, as they are not so easily seen. While this is a vicious enemy, it is not one that frequently gets into the fish tank except by flight and as only the adults fly they are easily detected by their size. In large outdoor rearing pools or lakes they are a very practical menace. The colors range from clear, dark reddish brown to dull olive. With some of the smaller genera, *Serphus* and *Zaitha* it was supposed that females lay the eggs on their own backs. Some writers have accepted this popular misconception without investigation. It has been fully established that the female fastens her eggs on the back of an unwilling male, who only submits to the indignity after a struggle.

Water Scorpion (*Nepidæ*). We have here another of the insects spending most of its time in aquatic dirt and rubbish awaiting innocent passers-by who, for their unwariness, will pay with their lives. Water

FIG. 108. WATER SCORPION (*Life size*)

scorpions depend upon their obscurity to get near their prey, which they quickly seize with their modified forelegs. While this insect is common enough to the naturalist, it is not one with which the fish-culturist need be seriously concerned.

Whirligig Beetle (*Gyrinidæ*). This well-known beetle is common to nearly all slow-flowing streams and pools, keeping up a perpetual movement on the surface of the water, on which they glide apparently without effort. On account of its size and shape it is often called the

FIGS. 109 AND 110. WHIRLIGIG BEETLE AND LARVA (*Enlarged three diameters*)

coffee bug. The breeder of fishes is not harrassed by this insect but occasionally an aquarist will be tempted to introduce one in a fish-tank. This is a mistake. They are predaceous and can inflict a severe bite. The larva, which is not so well known, is also predaceous.

Water Strider (*Hydrometridæ*). Another of the predaceous aquatic insects is the Water Strider. Quite as well known as the Whirligig Beetle, it adopts somewhat the same methods of securing its prey, darting

FIG. 111. WATER STRIDER (*Life size*)

over the surface of the water, waiting for the stream to bring down some helpless insect victim that has fallen overboard. They are capable of catching young fishes which come to the surface.

Mites (*Hydrachna*). These odd-looking little balls of intense red are sometimes placed in small tropical aquaria with fishes. This is in-

FIG. 112. WATER MITE (*Enlarged about four diameters*)

advisable, as they are parasitic. It is doubtful whether they actually kill their host. They are common in the still water of lily ponds.

Hydra. Although Hydra is not an insect we include it here as an important enemy of young fishes. *Hydra* is a polyp which attaches itself to plants, stones or the sides of the aquarium. Being thread-like in appearance it is apt to be overlooked, especially by the inexperienced. It

FIG. 113. HYDRA (*Greatly enlarged*)

is usually introduced with living food caught from pools. The spores are so small as to be unrecognizable, and therefore they cannot be avoided. The animal itself has a cylindrical body with from 5 to 12 tentacles sur-

rounding a mouth. The shape varies so amazingly that an accurate description is impossible. The two figures shown in Figure 113 are of the same individual. When alarmed the tentacles are entirely withdrawn, making recognition still more difficult.

They rapidly deplete an aquarium of daphnia and newly hatched fishes. When a school of fry under 5-16 inch long is disappearing without apparent cause, it will be well to take a sharp look for some harmless looking hydra.

Hydra possess a poison which quickly stupifies their prey, and to fish large enough to eat the hydra this poison doubtless has an unpleasant taste. There is no fish known which will eat them. To get rid of this pest, remove all fish, snails, etc., from the tank and place in it a solution of permanganate of potassium of a strength of 3 grains to the gallon of aquarium water. Allow this to stand for two days, change water and replace fish. This treatment will not kill plants.

If no small living food be placed in the aquarium, hydra will in a few weeks be starved.

One experimenter has claimed that by raising the water temperature to 110° Fahrenheit for a few minutes the hydra will all be killed, while the plants will not be affected.

LARGER ENEMIES OF FISHES

It should not be understood that the foregoing are the only serious enemies of pet fishes. In the greenhouse, outdoor pool, or even the library, misfortune is liable to descend in various guises. Chief among these are the cat, rat, muskrat, snake, heron, kingfisher and small boy. Fishes are also taken by the large frog, sandpiper, horned owl, crayfish, and blackbird. The latter specializes on picking out the eyes of telescope fishes if the water is near enough to the edge of tank for him to reach them.

Chapter Fifteen

Aquatic Plants for the Aquarium, Tank and Pond

AQUARIUM PLANTS

Whether aquaria are kept for scientific study or for the enjoyment of the beautiful, aquatic plants will always be found a useful—if not indispensable—adjunct. The fact that plants give off oxygen under the influence of light has been mentioned at several other places in this volume, but the principle is so important that it would be difficult to overemphasize it. Aquaria containing good plant growth may be tightly covered and if placed in a good light they will support a fair number of fishes, the life-giving oxygen being supplied exclusively by the plants.

That the roots of healthy aquatic plants absorb the products of decomposition in the bottom of the aquarium is an established fact. When an aquarium has been established for some time, the sand has become a little dirty and the plants have spread so that the roots of some are against the glass, a close observation will show a condition similar to that pictured in figure 114. The sand near the roots is distinctly whiter than that beyond their reach.

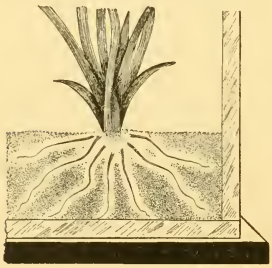


Fig. 114. Absorption by Plant Roots

No arguments need be put forward to establish the esthetic value of plant life in the household aquarium or the pool in summer. Without them no one could attempt to reproduce the effects of Nature. So well understood is the value of aquatic plants that aquarists are constantly on the lookout for anything new which might enhance the beautiful results already achieved. Occasionally something of real merit is found. We are pleased to be able to list several of these newer species here, together with all the better-known favorites. Only those plants having been proven satisfactory are described, but naturally in such a large range it will be found that the same conditions are not suited to all.

It is a good general rule to select young plants. They transplant better and sooner adapt themselves to new conditions. If old plants are used the dying leaves should be removed.

Much discussion has been brought out as to the best methods of planting, principally as to whether to use soil, sand or pebbles, or whether, in some cases, planting is necessary at all. Success has been attained in

FIG. 115. SAGITTARIA NATANS (*Reduced one-third*)

many ways. The author believes in the use of coarse sand, either with or without a mixture of pebbles, this latter being a matter of taste only. The disadvantage of pebbles is that they are likely to get into a siphon and clog it. Pebbles without sand collect dirt which cannot be removed. There are no experienced advocates of fine sand. It packs too hard for the roots to penetrate. If soil is to be used in pots or otherwise, an inverted piece of turf is excellent. It is compact, comparatively clean and is not likely to turn sour. In all cases soil is covered with sand or gravel to prevent washing out. As to other points in reference to planting, the use of fertilizer, etc., the reader is referred to page 14.

SAGITTARIA

This plant in the three described species comprises the most important group of aquarium plants. It has not the commercial importance of Cabomba, because the latter is convenient to use in small bunches in the "fish globes" seen everywhere; but to those who plant in real aquaria, Sagittaria receives first consideration.

It is a plant with bright green slender leaves of grass-like form, so that it is popularly referred to by aquarists as "grass." It takes its name from the arrow-shaped summer-leaves which stand above the water, Sagittarius being the sign of the archer in the Zodiac. The white flowers are the shape of miniature cups, with yellow centres, standing above the water. Although seeds are formed, the principal means of reproduction is by runners. Small tubers or corms are also formed among the roots, particularly in crowded situations. These produce plants.

A number of species are distributed throughout the United States, many of them quite large, frequently with leaves extending well above the water. These are only useful as bog plants and even for this purpose they are difficult to transplant successfully. The majority of wild Sagittarias are not suited to the aquarium.

There has been much discussion as to the classification of Sagittaria into a number of doubtful species. Environment makes such radical changes in its appearance that there is a tendency to claim new species when there is in reality no botanical distinction.

Sagittaria natans, known also as Ribbon Arrowhead, is perhaps the most important of the group to the aquarist. It is of moderate size and is suited to the average aquarium on that account. Multiplying rapidly, growing the entire year, supplying a large amount of oxygen and thriving under varying conditions, it is very valuable. When an aquarium is uprooted on account of Sagittaria or Vallisneria becoming too thick, it will always be found that the sand is not foul-smelling, showing that the roots purify the soil.

FIG. 116. GIANT SAGITTARIA (*Reduced one-half*)

Fig. 118

Fig. 117. Sagittaria subulata [*Pusilla*] (*Natural size*)
Fig. 118. Wild Ludwigia (*L. glandulosa*)

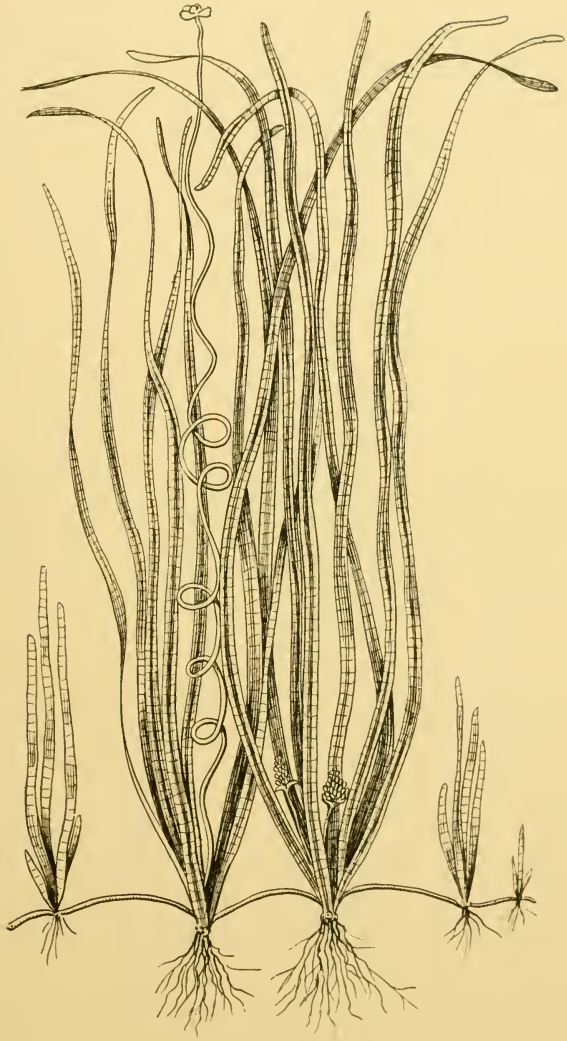


FIG. 119. VALLISNERIA (*Reduced one-half or more*)

Sagittaria gigantea is believed to be a cultivated variety of *S. sagittaefolia.* Its leaves are broad and stocky, having a decidedly substantial quality and is one of the easiest plants to succeed with. A healthy specimen is quite light in weight and on this account must be well planted with roots extending in different directions. Once established it holds well and will stand more rough usage from contact with fish-nets, etc., than any other aquatic. Height, 10 to 20 inches. It is better suited in appearance to a large aquarium than a small one, but a single Giant Sagittaria in the centre of a smaller tank, surrounded by some of its lesser cousins makes a good effect. So popular has this plant deservedly become that dealers have difficulty in supplying it, and they are always ready to buy up any surplus stock.

Sagittaria subulata has recently come into popularity on account of its small size. Fanciers of tropical fishes, now becoming so numerous, generally use several small aquaria, and in order to produce a symmetrical picture it is necessary to introduce plants of suitable proportion. The leaves are of a rather dark shade of green, narrow and thick through, presenting a strong, wiry appearance. *Sagittaria subulata* grows from 3 to 7 inches, the stronger the light, the shorter the leaves. It multiplies rapidly from runners and soon carpets the bottom of the aquarium, making either a good spawning bed or a miniature thicket in which young fishes may hide from cannibalistic parents. Can be had from some dealers and is collected in the coastwise States from New York to Alabama. It is incorrectly known as *S. pusilla.*

VALLISNERIA

Vallisneria (*Vallisneria spiralis*) is another of the grass-like plants, having strap-shaped leaves of the same breadth their entire length. It is known as Channel Grass, Eel Grass and Tape Grass. Appearing somewhat like Sagittaria, it has a distinct individuality of its own. The leaves are of a lighter green and have a more translucent quality than Sagittaria. Also the plant tends more to rise vertically in undulating lines, which produces a very pleasant decorative effect, being of a less spreading contour than Vallisneria. The leaves may also be identified by the margins being of a slightly different shade of green. By reflected light the margins appear the darker, but if held up to the light, the centre is the darker when viewed by transmitted light. Vallisneria is probably without a superior as an oxygenator. For use in large aquaria, particularly where artistic effects are striven for, it is without an equal. The aquarium shown in colors as our frontispiece is featured principally by this plant, although printing ink falls far short of giving an adequate idea of the radiant, light silky green color of the leaves themselves.

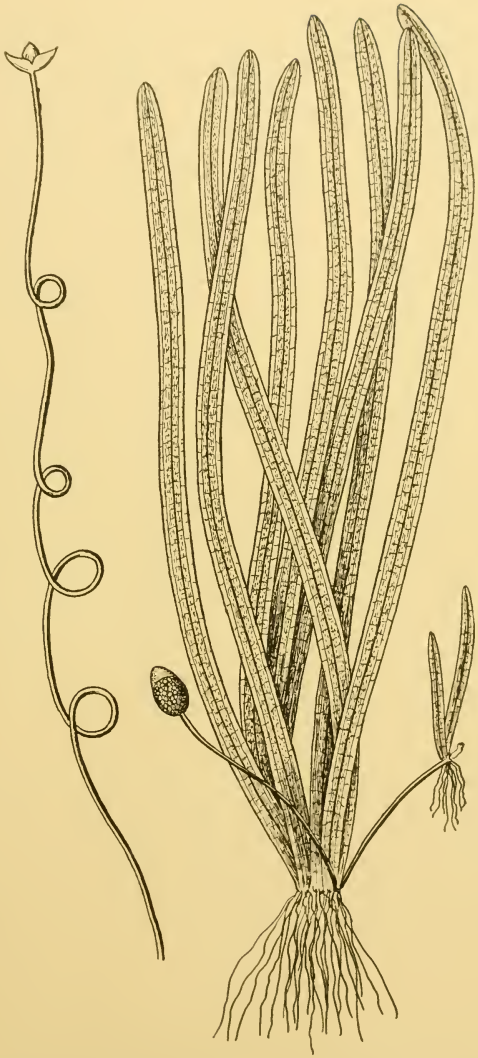


FIG. 120. GIANT VALLISNERIA (*Reduced two-thirds*)

For some years American aquarists depended upon plants gathered locally from rivers, creeks, mill races, etc. Owing to the long-established habit of dying down to the tuft in winter, the plant had a strong tendency to keep to the schedule, even when kept in a warm aquarium over winter. In order to overcome this difficulty a search was made for a stock growing in a climate without severe winters. This plan was completely successful. In 1910 we were fortunate enough to secure a single small plant from Italy which, by careful propagation and distribution among leading aquarists, has now multiplied itself into the many thousands. There is every reason why it should establish itself in further favor among those having large or fairly deep aquaria. It grows and multiplies constantly and the runners lie close to the bottom, not requiring to be pushed down like young Sagittaria plants. Contrary to the advice of some writers, we advise against deep planting. It is important that the crown be not covered, but just at the surface. The plant is not well suited to small aquaria, as it grows from 18 to 36 inches, according to conditions. If closely confined it is likely to get into a tangled mass whenever a fish has to be caught. Allowed to rise to the surface and then extend horizontally on it for some distance it produces a luxuriant picture. Rising from either end of the aquarium and trained over the surface towards the centre, Vallisneria makes the best of frames to show off the more brilliant beauties of the fishes. The sexes are separate in Vallisneria, fertilization taking place in a peculiar manner. The female flower, small, cup-shaped and white, floats at the end of a long spiral scape on the surface of the water. The male flower on another plant comes only a short distance from the crown. It is a case containing pollen balls. When the case splits the pollen floats to the top, where, by the action of wind, insects or other chance, fertilization is accomplished. Few of these plants in the aquarium start from seed.

For one or two large plants to dominate the centre of the aquarium, nothing is better than Giant Vallisneria, now brought from the Southern States by some of our leading dealers. Its leaves are as wide as those of Giant Sagittaria, but much longer, varying from two to four feet, according to conditions. This variety is also a constant grower. Stocks of Vallisneria or Sagittaria suited to the aquarium do not do well outdoors in direct sun, the old leaves dying and the new ones only developing a few inches in length.

ANACHARIS

Known to American aquarists as Anacharis and in Europe as Elodea it is also popularly called Ditchmoss, Water Pest, Water Thyme, and Babington's Curse. Some of the rather uncomplimentary titles are due to a

FIG. 121. WILD ANACHARIS (*Life size*)

characteristic which, at least in the aquarium, should be considered a favorable point—that is—rapid growth. It may generally be taken for granted that if an aquatic plant is thriving, it is doing good work for the aquarium. In form it is moss-like, the leaves growing on a fragile stem, the entire plant being completely submerged at all periods. Several species are distributed throughout the United States and Southern Canada. A cultivated variety, probably derived from A. canadensis, is considerably larger than the common local specimens to be found. The closeness of the leaves together depends upon the strength of light in which the plant is kept, the difference being so pronounced that sections of the same plant divided and kept in strong and weak light conditions will soon appear so different as to be scarcely recognizable as the same stock. The plant grows several feet in length, sending off occasional shoots and a few roots at random that reach down into the soil. In the aquarium it is best to only retain from 6 to 15 inches of the newer growth, cutting away the old ends, re-bunching and re-planting. Planting is a matter of little concern to Anacharis. In a well-lighted aquarium, where it will not be nibbled at by large fishes, it will prosper whether planted or not, particularly if not kept too warm. Anacharis is an excellent oxygenator and is a good plant for the beginner or for those who want to add variety to their aquarium vegetation. Allowed to grow into a mass it forms perfect hiding places for young fishes, as it does not grow so close but that they may move about in it. To be had of dealers generally.

CABOMBA

Commercially there is no doubt Cabomba is the leading aquatic plant. Its finely-cut, fan-like, bright green leaves make a very good first impression, although it does not long look so well in the aquarium. It is brittle and the fishes if active soon pick it to shreds. Even though this does not occur, it becomes long and spindly. Enormous quantities are gathered from ponds, some of them purposely planted, from Maryland to North Carolina.

The plant under natural conditions is a good producer of oxygen, but in the aquarium its activity in this respect is doubtful. Although its use is recommended by many writers, the author's experience and observation lead him to take exception to their views.

Cabomba caroliniana is the species usually sold in bunches in pet shops. It is well known as Washington Grass, Fanwort, and Watershield. In habit it is purely aquatic and propagates mainly by branching. The stems under natural conditions attain a length of several feet.

Cabomba roseafolia is a species whose principal distinguishing characteristic consists of a distinct reddish hue on the stems and lower sides of the leaves. It too is a handsome plant when first introduced.

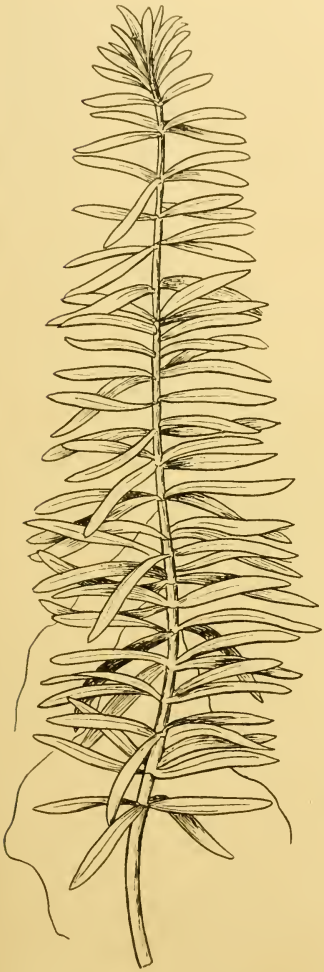


Fig. 122. Cultivated Anacharis (*Life size*)
Fig. 123. Cabomba (*Life size*)

MYRIOPHYLLUM

Here we have another plant which at first looks well in the aquarium but which deteriorates rapidly. It has, however, a strong redeeming feature, the very finely divided hair-like leaves being ideal for receiving the spawn of goldfishes. For this purpose it has grown more and more into favor. It is used either in the bunches as they are sold, or made into a spawning-ring as shown on page 51. As a spawn-receiving plant it has one advantage over Water Hyacinth in that the individual pieces may be spread out so as to give all the eggs a similiar amount of sun, whereas with Hyacinth one side is usually much more protected than the other, making the eggs hatch at different times. Before using Myriophyllum to spawn on it should be well washed off by moving it about in clear water, being careful to remove all insects, snails and snail eggs. When spawning is finished the plant had as well be thrown away.

There are a number of generally distributed species throughout America, all having the same general characteristics, but some are better than others as "spawning grass" on account of closer and longer leaves. They are all popularly known as Water Milfoil.

Myriophyllum verticillatum. This is the best American species and is found in both shallow and deep ponds throughout the United States and Lower Canada. Its leaves are dense and crowded, making an excellent spawning plant. *M. nietschei* is a cultivated variety of the same, the leafy filaments developing from 1½ to 3 inches in length.

Myriophyllum proserpinacoides or Parrot's Feather is a partially submerged form which should be allowed to creep on the surface of the water, where its blue-green, feathery leaves display a charm exclusively their own. Does well in the greenhouse or established on the edges of partially shaded lakes, where it becomes very robust and looks strikingly beautiful. The roots are not winter-killed. On account of growing so rapidly it requires too much attention in a small aquarium.

CERATOPHYLLUM

Hornwort, as it is generally known, is mentioned here on account of its resemblance to Myriophyllum, for which it is sometimes gathered. It is an extremely poor aquarium plant, being very brittle and liable to rapid decomposition. Besides its characteristic of being fragile it may also be recognized by having practically no roots, absorption taking place in the leaves.

It is found principally in ponds and slow moving streams, where it washes about freely with the current.

UTRICULARIA

Many species of Bladderwort are distributed throughout the Temperate Zone. They have somewhat the appearance of the finely-divided leaves of Myriophyllum, but may be identified by the small bladders dotted throughout. Our figure 125 of *U. vulgaris* gives a good idea of the general type. They thrive in the aquarium if given plenty of strong light. The Bladderworts are carnivorous plants, trapping the microscopic lower forms of animal life in their bladders, where they are digested. It has been claimed that they can trap extremely small fishes,

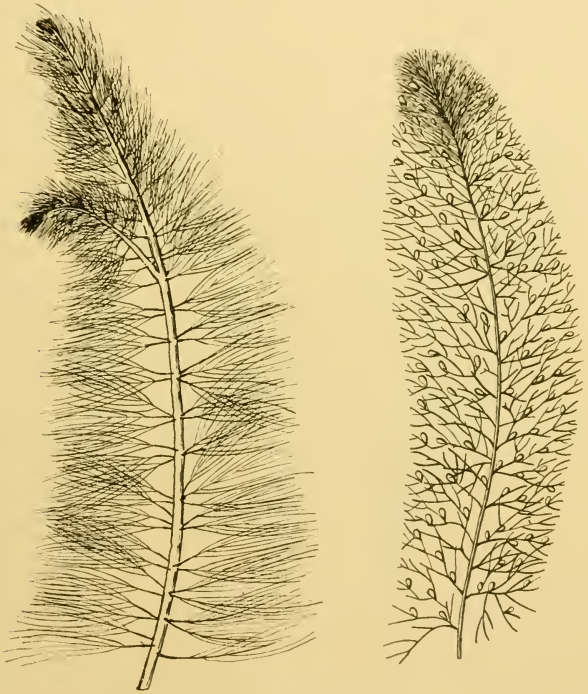


FIG. 124. MYRIOPHYLLUM NIETSCHEI (*Slightly reduced*)
FIG. 125. GREATER BLADDERWORT (*Reduced one-third*)

such as the young of Dwarf Gourami, but we do not know that this has ever been definitely proven. There can be no doubt, however, that the plant *does* take living food which would be useful to young fishes, and to that extent is objectionable in the aquarium.

HAIR GRASS

Eriocaulon septangulare, a dainty hair-like aquatic of recent introduction, fills small tropical aquaria in an agreeable manner. It is another of those plants forming a useful adjunct to the breeding of tropical fishes. It multiplies rapidly from short runners and is a good oxygenator. Of

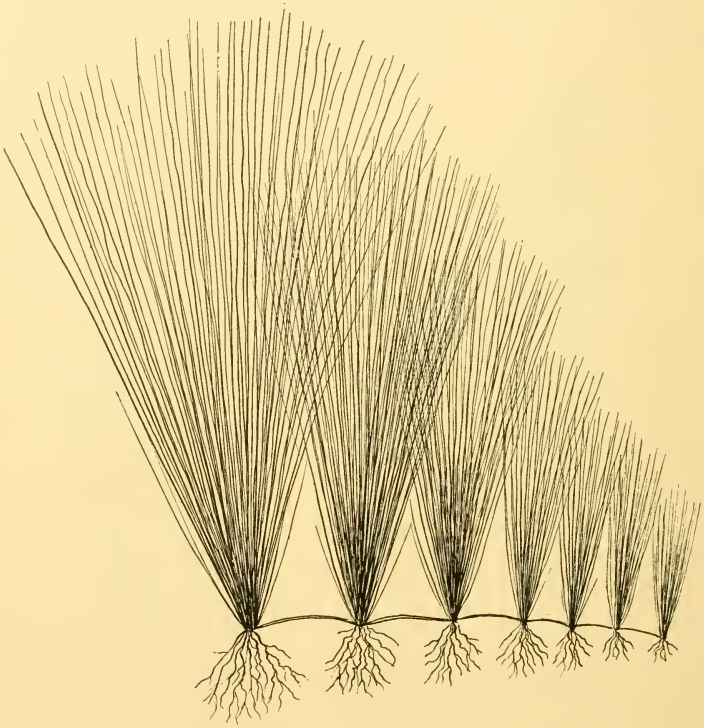


Fig. 126. Hair Grass (*Life size*)

a pleasing shade of light green it makes a contrasting group among other plants in a large aquarium, but it shows to best advantage in a small aquarium by itself. It grows from 3 to 8 inches and is native to ponds in the Middle Atlantic and Southern States.

Fig. 127. Potamogeton densus (*Reduced one-half*)
Fig. 128. Nitella gracilis (*Reduced one-third*)

POTAMOGETON

In strong contrast to the foregoing dainty plants is *Potamogeton densus,* or pondweed. As will be seen from figure 127, these leaves are broad and robust. In color they are a bright green. This variety is said to be of European origin but is now common in ponds in the United States. If established in soil in flat pots it flourishes in a well-lighted aquarium. Pieces collected from the wild may be introduced by fastening into the sand. They present a very attractive appearance and will last for quite a time, but should only be regarded as temporary and when the leaves begin to turn yellow should be removed. There are many widely distributed species of Potamogeton, all looking very attractive in a state of Nature, especially *P. crispus* with curly leaves. They look very tempting, but none seem to survive in the aquarium except *P. densus* and that only when established just to its liking.

NITELLA

Of the slender-leaved aquatics. *Nitella gracilis* is one of the best. Our figure 128 gives a good idea of its dainty form. It is not freely distributed but is found occasionally in ponds and streams in the Eastern States, usually attached to bits of stick or stone. From this it receives its popular name, Stonewort. In removing the plant to the aquarium, it is best to take also the base upon which it roots. If placed in a situation to its liking Nitella prospers wonderfully in the aquarium and is a fine oxygenator. Under the microscope the leaves show the circulation of protoplasm better than any other plant. Requires plenty of light.

LUDWIGIA

Popularly known as Swamp Loosestrife, this plant in about 25 species is widely and thickly distributed in North America, mostly growing at the edges of streams like Watercress. Although in reality more of a bog-plant than a pure aquatic, it does well in the aquarium, particularly if kept in the earth of the pot in which it was propagated from a cutting. Propagation is very easy in the greenhouse. About 5 short cuttings are placed in a 2-inch pot, having a top-layer of sand. This is not done under water but the pots need to be kept saturated and the air very moist. They soon root and when they have developed about an inch of new growth should be placed in the aquarium.

Ludwigia is one of the more important aquarium plants on account of its decorative value and pronounced individuality. When kept in a strong light the under sides of the leaves become a beautiful red color. Wild stock is not altogether satisfactory. It throws out too many roots to make a pleasing appearance, and in the aquarium becomes attenuated in character. A cultivated variety said to have come from South America is better in every respect and is easily obtained, for it is the kind propagated by dealers in aquatics. As it is sold in the original pots before being plunged into water it can safely be sent long distances. Growing to a length of several feet if untrimmed it is suited to large aquaria but may also be kept small by pinching back. Unlike Anacharis it should not be trimmed at the root end unless the stock has become quite old and no longer prospers. Does best in strong light and may also be propagated in the aquarium from cuttings. A little Ludwigia can be seen in our frontispiece.

Fig. 129. Cultivated Ludwigia (*Life size*)

SPATTERDOCK

Among the newer introductions into the aquarium are the submerged Spatterdocks. The large arrow- or spade-shaped leaves make a very characteristic appearance. Seedling plants gathered from lakes and ponds in the fall will do well in the aquarium over winter. If summer leaves appear and become too large for the aquarium the plant had best be removed. The Southern Spatterdock, *Nuphar sagittæfolia,* does not

Fig. 130. Southern Spatterdock (*Reduced one-half*)

develop aerial leaves, but they gradually lengthen as the warm season progresses. Figure 130 shows the plant in March. Later the stems and leaves will be longer. In October a new growth starts close to the thick, running root or rhizome. The leaves of this Spatterdock are of the brightest green hue and do not darken in strong light. Where the rhizomes have been broken off they have a tendency to rot, eventually killing the plant. This seems to be overcome by planting in sweet soil.

Fig. 131. Japanese Spatterdock (*Reduced two-thirds*)

The Japanese Spatterdock, *Alisma spec.,* has leaves of a considerably darker sage green, broader at the base. It is a continuous grower, has no aerial leaves and multiplies readily at the rhizome. Altogether a satisfactory plant for the large aquarium.

FONTINALIS

Known as Willowmoss these plants are found attached to stones or other substantial objects. They are of a pleasing dark-green color and have the advantage of doing well in a subdued light, although a moderate amount of direct sun does them no harm.

Fontinalis antipyretica grows in long branching form, with leaves closely adhering to the stem. It occurs in cold-water streams and rivers, being very plentiful in some localities but is not freely distributed.

Fontinalis gracilis is very much smaller and threadlike, the leaves being so small as to appear like a roughness on the stem. In the aquarium this plant seems to have a faculty of soon becoming covered with sediment. Indeed some aquarists find it useful to clear the water. As soon as the plant becomes well covered it is taken out, rinsed off and returned. As the stems are strong they stand this treatment successfully. A stone containing a thick bunch of *Fontinalis gracilis* is an attractive feature in the aquarium. It is a slow grower. The new leaves are bright green but soon turn to a dark sage color.

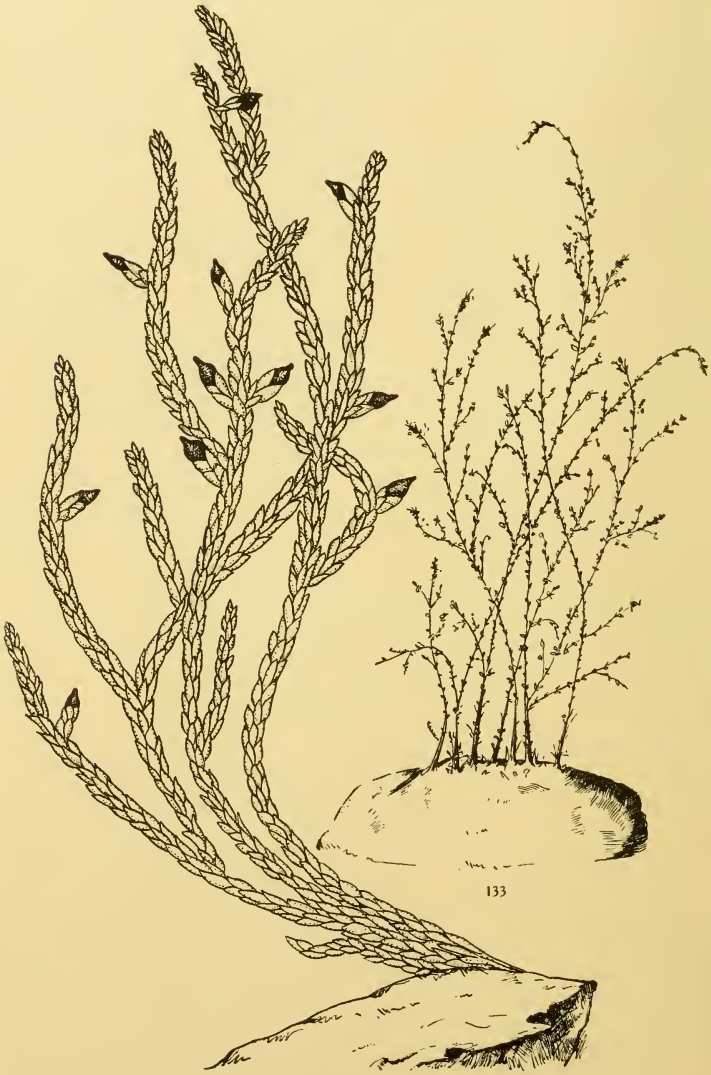


Fig. 132. Fontinalis antipyretica (*Life size*)
Fig. 133. Fontinalis gracilis (*Life size*)

FIG. 134. HERPESTIS (*Life size*)
FIG. 135. SPRING STARWORT (*Life size*)

HERPESTIS

Herpestis amplexicaulis bears a general resemblance to Moneywort, but in essential characteristics is quite different. It is a pure aquatic with thick leaves and a stout stem. Native to the ponds of Southeastern United States as far as Florida. It is one of the best of recent additions to aquarium plants. On account of being a slow grower its introduction is not likely to be rapid, but once established it does very well, holding its bright green leaves a long time. When out of the water it has a pleasant faint odor. Being of Southern origin it will prosper in the temperature of tropical aquaria where some plants will not do so well, although it thrives in cool water also. Incorrectly known as *Bacopa*.

CALLITRICHE

Floating in small, cool streams throughout the United States and Lower Canada one will find patches of brilliant, light-green small leaves. Examination will show them to be the floating leaves of a long-stemmed plant growing in the mud. These are various forms of Callitriche, or Spring Starwort, sometimes also called Water Fennel. When the plant is loosened we find it disappointing, for the lower leaves are thinner and quite different in appearance. The stems are tangled and difficult to disengage.

Callitriche verna is the commonest form, as well as the most easily established in the aquarium, but it shows to best advantage in shallow tanks where a top view can be had of the surface leaves. It should, however, only be kept with tropical fishes unless it is intentionally given to goldfishes to eat, as they are fond of it. The stems and roots when taken are usually swarming with various aquatic insects and crustacea. Although many of these are good fishfood it is best to thoroughly rinse this and all other plants before placing in the aquarium.

HIPPURIS

Formerly used as an aquarium plant, Mare's Tail has been overlooked of recent years, possibly on account of its tendency to stand above the water. Used in a suitable way this feature could be utilized to advantage. It transplants well and will thrive under varying conditions, but does best in ample light. Occurs in swamps from Labrador to Maine and also the Pacific Coast.

MONEYWORT

Lysmachia nummularia or Moneywort is also known as Wandering Jew, Creeping Jenny and Herb-twopence, the latter name and Moneywort no doubt being derived from the rounded shape of the leaves. It is com-

Fig. 136. Mare's Tail (*Life size*)
Fig. 137. Moneywort (*Life size*)

mon in all the Eastern States, growing in damp places, usually near or bordering streams. Considering that it is scarcely even a bog plant it does remarkably well in the aquarium, where it grows straight up to the surface of the water, regardless of where the light comes from. It is a fair oxygenator, but if kept submerged the leaves gradually dwindle in size, so that it is best to gather a new stock once a year, August or September being the best season to secure vigorous plants.

QUILLWORT

Isoetes is a widely distributed genus of a number of species. It is found in the mud and sand at the edges of streams and ponds. In size it

FIG. 138. QUILLWORT (*Reduced one-half*)

varies from a few inches to several feet. The small submerged species are worth trying in the aquarium, as they are tenacious of life. The leaves rise from the centre of a circle or rosette, producing a very pretty effect. Quillwort should be placed in a good light. It is eaten by some snails and fishes.

FIG. 139. HETERANTHERA (*Life size*)

HETERANTHERA

Heteranthera zosteraefolia is a very light green plant, slightly resembling Anacharis, but with longer, more widely separated leaves. It is a rapid grower, soon reaching the top, where it lays limp on the surface of the water. A good oxygenator, but has never become very popular on account of its rambling, untidy habits. Can occasionally be had of dealers.

LACE PLANT

This extraordinary plant, *Ouviranda fenestralis,* is a native of Madagascar. Its dark-green skeleton leaves appear very fragile, but in reality they are the toughest-leaved aquarium plant we know of. They are slow

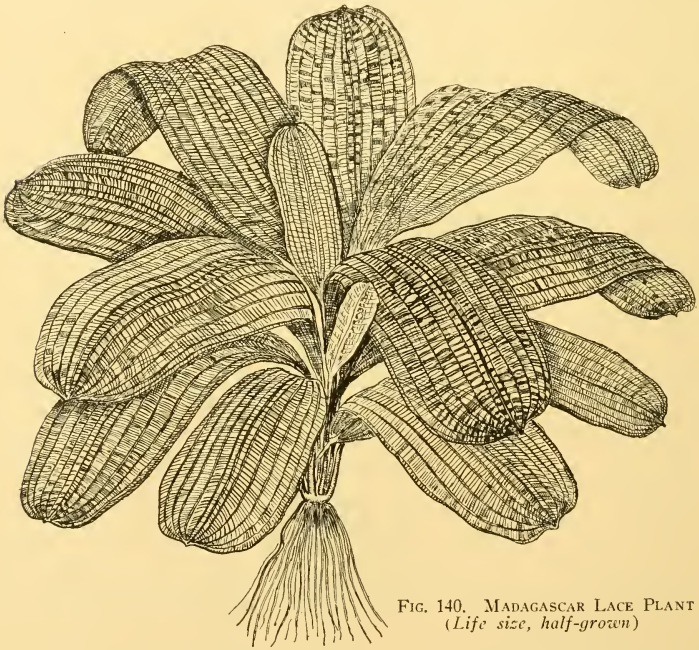


FIG. 140. MADAGASCAR LACE PLANT
(Life size, half-grown)

of growth and prefer a subdued light. Propagation is by division at the root. This sometimes takes place in the aquarium, but they do best in wooden tanks. At best they are slow growers which in a way is an advantage, for they eventually become rather large. The Lace- or Latticeleaf plant is used purely for ornamental purposes, its qualities as an oxygenator being negligible.

FIG. 141. WATER POPPY (*Reduced one-half*)

FIG. 142. DUCKWEED (*Life size*)

FIG. 143. AZOLLA (*Life size*)

FIG. 144. CRYSTALWORT (*Life size*)

WATER POPPY

Limnocharis humboldti, owing to its generally satisfactory qualities, has become one of the most popular plants in the indoor and outdoor tank, as well as the large aquarium. It grows very rapidly and continuously sends out new plants which have groups of buds. Usually a new bud blooms every day. The 3-petaled yellow flower with a brown eye or centre only lasts a few hours but is a most pleasing and artistic feature. The parent plant should be potted, preferably not very deeply in the water. The new plants run at the surface, occasionally sending down strong stems to obtain a fresh rooting.

Floating Aquatics

DUCKWEED

This commonest of all floating plants is found in several species in still pools everywhere. From the middle of summer until cold weather many ponds are completely covered with this green mantle, greatly interfering with the work of collecting daphnia for fish food. Duckweed itself is a good food for goldfishes large enough to eat it, and has a laxative effect beneficial to the finer breeds. The form most commonly found is *Lemna minor*. Propagation is by offshoot extensions.

AZOLLA

Azolla caroliniana is one of the less used of small floating aquatics. It is not in any way a brilliant plant but has a rather quaint charm. The leaves are of velvety appearance and range from a dull sage-green to dark red, according to age and the conditions of light. To be had of dealers. Native to the Southern States.

CRYSTALWORT

Riccia fluitans grows in masses in small, angular shapes, resembling crystal formation. It floats just beneath the surface and is valuable in the propagation of small tropical fishes, some depositing eggs in it, and the new-born young of the live-bearing varieties using it for hiding places. Native to the Eastern States and may be had of dealers in aquatics.

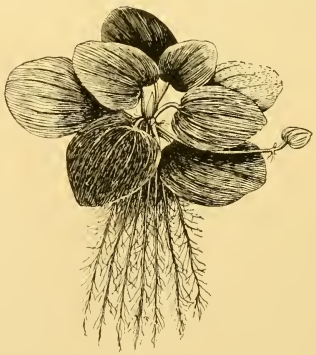


FIG. 145. SALVINIA (*Life size*)
FIG. 146. TRIANEA (*Slightly reduced*)

SALVINIA

Of the small floating aquatics Salvinia is one of the best. The heart-shaped leaves with bristle-like growth on the upper surface seem like bits of velvet connected by a thread. The roots are naturally long for the size of the plant but fishes usually eat them down to about half length, which interferes with a full development of size. In the greenhouse where they have a moist atmosphere and no interference they develop with amazing rapidity. The variety illustrated, *Salvinia natans,* is native to Europe and is the form commonly used in aquaria and pools.

Although it is claimed that neither Salvinia nor the common wild Duckweed perform any oxygenating function, the author and others have many times seen aquaria completely covered with either of these plants and, with no other plants in the aquarium, the fishes were getting along perfectly well.

FROGBIT

Hydrocharis morsus-ranæ, requiring the same conditions as *Trianea bogotensis,* deserves more attention than it is receiving. Of very pretty appearance when in flower, readily obtained from dealers, there is

Fig. 147. Frogbit (*Life size*)

no reason why it should not be better known. As will be noted in Figure 147 it propagates from runners, but the seeds also germinate under favorable conditions. The plant is of European introduction.

TRIANEA

Trianea bogotensis is an attractive, small floating plant with thick, heart-shaped leaves. It needs a moist warm atmosphere and not too much direct sun. Under these conditions it thrives and is a valued feature in the summer pool or greenhouse tank. It is not found locally in temperate climate but may be had of dealers.

WATER FERN

Not looking particularly fern-like, the Water Fern, *Ceratopteris thalictroides,* is the only truly aquatic species of the fern family. It is of comparatively recent introduction into the aquarium and indoor pool,

FIG. 148. WATER FERN (*Reduced*)

it being more suited to the latter. In a partially shaded position in the greenhouse it grows into floating masses a foot or more in diameter, piling up to some height on account of its peculiar means of reproduction,

the new plants springing directly out of the parent leaves, as is shown in Figure 148. Ordinarily the plants are about 6 inches in diameter and are of very pleasing appearance. Native to the Tropics around the world.

WATER LETTUCE

Pistia stratiotes is a floating plant with fluted, light-green velvety leaves, forming a rosette. It likes plenty of heat, a moist atmosphere and protection from the sun. Under favorable conditions it grows to a

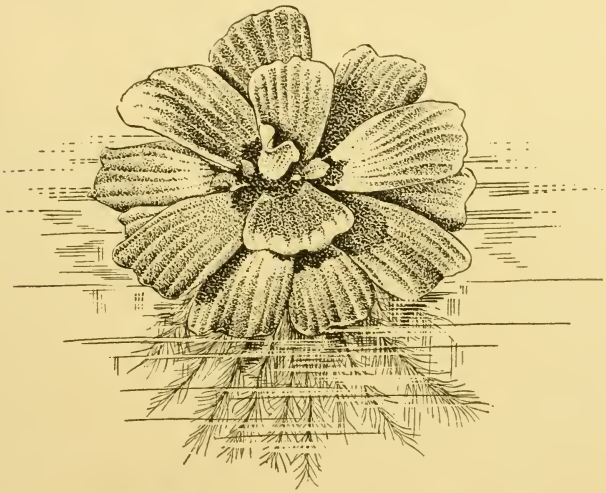


Fig. 149. Water Lettuce (*Reduced one-quarter*)

diameter of about 4 inches or more and is decidedly pretty. The roots sometimes attain a length of 18 inches, but they are not sufficiently dense to use for spawning purposes. Multiplies rapidly in a congenial environment.

WATER CHESTNUT

Probably obtaining its popular name from the serrated edges of the leaves somewhat resembling those of the Chestnut tree, *Trapa natans* forms one of the pleasing varieties among floating aquatics. It is an annual doing well in exposed out-door positions. New plants are pro-

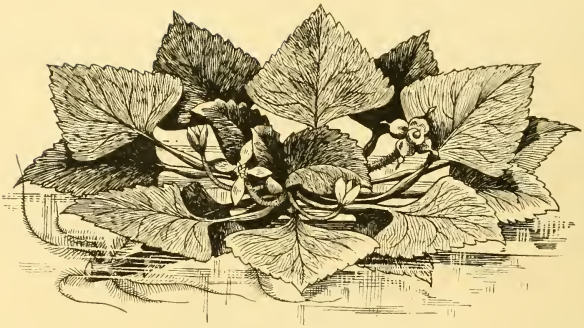


Fig. 149a. Water Chestnut

duced each year from large, hard seeds. The big, black, two-horned seeds sometimes sold in Chinese stores are of a closely related species of *Trapa*. Can be had of dealers after May 15.

WATER HYACINTH

Although Water Hyacinth, *Eichhornia,* is considered a pest in its native habitat on account of clogging up rivers and lakes, it is none the less a favorite with the aquarist, especially the breeder of goldfishes. Its long, finely divided dense roots are admirable for receiving the eggs of any fishes that spawn on plants. The pale purple flower-spike only blooms for a single day but is quite beautiful, having the general form of its namesake, the Hyacinth. Propagation is by runners at the surface of the water. Figure 150 clearly shows this. Water Hyacinths do best if their roots can root or drag in soil. Outdoors they do not like to be blown about nor to strike against the sides of a tank, although apparently not minding how closely they are crowded together. This plant does well in a warm greenhouse the year round. Unless supplied with plenty of light and heat during the winter they degenerate very much.

Fig. 150. Water Hyacinth, Showing Detail of Flower and the Formation of a New Plant

Fig. 151. Hardy White Water Lily (*Tuberosa richardsoni*)

WATER LILY CULTURE

All fish pools or large tanks standing in the sun should have water lilies growing in them. They are of easy culture and not only give protection to the fish but add greatly to appearances. Small or large varities may be had, according to the needs of the space. Water lilies are divided into the tender and hardy varieties. The tenders are more free-blooming and the day-blooming tenders are the most fragrant, as well as presenting the greatest range of color. They usually open in the fore part of the morning and close in mid afternoon. The night bloomers open in the evening and close about nine in the morning. They are not fragrant nor as elegant as the day-bloomers, but they are called the business man's water lily because he can see them in bloom in the evening and in the morning.

Water lilies need extremely rich soil. A mixture of half clay and half cow manure suits them very well. An inch top layer of sand will prevent any of this soil from getting into the water. The crown of the plant should not be covered and ought to be about 12 to 14 inches below surface of the water. They need an abundance of sunlight.

Before freezing weather sets in the tender plants should be taken up. Close to the main root will be found a few tubers about the size of shellbarks. These are the starts for next season's plants. They are to be broken off and kept in cool water or moist sand. In April they may be laid in shallow, warm water until sprouted, then placed in submerged pots and later permanently planted out in June.

Hardy water lily roots only need be kept moist and from actual freezing. In a pond they may be left out. In early Spring they form a number of new crowns. The parent root should be cut up into pieces, allowing a crown to each piece. Plant only one crown to a pot. Let all water lily pots be as large as space will permit. Most tenders will grow and bloom in a 7-inch bulb pan in an ordinary tub, but they are dwarfed from lack of space. They will do better in a box about a foot deep by thirty inches square, or in a hole 18 inches wide and 20 inches deep, as shown in Figure 163. Tropical water lilies have a surprising degree of intelligence in adapting themselves to the size of the pool they are in. The ordinary hardy water lilies if given as much space as they can use will have a surface diameter of about 4 feet. The usual tropicals vary from 10 to 15 feet, but will do well in pools of 6-foot diameter.

In the maze of offerings and alluring descriptions of water lilies, the beginner is at a loss to know what to select. We present a list of the most satisfactory varieties in each class. Most of them sell at moderate prices and can be had of either of the two leading dealers, Dreer's at Riverton, N. J., or Wm. Tricker, Arlington, N. J.

Hardy

WHITE: Gladstoniana, Marliacea albida, Richardsoni.
PINK: Marliacea rosea.
YELLOW: Marliacea chromatella.
RED: Paul Hariot, Gloriosa, Aurora, James Brydon.

Tender Day-Blooming

WHITE: Gracilis.
PINK: Mrs. C. W. Ward.
BLUE: Pennsylvania, Wm. Stone, Pulcherrima.
PURPLE: Zanzibariensis.

Tender Night-Blooming

WHITE: Dentata magnifica.
PINK: O'Marana.
RED: Rubra, Devonensis.

Winter-Blooming (Indoor)

BLUE: Mrs. Woodrow Wilson, Panama Pacific.

Small Hardys

Pygmaea (white), Pygmaea helvola (yellow), Laydeckeri lilacea (rosy lilac), Laydeckeri rosea (pink to red).

OTHER POND PLANTS

Lotuses (Nelumbiums)

Album grandiflorum (white), Luteum (yellow), Speciosum (rose), Pekinensis (red).

The culture of Nelumbiums requires more root-space than for water lilies. Planted in a shallow pond where they have plenty of space for the strong roots to branch out and travel, they prosper amazingly. They are hardy over winter, and if it is desired to confine them to a certain space or locality they should be boarded in or otherwise divided from the rest of the pond. The roots go several feet deep. The Lotus is one of the most beautiful of all decorative plants. Its magnificent leaves and flowers swaying majestically in the summer breezes give us an inkling of why the ancient Egyptians considered the plant sacred.

Among the best of the bog and pond plants are Variegated Sweet Flag, Cape Pond Weed, Marsh Marigold, Umbrella Plant, Cyperus Papyrus, Water Arum, Pickerel Weed, Sagittaria japonica, Sagittaria montevidiensis, and Lizard's Tail.

Water Snowflake is one of the most charming of the small floating aquatics. White, star-like flowers of 1-inch diameter are freely borne above the water. Parent plant should be rooted in soil near surface.

FIG. 152. NELUMBIUM SPECIOSUM

The Sacred Lotus of the Orient, from 4 to 7 feet in height, is easily the most magnificent of the aquatics with leaves and flowers above the water.

Fig. 153. Prizewinning Calico Comet Goldfish

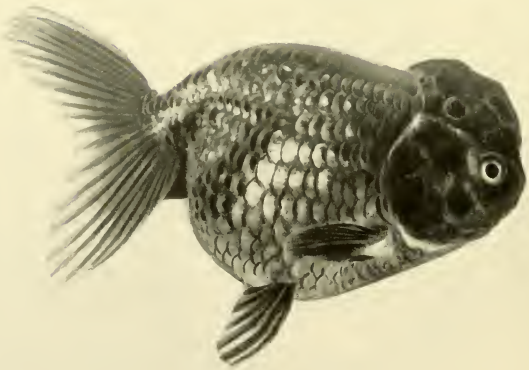


Fig. 154. Prizewinning Lionhead Goldfish

These two specimens show perhaps the greatest possible divergence of extremes in the accomplishments of fancy fish breeders. It is almost incredible that they are both derived from the same root stock.

Enemies of Aquatic Plants. The most serious enemies are musk-rats. These eat the roots of several hardy aquatics, particularly over the winter season. They are partial to the roots of the small yellow water lily, *Pygmaea helvola*.

Fig. 155. Aquatic Cut-Worm

A leaf-cutting worm (*Hydrocampa*), sometimes becomes quite a nuisance. It cuts a piece from the edge and, laying it on the leaf, attaches the two together and uses the two pieces as a cocoon. Loose bits of water lily leaves, Sagittaria, etc., observed floating around will, if pried apart, often be found to contain this white worm. The accompanying illustration is of life size.

Chapter Sixteen

Photographing Fishes

PHOTOGRAPHING FISHES

Achievements of modern photography have done much to lessen the difficulties of photographing living fish, although a picture good in every respect demands all the patience and care at one's disposal. Exact photographic records are extremely interesting to the fancier, valuable to the scientist and form the only certain basis for noting the changes in the fancy breeds of goldfish.

A high-grade lens that will work at F 6 or better and a shutter that will give an exposure of 1-25 second should be used. Sufficient length of bellows is needed so that the fish may be photographed about two-thirds life size. Sharp negatives can be had in this way and those which turn out well can be enlarged. Direct photography at life size is not practicable, as the depth of focus and power of the light are very much cut down at this close range. The chances of blurring by movement are greatly increased by attempting to photograph at life size. A photographic plate size 5 x 7 is quite satisfactory for photographing goldfish. For the most of the tropicals, 4 x 5 is sufficient. The Graflex camera is very convenient, allowing one to focus up to the instant of exposure.

To properly carry out this work a special photographing aquarium should be prepared. It should be seven inches deep, seven inches wide and two and one-half inches through from front to back. The front should be of ⅛-inch plate glass. This is important. A white background for photographing dark subjects and a black for light ones will be needed. A piece of cardboard folded twice and stood on end immediately in back of the aquarium will be found to be satisfactory. The back may be painted with flat black to serve for the alternate background. If this is done the two creases should be stripped with tape so the board will not separate when the fold is reversed. To carry out the background effect completely, cut a piece of glass the size of the inside bottom of the aquarium. Paint one side white and the other black, using either as required. The fish will frequently sink to the bottom, and if the background is of the proper color throughout, the photograph can be as well made there as higher in the water.

A very important item is to have a movable glass partition so that the fish may be forced near the front glass and thus kept in focus. Thin brass forms to snap on either top end of the aquarium and leaving notches filed to hold glass partition in position will be found most convenient.

FIG. 156. PHOTOGRAPHING AQUARIUM

This aquarium was used in making all the photographic reproductions of fishes shown in this volume. Note glass partition for keeping subject in focus.

Fig. 157. Prizewinning Celestial Telescope Goldfish

As well as being one of the most extraordinary appearing of goldfishes, the Celestial is also the most difficult to breed and keep alive.

All the camera except lens should be covered with a black cloth at time of exposure to prevent its own reflection in the aquarium. The author believes that sunlight furnishes the best illumination, giving better color values and modelling than flashlight. Exposures should be made only on very bright days from eleven until two o'clock, and in the period, if possible, between April 10 and September 1. At other times flash-powder will be better, using a liberal supply. Care should be taken not to allow the dust from flashlight to settle in the aquarium, as it contains metallic salts injurious to fishes. Keep the sun on the subject and directly behind the camera. The water should be as free as possible of all particles, as they show in the picture with annoying distinctness. Much patience is sometimes required to get a fish into a satisfactory "pose," but when a good picture is obtained, it is well worth all the trouble it costs.

The photographing aquarium shown herewith was constructed by pouring cement in a form surrounding the four uprights. Just after the cement is poured, quarter-inch square sticks of wood should be pressed in where the glass is to stand. These are removed when cement is dry. Waterproof the base as described on page 216, then fill all four depressions and posts with aquarium cement and insert glass. Owing to small size of aquarium it is best to do all cementing before any glass is inserted for it is impossible to satisfactorily reach inside. Only the front needs to be of plate glass. This should be inserted first and all surplus cement neatly cleared away. It will be noted that this style of construction has no bottom metal frame to interfere with photographing when the subject happens to be low, which is often the case. One part of cement to two of sand is a good proportion. White cement makes a pretty effect and when using a white background, no other inside reflector is needed. This aquarium was used in making the photographic illustrations of fishes in this volume.

Unless the base immediately in front of the glass is of a dull black it will be desirable to cover it with a dull black or red cloth. Black is better.

Chapter Seventeen

Construction of Aquaria, Tanks and Ponds

AQUARIUM CONSTRUCTION

The amateur aquarist with a little talent for things mechanical can find profit as well as pleasure in making an aquarium according to his own ideas and requirements. The few necessary tools either are, or ought to be, a part of every household equipment.

Naturally the first consideration is that of the space to be occupied by the aquarium. In determining this it is well to be influenced, as far as conditions will permit, by the needs of the aquarium inmates. As to proportions, it will be found that most aquarium fishes do best in shallow aquaria with plenty of water surface. However, for artistic arrangement and symmetrical plant growth we must have a certain amount of depth. Twenty inches deep is sufficient even for large aquaria. In the smaller sizes, plants of suitable height can be secured. For all-round purposes, bearing in mind both the artistic and the useful, a good general rule is to make the aquarium in the form of a double cube. That is, the width and height identical, and the length twice that of either. Unless an aquarium is to be viewed only from the top, it is not advisable to make the width over 25 inches, as even a slight cloudiness of the water considerably obscures the fishes when there is so much of it to look through. Within reason, make the aquarium as large as possible, but nothing over a 70-gallon size is to be recommended for the household. An accidental breaking of the glass, even at this size, is too great a catastrophe to contemplate with composure. Since it is very little more trouble to keep a large-sized aquarium than a small one, and the results are so much better, at least with goldfishes, we would unhesitatingly say to those weighing the merits of two sizes, *take the larger.*

For a large variety of tropical fishes, a number of small aquaria will be found preferable. These will be treated of hereafter in the present chapter.

After the considerations of size and proportions, which we have already touched upon, we will now take up in order the points of construction, laying particular emphasis on the factor of safety.

Bases. The best material for general use in aquarium bases is slate. It is inexpensive, durable, easily worked, free from cleavage cracks, and in every way reliable. The requirements for thickness are from ¾ inch for sizes up to 30 gallons, to 1¼ inches for 130 gallons. Polished Tennessee marble makes a handsome and durable base. White marble is too glaring and besides is easily chipped in moving an aquarium about. Also

when brought into contact with aquarium cement it absorbs and spreads the oil, making a bad appearance. Bases of heavy white pine, strongly cross-battened, have been used with success, but the wisdom of using a wooden base is open to serious question, especially as wide, thick pine boards can scarcely be had any more, even at high prices. The ever-present danger of warping either from a leak or the weather, or again from bending due to continuous heavy pressure are considerations weighing against the wooden base. If an all-wood frame is used, it is desirable to line the bottom with a sheet of glass, preferably wired, embedding it in soft aquarium cement at the edges, and at several supporting spots near the centre. The same plan is to be recommended in aquaria with solid metal bases, in order to keep iron rust out of the water.

Aquarium bases usually extend from one to one and one-half inches beyond the frames on all sides. Slate or marble bases ought to be bevelled sufficiently on the upper edges and corners to take away the sharpness. The necessary holes through which the frame is to be clamped on can be drilled with an ordinary metal drill, but it costs very little extra to have the slate-worker do this when he is finishing the base. Aquaria up to 10 gallons require 4 bolts, 20 gallons 6, and for the larger sizes they should be placed about 10 inches apart.

Frame Metals. Angle brass, iron or aluminum form the best metal aquarium frames. For the amateur worker, brass offers the best advantages. It is easily sawed, drilled and soldered, besides making a handsome appearance when polished and lacquered or nickel-plated. If nickeled it should be heavily coated. Angle iron is not so attractive in appearance, but is undoubtedly more rigid. It cannot be soldered. Consequently the four corners of the upper and lower frames have to be riveted through connecting elbow pieces on the inside or special castings on the outside, and then the whole riveted to the uprights. Aluminum has seldom been used, but makes an attractive frame. As the soldering of this metal is of doubtful durability it is safer to rivet the same as with iron.

For aquaria up to 25 gallons, ⅝-inch angle metal is suitable; up to 50 gallons, ¾ inch; up to 75 gallons, 1 inch; up to 125 gallons, 1¼ inch. The author prefers seeing as little of the frame as possible and for ten years has successfully used a 60-gallon aquarium constructed with only ⅝-inch angle brass, but he would not care to make this as a general recommendation. It is mentioned so that if others have the same idea they will know that it is a mechanical possibility.

Unless constructed of heavy angle iron it is best to carry a light rod across short dimension of the centre of top frame of aquaria over 30 inches in length, to prevent bulging by water pressure.

Frame Construction. A hack-saw with fine teeth for metal-working will be needed to cut the proper lengths of angle metal. After carefully determining proportions desired, cut the four uprights and then the material for top and bottom frames. If working in brass the latter should

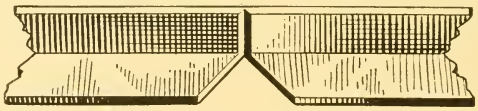


Fig. 158. Cut, Preparatory to Bending Angle Brass

each be left in one piece. By accurately bevelling the two ends and preparing right-angle cuts at three points as shown in figure 158, the whole can be bent into a frame that will produce very neat corners and make soldering easy. The right-angle cuts should be finished with a square file and carried within about 1/32 inch of going through. This leaves the bar very weak at these points and considerable care is necessary in handling in order that some accident does not break them apart before it is time to bend. If one breaks it is not a very serious matter, only the corner will not have quite such a neat appearance. In practise we find it best to bend each cut as soon as finished and roughly fasten with solder. When all

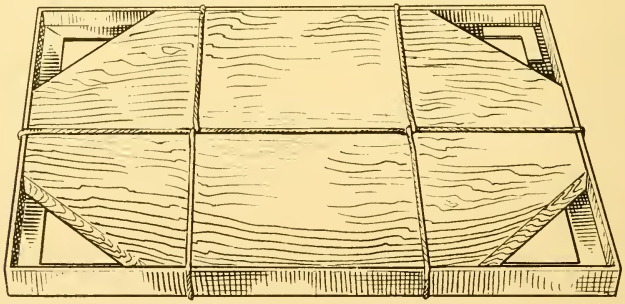


Fig. 159. Frame Secured Around Wooden Form. Note Re-inforcement in One Corner

three bends have been completed, place within it a wooden form as shown in figure 159. Except for the corners being cut off (to allow for soldering) the edges of form should be perfectly rectangular and fit closely. Now secure quite firmly with stout twine. After all corners are trued up with the board, apply the permanent solder. Melt solder from any

corner that does not stand true without forcing. In the upper-right corner of our illustration will be noted a right-angle flange reinforcement, cut from a flat piece of 1/16-inch brass. It is advisable to use these. They add greatly to the strength and actually make the work of soldering easier. After preparing the surfaces with solder-flux it is only necessary to place solder on the frame, lay the flange on top of it and apply torch beneath. When solder melts, press flange down and into exact position with a small stick of wood. It is better to have flanges sufficiently narrow to allow the uprights to fit in back of them.
The same form can be used for upper and lower frames. Should there be any irregularity in shape they will both be alike, and so far as strength is concerned, it will only be necessary to keep corresponding defective corners parallel with each other, so as not to make any twisting strain on the glass—a force which, sooner or later, will cause it to break. If the frame is too large for a board, it may be trued by lines drawn to lay it over. The use of forms, however, is so desirable to the amateur that we recommend having boards rabbited together in order to secure sufficient width.

To test the squareness of upper and lower frames, lay them on the floor, make marks at the corners and turn completely over, trying both length and width in this way. Tests by squares at corners are only approximate, as the angle metal is seldom perfectly straight, especially lighter brass. Before leaving the subject of bending the frames to right-angles we strongly suggest that an experimental bend first be made with a waste piece of angle brass. A little practise will be necessary to learn just how thin a particular lot of brass must be filed in order to make a good bend.

The next step is to bore holes in the lower frame where it is to be bolted through the base, countersinking for depression of bolt or rivet head, and allowing enough room not to interfere with the glass. Now solder in uprights at perfect right angles to inside of top and bottom frames, being careful not to use enough heat to melt former soldering.

It will be observed that the glass will be supported by the upright posts but not by the top nor bottom frames. This is corrected by soldering, about every eight inches, a small piece of brass (cut from the same material) to the horizontal frames next to where the glass is to come, thus giving it even support on all four edges. The pieces are soldered down perfectly flat and if high should be filed down. Before the glass is finally inserted it must be laid in the frame to see that the points of contact are even. Deficiencies can be made up by a drop of solder on the brass, and filed down as required.

The frame being trued up it is now bolted through the base, aquarium cement being liberally supplied in the bolt holes and between the frame and the base, all surplus being immediately wiped away.

Soldering. The ordinary amateur is equipped neither with the facilities nor the experience to use a soldering iron to advantage. The author has engaged in considerable aquarium construction and has usually been able to get along very well without an iron, its main use being to clear surplus solder away more quickly than can be done with a file. Before soldering, the surface is properly prepared by scraping and the application of a flux composed of hydrochloric acid which has dissolved as much zinc as possible. An alcohol blow-torch is satisfactory for small work, but for the heavier construction a gasoline torch is better. When the heat is applied and the liquid of the flux has boiled away, touch the heated surface occasionally with soft solder wire. Apply a little more heat after first sign of melting, withdraw flame and proceed to quickly solder. Where work is in a position so that it is difficult to hold the pieces steadily in place while solder cools, an assistant can instantly "set" it by pouring on a little water. If acid flux darkens the hands where it touches, the stain can be removed by dilute ammonia water.

Small Aquaria. Very compact, neat and substantial aquaria can be made in the foregoing manner, but without projecting base—in fact without slate at all. The bottom is self-contained concrete. The top frame and upright corner posts are of ½-inch angle brass, and the bottom frame of 1-inch size. In the inside edges of this are soldered a few brass screws. Now prepare a mixture of one part of Portland Cement to two of clean sand, brought to a thick, mushy consistency by addition of water. Lay the frame on a good, flat piece of glass and pour in the cement to a depth of ¾ inch, seeing that it lays smooth, particularly where the glass is to rest.

After the cement is poured and smoothed it should be covered to be allowed to dry slowly. In about two days the frame and base can be slid off the glass. The screws soldered on inside will always hold the base securely in place. To prevent free chemicals washing out of cement into the aquarium water it is well to waterproof the inside of base before setting glass in. This may be done by melting chips of paraffine under the alcohol blow-torch, or by pouring on a mixture of paraffine dissolved in warm gasoline. To prepare this mixture place a quart bottle of gasoline in a butcket of warm water. Add two ounces of paraffine chips and stir until dissolved. Keep the solution warm and saturate the base with it. When dry, place in glass as in an ordinary aquarium.

(The foregoing mixture of gasoline-paraffine will waterproof wood, concrete, brick, fabrics or anything that will absorb it. For fabrics to be used or bent, use only one ounce of paraffine.)

After making one of these aquaria the knack becomes very easy. A row of them of uniform size presents a neat appearance and can be used in small space, since there is no projecting base. This style of construction is suitable for aquaria with bases up to eleven by eighteen inches. In larger sizes the uprights and top angles ought to be from five-eights to three-quarter inch metal, while heavy wire screen should be embedded in the cement for re-inforcement.

If the frames are to be nickeled this should be done before pouring the cement base.

Glass for Aquaria. Although double-thick window glass may be used for aquaria up to the 25 gallon size, plate-glass is so much handsomer and costs so little more, it seems like a wise investment. If window-glass is used, the imported kinds will be found best. Plate-glass is now made in 3-16 inches thickness. This is suitable for aquaria under 50 gallons. For those for 50 to 75 gallons, the best thickness is ¼ inch, and for the still larger sizes up to 120 gallons, ⅜ inch. The author and others have occasionally picked up bargains in plate-glass from plate-glass insurance concerns, who often have on their hands large remnants of bulk-windows.

Setting the Glass. The edges of the glass should be carefully cleaned with whiting, ammonia or alcohol to remove any grease. It is well to first coat the edges which are to come into contact with the cement with gold size, allowing this to set for a day or two. This is more particularly needed with large plate-glass aquaria. Apply a liberal coating of aquarium cement to the inside of frame, and a thin but well covered coat to the contact edges of the glass. Press into place slowly but firmly, cleaning away at once all surplus cement. Light sticks cut of a length to brace across inside of aquarium will maintain an outward pressure on the glass for several days until it is fairly set. After the glass is well set it is advisable, especially with the larger sizes, to run a line of aquarium cement up the inside corners and along the bottom edges, covering with a narrow strip of glass, or, better, embedding a glass rod of from ¼ to ⅜-inch diameter in it, pressing in as far as possible and wiping away the surplus cement.

Fill slowly in about a week and change water several times in two weeks before putting in fishes.

Large aquaria nearly always leak a little at first, or after moving them, or even after emptying without moving. This usually corrects

itself within a few days, but, as elsewhere directed, it can nearly always be stopped by making the water very muddy. The particles of dirt get into the leak and choke it up.

Aquarium Cements. The prime requisites of an aquarium cement are resistence to water, adhesiveness, moderately quick setting without ever becoming stone-hard, and being non-poisonous. A cement combining these qualities is composed of one pound of litharge, one pound of Plaster of Paris, two ounces of powdered resin and one-half pound of glazier's sand; mixed with boiled linseed oil to a consistency of putty suitable for glazing. This cement has been found to be good for both fresh and marine water aquaria. A durable cement for those who cannot obtain very fine sand is made of equal parts by weight of zinc white, whiting and litharge, mixed with boiled linseed oil to a firm but tacky consistency.

Cement for Marine Aquaria. A cement used for large, city marine aquaria is composed of 3 parts by measurement of Portland Cement, 3 parts fine white sand, 1 part powdered resin; mixed with boiled linseed oil.

Cement for Wooden-Framed Aquaria. The best cement for small wooden-framed aquaria is made of 1 part of gutta percha and 4 parts of pitch, boiled together and applied warm, first heating the glass somewhat. It is difficult to handle this quickly enough on large aquaria, for which the following will be found better: 3 parts Portland Cement, 2 parts zinc white, 3 parts fine sand, 1 part powdered resin, made into a firm paste with boiled linseed oil.

CONCRETE AQUARIA

The making of concrete aquaria opens a new and an unlimited field. Those who have felt that the metal-frame aquarium is hopelessly restricted and commonplace can here find more room for individual expression, design and achievement. The illustration facing title page gives an idea of possibilities along this line. The aquarium shown is one designed and built by Mr. L. M. Dorsey and probably represents the highest development, up to this time, of artistic ideas as applied to a household aquarium. In the Philadelphia Aquarium Society annual competition Mr. Dorsey was awarded the prize cup three times, thereby becoming its permanent possessor.

As individual ideas will vary so widely in the design of concrete aquaria, only a few (yet important) directions can be given. Cement should be of the highest grade, fresh and free from lumps. A mixture of one part cement to two of clean, sharp sand is about right. Wooden

forms ought to be soaked with water just before using, or else thoroughly paraffined. Cement mixture should be wet enough to just pour, and needs to be well tamped to avoid bubbles. Re-inforcement rods (¼ inch diameter) are essential, especially around the top edge, where a continuous band should be formed. Over the bottom the bars should be wired together, forming 4-inch squares. Do not be in a hurry to get the forms off. The whole job should be moistened for a day and allowed to stand for two more days if their removal is going to cause any strain. Glass must not be embedded directly in the concrete, but provision made for later setting it in with ordinary aquarium cement. If sides do not support the glass evenly they should be cut away or built up until they do. Otherwise glass is sure to crack when the soft aquarium cement yields to the water pressure. After base is finished it is well to paraffine it as described on page 216. All cement pouring should be done at one operation.

CONSTRUCTION OF WOODEN TANKS

Many expert fanciers are of the opinion that for the welfare of fishes there is no receptacle equal to a well-seasoned wooden tank. For breeding purposes they are especially valuable, but in no case should tanks be used before numerous changes of water have been made over a period of several weeks.

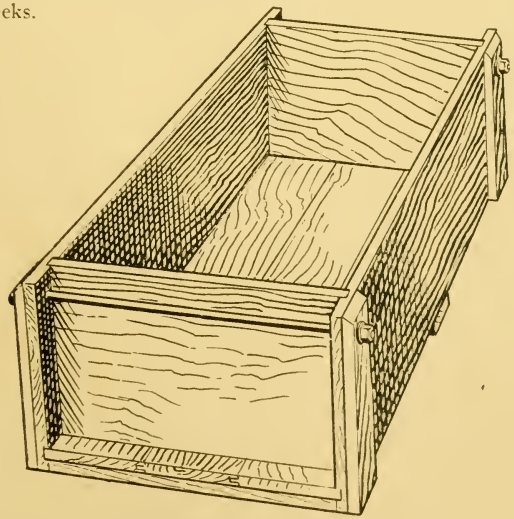


Fig. 160. Wooden Breeding Tank

The best wood for tanks is well-seasoned cypress, the natural habitat of the tree being in wet places. Any size tank may be made, but there are two sizes found quite convenient and which cut to good advantage out of the lumber. The larger measures 16 inches high, 30 inches wide and 48 inches long. The smaller one measures 9 inches high, 24 inches wide and 32 inches in length. For the larger size 1¼-inch lumber is used, which is about 1⅛ inches when dressed. Here a board 16 inches wide is used, avoiding seams in any of the sides, and being but one in the bottom. The side and bottom boards are rabbeted to ¼ inch deep and 1½ inches from edge to receive the ends. Bottom boards are tongued and grooved. All joints should receive a preliminary coating of white lead paint. After this is dried a thicker coat should be applied just before putting joints together. The tank is then clamped and 1¾-inch screws inserted through the sides into the bottom and ends, and through the bottom into the ends. Cleats 3 inches wide are placed across centre of bottom and all the way around the ends. Through the top of latter is passed an iron rod ¼ inch thick, then secured and tightened with washer and nut at ends. The smaller tank is constructed in the same manner, except that cleat across centre bottom and the iron rods are omitted.

While painting the outside improves the appearance, it has more of a tendency to rot a tank than preserve it, as the paint prevents the evaporation of the moisture naturally gathered from the inside. Leaks will usually correct themselves in a few days, but should they not do so, a few handfulls of earth stirred in the water and allowed to stand a few hours will make the job tight. Occasional stirring of the dirty water helps. The white lead should be allowed a day to harden before filling with water.

CONSTRUCTION OF TANKS AND POOLS

For outdoor purposes it is better to dig holes in the ground and puddle them with clay rather than make poorly constructed concrete basins or pools of any size. Unless the work is properly done the frost is certain to crack it, and even the weight of the water may be sufficient to bring about this result. Repaired work is never satisfactory, and the next winter will open more seams, making continual expense, dissatisfaction, loss of water and of fishes. With indoor concrete tanks too, thorough construction is a good investment.

The main points in the construction of such work are good foundations, thorough reinforcement, good cement properly mixed, and one continuous job of the finishing coat. The concrete centre ought also be poured within the space of one day. There is some difference of opinion as to the necessity for a base of cinders. The author favors them. If used they should be the hard kind, wetted down and packed solid to a

depth of one foot or more. For tanks of moderate size—say 11 x 22 feet—reinforcement should be by use of ¼-inch steel rods, crossed on squares of 8 inches. The bottom needs two layers of these bars, one near the upper and one near the lower surface. This protects against both

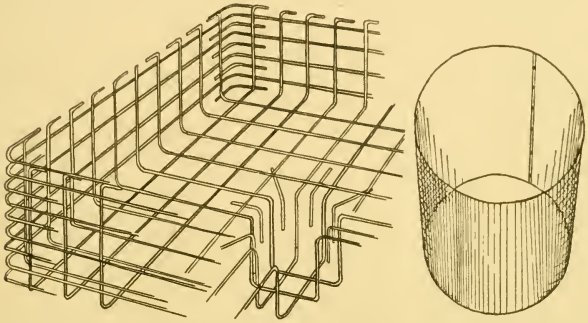


Fig. 161. Correct Arrangement of Reinforcing Steel, and Galvanized Iron Form for Water Lily Pot

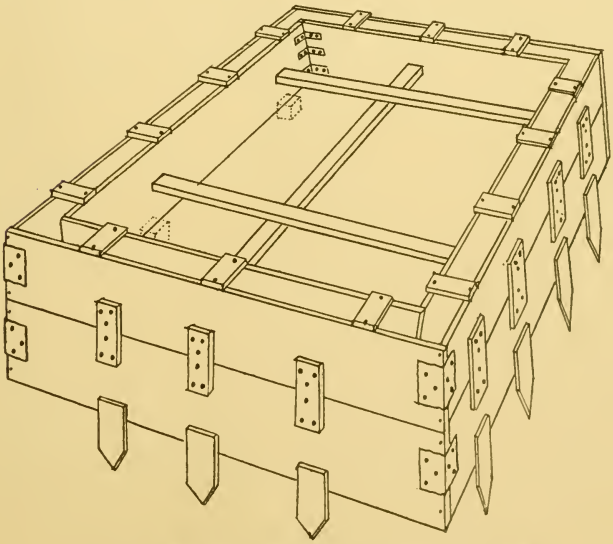


Fig. 162. Wooden Form Ready for Concrete Pouring

The dotted blocks represent bricks or stones to hold inside form to same height as the outside. Note slope of inside form.

inside and outside pressures. The lower frame of bars is bent up at the ends to form a cradle, thus reinforcing the side walls. The ends are finally again bent over at right angles, running in the direction of the wall, and laced together. Above this are two continuous bands of the steel. Figures 161 and 163 will indicate these points. The corners are always the weakest points. As the concrete is poured, lay in extra right-angle pieces of 12 inches total length.

The pouring of the concrete makes a great strain on the forms. These need to be thoroughly braced in the beginning, for it is impossible to improvise means of looking after these points, once the work has started and the walls have bulged or the corners sprung. The outside bottom stakes are merely driven into the ground and not otherwise fastened. Outside corners in addition to being nailed are secured by pieces of tin, nailed through. Inside corners are held by iron elbows (to be had at hardware stores). They are secured by screws. The nails fastening side-cleats should be driven through and turned over. Concrete walls had best be thicker at the bottom, putting all the slope on the inside. A good inside depth for ordinary purposes is 15 inches, filling to 13½ inches with water. If an overflow is to be made through side, make a core of soft wood and saturate it with water so that it will contract upon

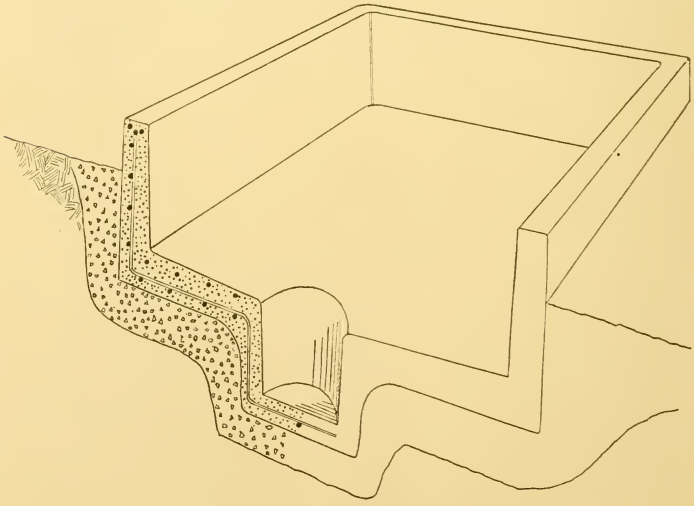


Fig. 163. Cross-section of Finished Pool

The lowest layer represents cinders. We have indicated here the upper layer of re-inforcement in the base, impossible to show in Fig. 161.

drying. For outdoor pools an inside slope of 2 inches is about right. This would be, for a 7 x 9-foot pool, a top thickness of 4 inches, with 6 inches at the bottom. Base, 6 inches thick. For larger sizes add 1 inch of thickness to walls and base. Indoor pools require no slope. In making all calculations, allow ⅜ inch for thickness of finishing coat. The forms should be levelled up and made absolutely true in the beginning. It is a bad plan to depend upon the finishing coat to correct inaccuracies. It seldom does it. Some considerable care is necessary to establish the four corners at perfect level. Select one corner and measure each of the other three from that. If the spirit-level is attached to a board, its trueness should be tested by reversing the ends. In any case the level should be reversed on each test.

The concrete is mixed 1 part cement, 2 parts sand, 4 parts ¾-inch crushed stone or round stone. This is poured to within ½ inch of top of form, beginning with the base and must be well tamped to avoid bubbles and open spots. Those wishing to secure the best possible results first place a thin skin of cement over the cinders so the water in concrete will not seep into the cinder base, it being desirable that all concrete work dry slowly in order to crystallize perfectly. This preliminary skin is as thin as possible and is applied the day before. It is composed half each of sand and cement. If this is used, the lower layer of re-inforcement may be laid directly upon it.

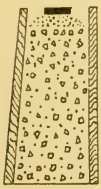


FIG. 164

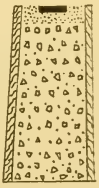


FIG. 165

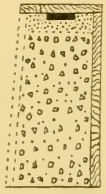


FIG. 166

Fig. 164. Tile Set on Cement Mound. Fig. 165. Top Finishing Coat Brought to Level of Form. Fig. 166. Guide-board in Position for Inside Finishing Coat (Whether or not tiles are used, this is the best method of finishing)

Finishing coat should be applied within 24 hours, and is made 1 part cement, 2 parts sand. Finish one side at a time, top edge first, inside surface next, then outside, and the bottom after 4 sides are complete. Begin by filling to top of form. Now take off inside form *from one side only*. Lay a piece of perfectly straight board along top edge. This makes an infallible gauge for thickness and straightness of finishing coat (Figure 166). Here we might say that it is advisable to have an experienced finisher do this work, but a resourceful amateur can do it. Now do the outside in the same manner, the idea here being to have the top bind with the sides while fresh. The outside being done last is less likely to be kicked. Try to protect the job from rapid drying in the sun.

It is very nice to sink a hole in the centre for the reception of a water lily plant. This adds considerably to the planning and labor, but the result is worth it in satisfaction if one is fond of beautiful aquatics. At the same time the bottom can be drained towards the centre, a good point when it comes to the annual cleaning-out. Figure 163 shows this. The hole ought to be about 18 inches wide at the top, 15 at the bottom and 17 deep. The galvanized iron form is removed by bending it inwards at one point. This form is of *thin* metal and has no bottom, it being impossible to withdraw a bucket on account of suction.

Another added attraction for those caring for the aesthetic side is the addition of tiles in the edges. To try to push these into the finishing coat is to court certain trouble and a botch job. As soon as the concrete is poured the tiles should be set on little mounds of cement as indicated in Figure 164, seeing that they come to exactly the right level, fixing the four corner ones first. Next day the finishing coat is filled around them and they help to establish the correct level. The cement will slop over on them a little, but this is no matter. Most of it can be wiped off with water and the balance after drying, with dilute hydrochloric acid.

The author is not partial to drain-pipes. They may become dislodged and let the tank run dry, or, on the other hand, they may get sand in them and not go back into place. However, this is a matter of personal preference.

In two days after the finishing coat is applied, a little water may be run in. On the fourth day fill completely. All cement containers should be seasoned before the fishes are introduced.

This can be done by changing the water six times over a period of two weeks. This is not thorough and a longer time is better. Seasoning can be accelerated by different chemical processes. The safest is to fill the pool and slake a large piece of lime in it. In a pool 8 x 12 feet, slake about half a bushel. There is no danger of using too much. After slaking, stir every few hours and clean out thoroughly in two days. Another method is to place a piece of blue litmus paper (obtainable in drug store) in the water after it has stood a day and been stirred up. Then slowly add and stir in commercial sulphuric acid until the paper shows a faint pink hue. Allow to stand another day and if the paper goes back to blue, repeat addition of acid. When the pink shade remains draw off water, clean thoroughly and use. Enough acid to turn the paper a distinct pink or red should not be used. Always stir water well before determining color of paper. This test is only for the acid process.

Aquarium or Tank Capacity. To ascertain the gallon capacity of any rectangular tank, multiply the length, breadth and depth together in inches. Divide by 231. The result will be in gallons.

A gallon weighs 8 1-3 pounds.

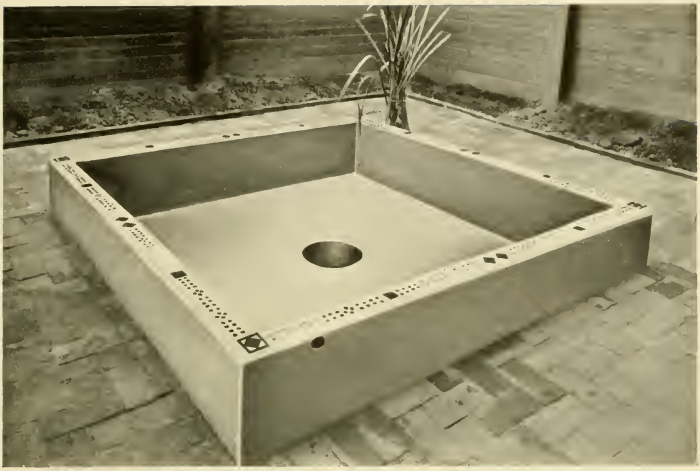


Fig. 167. Finished Pool, Showing Sunken Lily Pot and Overflow

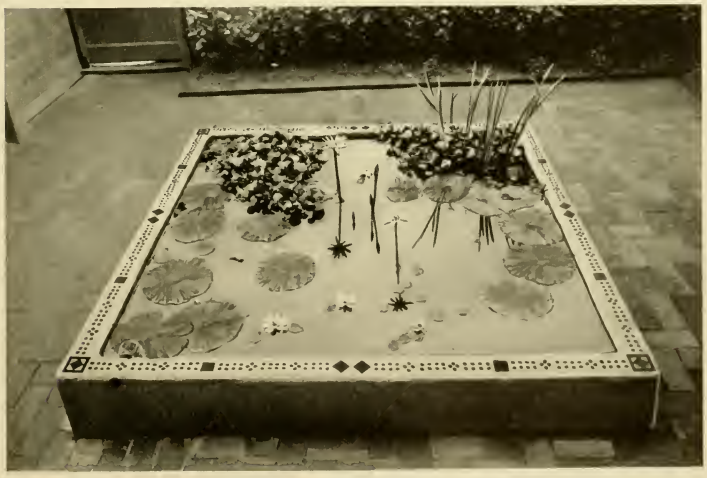


Fig. 168. Same in Use, With Tropical and Pigmy Lilies in Bloom

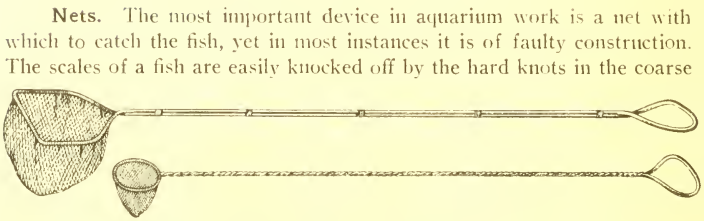
Fig. 169. "Queen Lil," a Many-time Prizewinning Scaleless Telescope Goldfish

Chapter Eighteen

Aquarium Appliances

AQUARIUM APPLIANCES

Nets. The most important device in aquarium work is a net with which to catch the fish, yet in most instances it is of faulty construction. The scales of a fish are easily knocked off by the hard knots in the coarse



FIGS. 170 AND 171. PROPER NETS FOR GOLDFISHES AND YOUNG TROPICALS

threads composing nets usually sold. This is very bad for the fish. A far better material is Brussels netting of a mesh such as is used on window curtains—not too fine.

When fish have to be caught from a globe, a round net is convenient, but for a straight-side aquarium, a square or oblong net is very much better. Usually these cannot be purchased, but to make one is a simple matter and well repays for the effort. Perhaps the easiest way is to purchase a round net, remove netting, bend wires to an oblong form and re-cover with Brussels netting.

Glass Cleaners. The best device for cleaning the inside glass of straight aquaria is a safety razor blade secured in a stick and riveted through. First rivet or wrap end of stick with fine copper wire to prevent

FIG. 172. SAFETY RAZOR BLADE AQUARIUM GLASS CLEANER

splitting, place razor blade firmly in iron vise and drive down stick to proper point. A blade may be used directly in the hand, but in this case it is better to dull one edge first in order to avoid cutting the fingers.

A dime rubbed flat against the glass will clean it. For cleaning globes a piece of thick felt is very good, although any piece of clean fabric will do.

Dip Tube. Sometimes particles of food remain too long after feeding. Also dirt collects in spots. Such places can easily be cleaned by use of a dip tube. Any tube of from one-quarter to three-eighths inch

inside diameter and about six inches longer than the depth of the aquarium will do. Glass is preferable. Hold the thumb firmly over one end, place other end near particles to be lifted. Remove thumb, allowing water and particles to rush into tube. Replace thumb, lift out and empty. The capacity of the tube can be considerably increased by heating the centre over a Bunsen flame and blowing a sort of belly.

Siphon. When much dirt needs to be removed or the aquarium emptied, a siphon should be used. This consists simply of a hose sufficiently long to reach from the bottom of the aquarium, up over the edge and down again to a point near the floor. The longer the drop, the more rapid the flow. Fill tube with water, close both ends by finger pressure, insert one end in the aquarium and hold the other as low as possible. Release the ends of tube and the water will flow as long as there is water in the aquarium at a higher point than the discharging end of tube. Care should be taken not to draw in fish or snails.

Forceps. A pair of forceps for aquarium work forms a most handy tool. Their construction is very simple. Take a piece of ⅛-inch brass wire thirty inches long and bend to shape shown in Figure 173. Where the wire crosses, hammer out a small flat space through which a rivet

Fig. 173. Aquarium Forceps

can be fastened. A small section of brass wire or a copper tack can be used as a rivet. When the forceps are otherwise completed, flatten out the ends by hammering on an iron vise or other firm surface. The jaws of the forceps automatically remain open. Pressure on the upper loop closes them. They will be found quite handy in adjusting plants and lifting out snails, stones or other small objects.

Planting Sticks. To secure the roots of plants in sand would seem a very simple matter, but when the aquarium is filled it is most difficult to set them without the help of one or two planting sticks. These are as simple as they are useful, being merely thin sticks with a dull

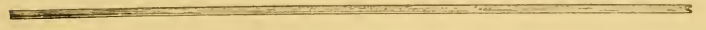


Fig. 174. Planting Stick

notch in the end. About three-eighths of an inch is a suitable size diameter for the sticks. The notch should be slightly rounded on the edges to avoid cutting the roots as they are forced into the sand. Two

sticks are better than one. Plants like Giant Sagittaria should be pressed down from two sides. After the plant is placed to the proper depth, it should be held with one stick while the other is used to push sand over the roots and to press down straggling roots which have not been covered. Aquariums should not be planted while filled, but sometimes a few plants ride loose on the first filling or some are added later. For such occasions planting sticks are most handy. A pair of rulers will do for an emergency. Almost anything is better than the fingers.

Scissors. A pair of scissors with a 15-inch rod securely wrapped to each handle is useful for trimming dead leaves from plants. With this

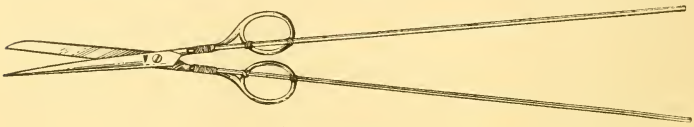
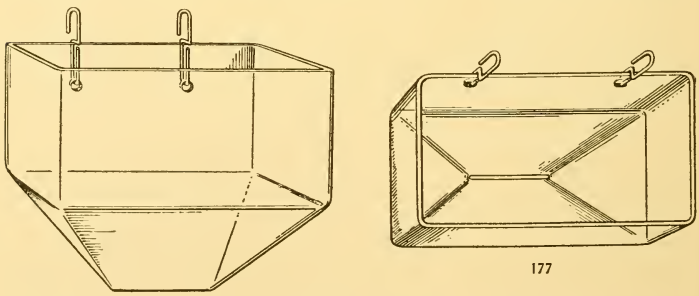


Fig. 175. Aquarium Scissors

tool plants can be reached without disturbing anything, and one can get a better view of what is to be done than when working elbow-deep in the water.

Live-bearing Jars. With most varieties of viviparous (live-bearing) fishes it is desirable to promptly separate the mother and other fish from the young in order that they will not be eaten. One simple method is to take a glass funnel about six inches across the top, file a nick where base joins tube, break off tube and place a small piece of U-shaped wire



177

Figs. 176 and 177. Side and Top Views of All-Glass Breeding Jars, Showing Escape Slit

in the opening so that the wire divides the hole in half. The funnel is then placed in a bell jar or other aquarium of a size that will suspend it

by the edge, bring the water as high as possible in funnel, place female fish in funnel and cover over with screen. The wire will prevent the mother fish from becoming jammed in the outlet, but will allow the young to pass through and collect in the lower portion of jar.

Very excellent breeding glasses come from Germany. These have a long narrow slit in the bottom and may be hooked on the inside of any receptacle. See Fig. 177.

Spawning Net. In the spawning season aquarium space is often limited, particularly among amateur breeders who have perhaps a single aquarium. The breeding fish should be separated from the others, as the idle fish would eat the spawn. An easy way over this difficulty is the

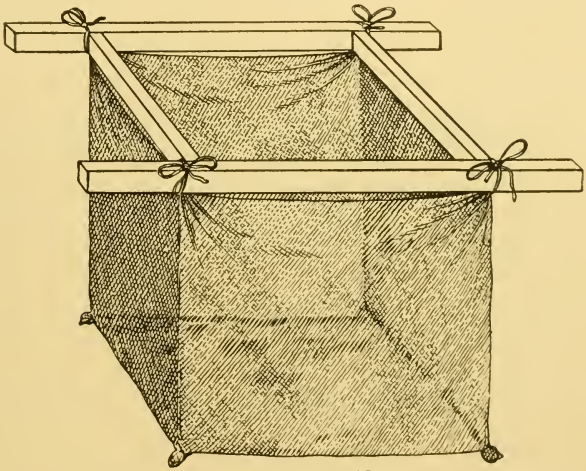


Fig. 178. Spawning Net

use of the spawning net. This is simply a square bag of cheesecloth suspended in the aquarium. Figure number 178 will clearly show how this may be done. The four corners should be weighted down with bits of lead or stone sewed in. The plants and spawning fish are simply transferred into the net. Confined in this comparatively small space the chances of the eggs becoming fertilized are increased, while the netting is sufficiently open to allow the aquarium water to flow slowly through it and prevent suffocation. In this way the large amount of dirt usually stirred up in an aquarium at spawning time, and which can do the adhesive eggs no good, is entirely avoided. The size of the net will depend somewhat on the proportions of the aquarium, but the capacity

of net (portion in water) should be about twelve to eighteen inches long, ten inches wide and ten inches deep. In constructing, allow extra material for space between top frame and surface of water.

Constant Aquarium Filter. This device is for use in connection with the air pump referred to on page 10. It is capable of a number of variations, once the principle is understood. There are two columns of water in the tubes, one solid and one punctuated by air bubbles, thereby making it the lighter. This causes it to rise and therefore establish circulation as long as air is supplied. A ⅜-inch diameter glass surgical drain is shown at A. This should contain about eight small openings and be suspended two inches above the sand. This is connected by a short piece of rubber tubing to the rest of the system, which is of glass tubing from 5/16 to ⅜ inch inside diameter. The dark sections represent rubber joints, making the system more flexible, less liable to breakage, less expense in case of break and makes cleaning of each section easy. (The tubes require an annual cleaning.) Air is injected under pressure at C, which should be five inches above lowest point of pipes. This starts the flow, which is discharged into D, a small filter suspended in the corner of the aquarium, and just above water level. It may be made of glass, aluminum, porcelain or eathenware, and should approximate in size five inches in diameter by two deep, the bottom having a few perforations. The best filtering medium in this work is absorbent cotton, which should be laid on a few pebbles, glass bars or bits of charcoal for good drainage. The force of air and the distance between C and the surface of water determines the speed at which the water travels. The lower the point at which air is injected, the greater the speed. To start the system, disconnect at B, suck with the lips to start siphon, re-connect while water is running. After water in rise tube has reached aquarium level, turn on air-cock at C. This cock should always be closed when air is not wanted and pump not working, in order to prevent water backing up into air pipe. All rubber joints should be tightly secured by wrapping with thread or narrow strips of electric tape. Rubber cement spread on connecting surfaces helps make a good job. If there is danger of glass tubes being broken it is best to use pipe of block tin. For salt water, use glass or lead.

Instead of filtering at top of aquarium it is possible to pass the water through a big, large-necked bottle of sand at the lowest point of dip. Both tubes pass through a rubber cork, the dirty water being carried to bottom of bottle, discharged in a layer of pebbles, brought upwards through fine sand and taken off by rise pipe just inside of cork. The sand should not quite fill bottle. Cork must be securely tied down. This is a nice arrange-

ment, but was abandoned by the writer owing to the trouble of disconnecting everything and washing sand every ten days, which was necessary owing to clogging. In top filter the cotton must be changed every two days, but this can be done in a few seconds.

This arrangement both filters and aerates the water. If filtering is not needed, the filter can be removed and aeration will go on.

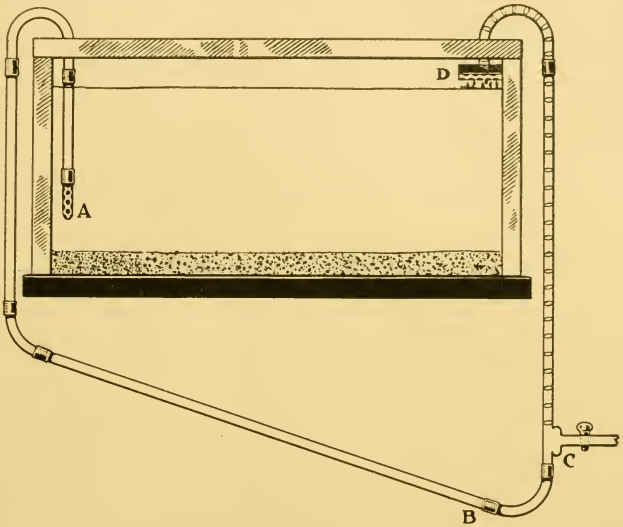


Fig. 179. Water Circulation by Air Pressure

Water can be raised by this method from fifteen to twenty-five inches above level. To secure the greater height, use ¼-inch inside diameter tube, take plenty of drop and allow eight inches from lowest point to C. By this means and a little ingenuity a return fountain can be made. To secure a uniform flow it would require a small tank to receive the discharge from the pipe, and from this an overflow to aquarium in case the water supply comes too rapidly for discharge rate of fountain.

It is not necessary to carry pipes over edge of aquarium as shown in diagram; they may be carried through the bottom, carrying dirty water directly down. The rise tube should be brought up through inside, over edge of filter. Short pieces of tubing long enough to reach above the sand and to extend an inch below the aquarium base should be used for passing through the slate. A very effective means of securing these in

permanent position is to melt by alcohol blow-torch some chips of gum shellac. This melting is done in the aquarium directly around the tube and is continued until a small mound is formed. A piece of wet cardboard will protect nearby glass from the heat. Gum shellac has perfect resistance to water. It will adhere to almost anything and is of especial value in connecting glass to metal. When cool it is quite hard.

Chapter Nineteen

Forty Don'ts

FORTY DON'TS

Don't overfeed.
Don't overstock.
Don't inbreed too long.
Don't use very deep aquaria.
Don't delay treating sick fishes.
Don't start with expensive fishes.
Don't allow dead leaves to accumulate.
Don't use fishglobes except temporarily.
Don't attempt to move filled large aquaria.
Don't neglect to look fishes over carefully.
Don't fail to replace covers on tropical aquaria.
Don't use oil stoves if anything else can be had.
Don't keep very large and small fishes together.
Don't always blame the dealer if your fishes die.
Don't use coarse nets. Brussels netting is better.
Don't keep any aquarium in a very subdued light.
Don't introduce plants without thoroughly cleansing.
Don't fail to give the fishes an occasional pinch of salts.
Don't fail to sterilize a net after lifting a diseased fish.
Don't put the fish outdoors the first warm day of Spring.
Don't be too sure the family cat won't fish in the aquarium.
Don't entrust the feeding to another if this can be avoided.
Don't as a beginner disregard the greater experience of others.
Don't sell surplus stock for a song. It had better be given away.
Don't feed large earthworms. They should be chopped and rinsed.
Don't slide all-glass aquaria. Scratches may cause them to break.
Don't forget that most fishes enjoy an occasional variation in food.
Don't assume that ordinary artificial light is a substitute for daylight.
Don't experiment with rare tropicals to see how cool they may be kept.
Don't suddenly change the temperature of the water, either higher or lower.
Don't allow unconsumed food to remain in the aquarium. Remove with dip-tube.

Don't use unmixed raw water from the faucet. The excess of oxygen is undesirable.

Don't fail to join an aquarium society, either as an active or a corresponding member.

Don't place daphnia in the aquarium without first looking carefully for insect enemies.

Don't fail to thoroughly disinfect an aquarium in which there has been a contagious disease.

Don't tear up the plants in trying to catch a fish. A little patience will avoid later regrets.

Don't be stingy, but give away a few interesting fishes to those who might become fanciers.

Don't keep goldfishes and tropicals together. They may not quarrel, but the appearance is not good.

Don't throw away dead rare fishes. Preserve in alcohol. Scientific institutions are glad to have them.

Don't always use chemicals on a fish a little out of condition. A change of aquarium or of food may be all that is necessary.

ILLUSTRATIONS AND THEIR SOURCES

The gold stamp on the back of book cover is an illustration of the Pterophyllum scalare.

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CROSS INDEX

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