

FRESH-WATER
AQUARIA

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FRESH-WATER AQUARIA

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FRESH-WATER AQUARIA

Their Construction, Arrangement, and Management

With descriptions of the most suitable water-plants and Fishes, coldwater and tropical, and how to keep them

By

Rev. GREGORY C. BATEMAN, A.K.C.

Seventh Edition

Entirely Revised by JACK HEMS

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PREFACE TO THE FIRST EDITION

I WAS always fond of Natural History, and while I was a boy I frequently looked forward to one day possessing an aquarium so large that I might collect as many aquatic creatures as I liked from the neighbouring ponds and streams, place them all together in my tank, and then make myself quite happy by watching the habits and the changes of my captives. But, alas! in course of time, I found, as so many find, that the realisation of one's hopes does not always bring with it the anticipated pleasure. For when I did eventually own as big and—as appeared to me at that time—as suitable an aquarium as I could wish for, and when I did stock it with many curious and (to my mind) interesting animals, I was, after all, not very happy, nor even content; far from it. The Sticklebacks and the aquatic Spiders would not build their nests side by side; the *Dyticus marginalis* absolutely refused to live on anything like friendly terms with the Minnows; the Snails while crawling over my most valued plants were not able to refrain from devouring them and ruining them; the water would not keep bright, nor the glass of the tank clear, and my patience was sorely tried. I bought or borrowed whatever books I could upon aquarium and kindred matters, but I was not able to obtain all the information I required. Then I attempted to find out by experiment that which I could not ascertain by reading. After not a few failures and disappointments, most of my attempts were successful, and as I began to have more knowledge of these

things I resolved that I would, at some time or other, try to write such a book as that I wished for so much when I was making my first blunders in aquarium matters. By and by an opportunity was afforded me of contributing to *The Bazaar* a series of articles upon the fresh-water aquarium. These articles are now republished in book form, and so in this way I have kept my resolution and have written my book ; but as I finished looking over the " proofs " of its last chapter, I confessed, with not a little mortification, that it fell far short of the volume I had hoped to write. However, I shall feel very thankful if I can be the means of saving some keepers of an aquarium from disappointment and many aquatic animals from unnecessary suffering.

Before, or while writing the above-mentioned articles, I read all or portions of the following books, and to the authors I am more or less indebted :

" Land and Fresh-Water Shells," by R. Rimmer, F.L.S. ; " British Beetles," by E. C. Rye ; " Manual of British Beetles," by J. F. Stephens, F.L.S. ; " British Wild Flowers," by Miss Pratt ; " The Aquarium," by J. E. Taylor, Ph.D., F.I.S., etc. ; " The Fresh and Salt-water Aquarium," by Rev. J. G. Wood, M.A. ; " Lakes and Rivers," by C. O. G. Napier, F.G.S. ; " Ponds and Ditches," by M. C. Cooke, M.A., LL.D. ; " Pond Life—Insects," by E. A. Butler, B.A., B.Sc. ; " Popular History of the Aquarium," by G. B. Sowerby, F.L.S. ; " The Book of the Aquarium," by Shirley Hibberd ; " Introduction to Entomology," by Kirby and Spence ; " The Natural History of British Fishes," by F. Buckland ; " Land and Fresh-water Shells of the British Islands," by J. E. Gray, Ph.D., F.R.S. ; " Popular History of British Crustacea," by Adam White ; " The Microscope," by Jabez Hogg, M.R.C.S., F.R.M.S. ; " The Home Naturalist," by Harland Coultas ; " Country Walks," by the Rev. H. Houghton, M.A. ; " The

Badminton Library"—"Fishing"—by H. Cholmondeley Pennell; "L'Aquarium," J. Rothschild, Editeur. In addition to these books, I have consulted *Science Gossip* and *Cassell's Natural History*. There are other books whose names and authors I have forgotten, but some of the useful information which I obtained from them I remember, and for it I am grateful. But the correctness or inaccuracy of whatever information I have gained from books or articles, I have tried to prove by practical experience.

G. C. B.

JACOBSTOWE RECTORY,
NORTH DEVON.

PREFACE TO THE SECOND EDITION

THIS Edition represents a complete revision of the original matter. The alterations, except the chapter on the "Breeding of Goldfish," are chiefly in the form of additions in the shape of descriptions and illustrations of those fish, suitable for life in a tank, which were not generally imported into this country at the time of writing the former edition.

G. C. B.

BRATTON CLOVELLY RECTORY,
DEVON.

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FRESH-WATER AQUARIA

CHAPTER I

THE AQUARIUM

FEW things are more interesting and less troublesome than a well cared-for aquarium. It makes no litter to annoy the tidy housewife, and no noise to distract the student. Besides, if properly arranged, it is very ornamental. The aquarium also is exceedingly useful to the naturalist in the prosecution of his studies ; and by its help the botanist can conveniently observe aquatic plants as they pass through the various stages of their existence.

Those who intend to keep an aquarium must remember that though few things are less troublesome, still it does require a little care, and that little care should be given regularly and daily. A few minutes at a time will suffice—just long enough to feed the fish, to see that there is no death and no decay, to notice that the light has not been so strong as to cause the confervæ to grow too rapidly, and to take care that the representatives of the Animal Kingdom do not exceed the proper proportion according to the amount of plant-life and water provided. The reason for this is that the fish inspire the oxygen held in solution by the water, and expire carbonic-acid gas. The plants, by respiration, consume the carbonic-acid gas supplied by the fish, using the carbon for the construction of their tissues and fibres, and liberating again the oxygen for the use of the animal life within the aquarium ; or, to put it plainer, the fish breathe out carbonic-acid gas and breathe in oxygen.

The plants, however numerous they may be in the aquarium, will not alone supply sufficient oxygen. For the principal

duty of the vegetation is, as it has been said, to decompose the carbonic-acid gas expired by the animals, absorbing the carbon into their own substance and setting free the oxygen for the use of the fish ; but the oxygen must be chiefly drawn from the atmosphere which comes in contact with the surface of the water. Therefore it will be seen that the shape of the aquarium is a very important matter ; and that this is the case is proved by a simple experiment. If a wide mouthed

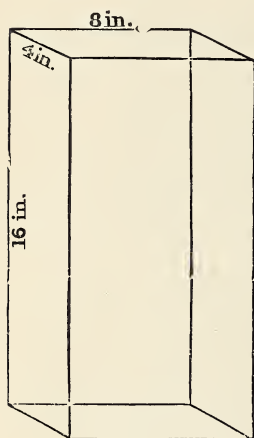


FIG. 1.

poured into a shallow dish or pan about 2in. deep, and three or four minnows be placed in each vessel, it will be seen that while the fish in the pan remain apparently well, those in the bottle will, after having ascended to the surface of the water, die.

The reason that the fish in the one case die and in the other live, is because water is simply a vehicle for holding in solution the oxygen which is necessary to animal life. And the greater the surface of water exposed to the air, the more oxygen will it absorb in proportion to its bulk.

An aquarium of the shape and size of Fig. 1, which would present to the air a surface of water of 32 square inches, would hardly supply the oxygen necessary for the health of three small fish ; while one like Fig. 2, having a superficial measurement of 64 square inches, would hold comfortably six small fish ; but one of the shape and size of Fig. 3, presenting a surface of 128 square inches, would supply sufficient oxygen for twelve fish. And yet all three aquaria would contain exactly the same quantity of water, viz. 512 cubic inches.

I have kept twenty-six small minnows for a week in an ordinary soup-plate, a little more than half-full of water, and

then only one of them died. Further, I have had one pike (9in. long), twenty very small roach (about $1\frac{1}{2}$ in. long), nine perch (from $2\frac{1}{2}$ in. to 3in. long), and one Great Newt (*Molge cristata*) living in perfect health in an aquarium 21in. by $13\frac{3}{4}$ in., but which contained water only 2in. deep—sufficient to cover the dorsal fin of the biggest fish as he swam just clear of the bottom. And these fish lived in this comparatively small quantity of water in apparently the best of health, not only because the water was very shallow in proportion to its superficies, but also because the act of their swimming agitated the surface of the water, thus helping to aerate the whole of it; and for the same reason the twenty-six minnows lived for a week, and would have done so longer, in an ordinary soup-plate half-full of water.

Of course, an aquarium ought not to be so shallow that the water-plants will fail to grow properly. Conversely, no tank containing fish should exceed a depth of 22in., unless, of course, artificial aeration be used.

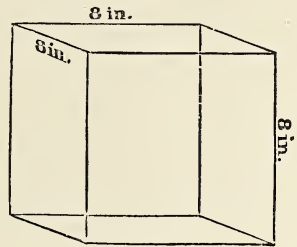


FIG. 2.

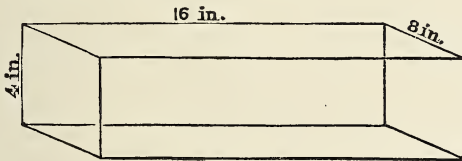


FIG. 3.

It is almost unnecessary to say that if an aquarium is taken up as a toy, to be fussed over for a few days and then to be neglected for weeks, it will be anything but pleasing and instructive. The water in these circumstances will quickly become corrupt and offensive, many of the animals will die, those which are unfortunate enough to survive will be extremely miserable, and the owner and his friends will

come to the conclusion that an aquarium is certainly not what I have described it to be—both pleasing and instructive.

There are very many kinds of aquaria, ranging from the simple, flat earthenware pan to the beautiful and expensive combination of plate-glass, slate, fountains, enamel, and

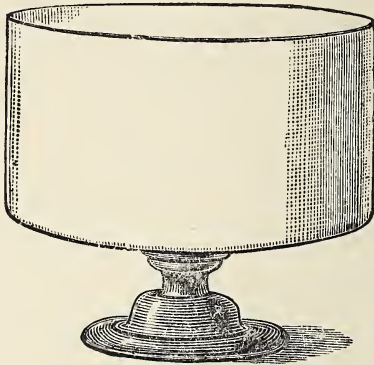


FIG. 4.

gilding. The most up-to-date tanks to-day can be supplied in a number of finishes including chromium-plate, penny-bronze, oxydized copper and old gold lacquer. The commonest aquarium, perhaps, is that often described as an “inverted propagating glass” (Fig. 4). Such an aquarium, however,



FIG. 5.

causes much discomfiture to the fish and too great a growth of *confervæ*; and its proneness apparently to distort its inhabitants as they swim round it. However, the transparency can be partly overcome by judicious shading, the method of which will be explained when “light” is spoken of, and the apparent distortion may sometimes be avoided by taking care to choose white and well-blown glasses. In buying an aquarium of this kind, that which is broadest and shallowest should certainly have the preference.

Another receptacle for water and fish is the common glass

globe (Fig. 5), which has nothing whatever to recommend it, except perhaps to those who delight to hang their unfortunate captives—suspended by a chain from the ceiling—in front

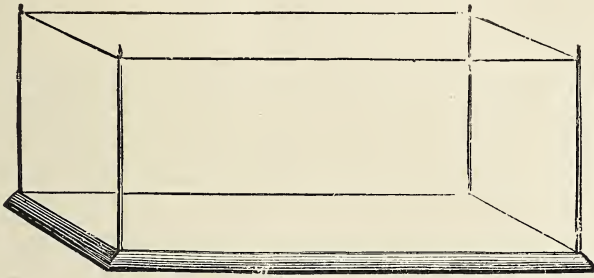


FIG. 6.

of the window; and of course an aquarium which is to be placed in this position—the worst possible—must, on account of its weight, be small; besides, if full, the surface of water exposed to the air must be extremely limited.

The ordinary oblong tank (Fig. 6), containing four glass sides, is both ornamental and useful. This aquarium is usually made of steel anglebar, plate-glass and slate.

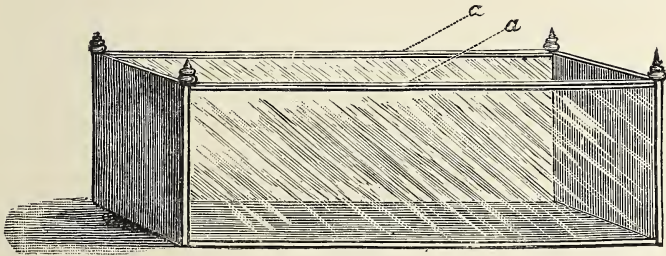


FIG. 7.

A very useful tank which may be made at home is shown in Fig. 7. It is constructed of glass, wood, and slate. The ends and bottom are of wood, the former being lined with thin window-glass, the latter with slate, and the sides are formed of plate-glass.

A more useful aquarium than the last mentioned is one formed of slate and plate-glass only (Fig. 8). It can be made by an amateur without much difficulty.

Explicit directions for making aquaria similar to those shown in Figs. 6, 7, and 8 are given in Chapter II.

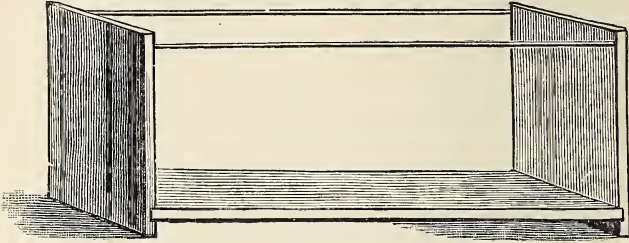


FIG. 8.

CHAPTER II

MAKING AQUARIA

IT is comparatively easy to make an aquarium to resemble Fig. 7. The ends and bottom are made of 1in. well-seasoned deal, dovetailed together. They are grooved. The grooves run with the grain, and are $\frac{3}{8}$ in. deep, about the same wide, and $\frac{3}{8}$ in. from each edge. The ends are held firmly in their places by two bars at the top of the aquarium (Fig. 7). These bars are 2in. broad and 1in. thick. They are dovetailed into their places, and have grooves to correspond with those in the bottom and the ends.

The ends are lined with window-glass and the bottom is lined with slate. The sides are formed of plate-glass, $\frac{1}{4}$ in. thick; these must be put in their places before the crossbars at the top of the aquarium are fastened, the grooves into which they go having previously been half-filled with cement No. 2 (page 19). Cover the bottom with a thin layer of the cement just mentioned, and press the slate firmly and gently into its place. Fix, in the same way, the glass linings for the ends. Fill up the corners with a cement of red lead and putty mixed to the depth of $\frac{1}{4}$ in., and when it is somewhat hard put over it a coating of the cement which was first used. The junction of the glass linings with the ends and the dovetailing of the crossbars can be hidden by four strips of wood, $2\frac{1}{2}$ in. wide and $\frac{1}{4}$ in. thick, neatly mitred together. The woodwork will look well either stained, sized, and varnished, or French-polished. The aquarium should have six little feet 1in. high, screwed to the bottom.

Slate $\frac{3}{4}$ in. or 1in. thick will be required to make a tank like Fig. 8. It may be procured by the foot at practically any slate merchant's. The three pieces which will be wanted can

most likely be obtained the size required. The bottom 30in. long and 16in. wide, and the ends each 16in. by 13in., will make an aquarium of good dimensions. At 1in. from the extremity of each end—that is, across the broad part—cut a groove $\frac{1}{2}$ in. deep and $1\frac{1}{2}$ in. broad. This is supposing that slate 1in. thick has been chosen; but if it is only $\frac{3}{4}$ in. thick, then the groove must be proportionately smaller each way. The groove may be cut in the following manner: First mark with an awl the exact place and dimensions of the groove. Then get two straight-edged pieces of wood some inches longer than the breadth of the end; place them each side of the line which is to be cut, and nail them to the bench—they should be just wide enough apart to admit a tenon-saw—and with the saw cut the line to the required depth, $\frac{1}{2}$ in. Without some such preparation as this it would be difficult to cut the sides of the grooves with the necessary accuracy. When both lines have been sawn in this way, take a chisel and mallet and cut out the slate which lies between them. But before using the chisel take the precaution to put two or three folds of carpet, or the like, between the slate and the bench to prevent all jarring and the danger of a crack. These grooves are to receive the ends of the bottom.

There is another way for making the cuts for these grooves. It is this: Get a piece of hoop-iron, about a foot long, and straighten it. Then for a handle procure 10in. of broomstick, more or less, saw it half through lengthwise, and hammer the hoop-iron into the groove. Mark with an awl the place on the slate where the cut is to be made—and deepen this mark a little by running the point of a three-cornered file a few times carefully up and down. Fill the slight groove thus made with fine white sand, and moisten it with water by means of a wet brush. Now run to and fro in this sand and water the edge of the tool which has just been made. By continually doing this, always keeping plenty of sand and water under the edge of the iron, the cut will gradually become deep enough. When the cuts have been made, the portion of slate between them may be chiselled out as before directed. As a

rule, the slate can be split cleanly out by striking the chisel against the edge and not on the top, and there is less danger of breakage. The latter method of making the cuts is the more satisfactory of the two—the former so quickly blunts the saw.

Now along both sides of the bottom and of each end, cut, at a distance of $\frac{3}{4}$ in. from the edge, grooves $\frac{1}{2}$ in. deep and $\frac{3}{8}$ in. broad. These grooves are to receive the plate-glass sides, $\frac{1}{4}$ in. thick. After this bore four holes, $\frac{1}{4}$ in. in diameter, right through each end. Two of these are to be $1\frac{1}{2}$ in. from the edge and $\frac{1}{4}$ in. below the groove which is to receive the end of the bottom, and two 1in. from the top and just within the grooves cut for the glass (Fig. 9).

The holes are for the bolts which run across from end to end to hold the aquarium together. Bore them with an ordinary brace, and a bit used for metal. The bolts should be made of brass wire ; but iron will do. It is a wise precaution to have the thread for the nut a little longer than necessary, for it can easily be shortened when the bolts are in their

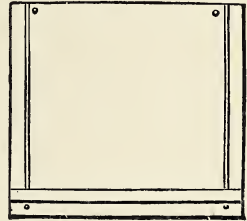


FIG. 9. END OF SLATE AQUARIUM (FIG. 8), showing Grooves for Glass Sides and Slate Bottom and Holes for Bolts.

places, and the long threading is a great convenience in the screwing-up. Before putting the aquarium together, place a little cement in all the grooves. Then raise the bottom on blocks of wood to such a height that it will be level with the grooves cut to receive it in the two ends. And when this has been done, put the ends, plate-glass, and bolts into position, and screw them all together, turning the nuts of the bolts with only the finger and thumb. Before the nuts are quite screwed home, press the glass gently downward, so that it is forced firmly into its place. Carefully finish filling up the grooves with cement, and the aquarium will be completed. If iron bolts have been used, paint them with Brunswick Black.

Fig. 10 represents a very easily and cheaply made aquarium.

It is a small tank, chiefly useful for observing the habits of insects and the like. Being of little weight it can conveniently be moved about when full of water. It is deeper and narrower

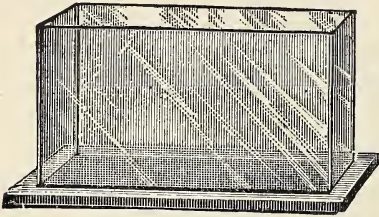


FIG. 10. PORTABLE AQUARIUM.

in proportion than an aquarium in which fish are kept ought to be. The foundation is made of 1in. well-seasoned wood (mahogany answers the purpose excellently). Cut a piece 14in. long by 11in. broad. At 1in. from

the edge, all round, make a groove $\frac{1}{4}$ in. wide, and the same deep; four pieces of moderately stout zinc moulding, 10in. long, are also required. Bore a hole $\frac{1}{4}$ in. in diameter at each corner of the grooving in such a way that the square part of the moulding when sunk in the wood will come flush with the outside of the groove; and when this has been done make a cutting with a keyhole-saw to receive the flat portion of the zinc upright (Fig. 11). Drive gently with a mallet each piece of moulding until its end has come flush with the other side of the wood foundation; then by driving a long French nail, *minus* its head, into the side of the wood and through the flat part of the zinc, each upright can be made firm. Now cut

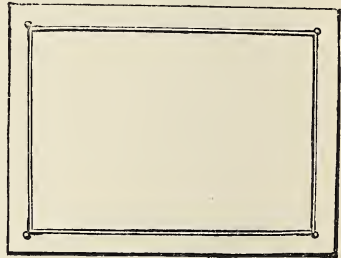


FIG. 11. BOTTOM OF PORTABLE AQUARIUM, showing Grooving for Glass and Zinc Moulding.

two strips of zinc 12in. long and two 9in. long, all 1in. wide. Mitre them, then join together with solder. When this has been done, take what is made of the aquarium, turn it upside down, place each upright on a corner of this frame, and solder them carefully there. Next get a piece of roofing slate, and with an old saw cut it to fit as a lining for the bottom. The

four sides may be of window-glass of a moderate thickness. Use red and white lead as the cement, and paint it, when dry, with two coats of sealing-wax varnish or Aspinall's Bath Enamel. If this cement is not covered in some way, every aquarium in which it is used must be thoroughly soaked before it is stocked ; indeed, the soaking of a new aquarium in which cement of any kind has been used should never be omitted. Fill the spaces which may have occurred through inaccurate work between the outside of the glass and the groove in the wood foundation, with Portland cement or plaster of Paris, and the tank is complete.

If the uprights are not more than 6in. in height, they will need no support at the top. Instead of the groove cut in the wooden foundation, slips of wood may support the glass at the bottom ; the slips will save trouble, but will not make the aquarium look so neat as the grooving would. Aquaria made in this way are easily and cheaply constructed, and are not likely to leak.

The following cements have been found useful in the construction of aquaria :

1. Red lead and best putty—the two being mixed together into a stiff paste.

2. One pint each of plaster of Paris, litharge, fine white sand, and one-third pint of finely-powdered resin. This (or in this proportion) should be kept in a well-stoppered bottle, and when wanted the necessary quantity should be made into a putty with boiled oil and driers. This is a very quick-drying cement. It becomes, if anything, too hard.

3. The same as No. 2, with the exception of the plaster of Paris and the driers.

4. The best Portland cement for large garden tanks.

5. One part pitch and one-fourth part gutta-percha, applied when warm. These should be melted together in an iron ladle over a gasflame or lamp. This cement is especially useful for an aquarium made of wood.

CHAPTER III

THE CABINET AQUARIUM

AN arrangement called the "cabinet aquarium" is exceedingly interesting and instructive. It consists of a kind of backless bookcase, upon the shelves of which are placed small aquaria containing such aquatic plants and animals as are unsuitable, owing to various reasons, for the general tank. These shelves should be strong, and so constructed that they will stand quite firmly. They may be made of almost any kind of wood, and in either a plain or an ornamental manner, as the taste of the aquarium-keeper may dictate or his purse allow. They may also be constructed to stand upon the floor, or upon a table. Care should be taken, however, that the shelves are at different distances apart, the greatest space being between the first two shelves, counting from the bottom. Shelves thus arranged will hold vessels of various sizes.

The most suitable position for the cabinet aquarium is before a window, but out of reach of the direct rays of the sun. Then, if the stand has been wisely built, the contents of the aquaria can be easily watched without any inconvenience.

No shelf should be so low as to occasion stooping on the part of the aquarium-keeper, or so high as to necessitate his standing upon a chair or stool. If the stand is required to hold very many vessels, it should be long rather than too high or too low. A cabinet aquarium, if properly arranged and cared for, is rather an ornament in a room.

None but those who have possessed some such arrangement as a cabinet aquarium can readily understand how much interest and instruction it is able to afford. Some change or other is always taking place in the various aquaria, and thus

there is continually a fresh lesson to be learnt or a new wonder whereat to be astonished. As nearly all the little tanks can be made more or less self-supporting, a very small amount of trouble will be required in their management. If the shelves are made to stand upon the floor of the room, and not upon a table, a small cupboard or a drawer or two may be contrived beneath the lowest shelf, which will be very convenient for holding siphons, nets, cans, and the like.

An arrangement of a simpler kind than that just described can be made by placing a piece of strong board lengthwise across any large tank which has slate or wooden ends. Such a board will hold several small aquaria. If it be of a fair length, three small inverted propagating-glasses may be placed upon it at equal distances apart, the middle glass being a little larger than the other two, chiefly for the sake of appearance. The glasses will stand quite firmly if the knob of each is inserted through a hole made in the board. There may also be room for other and smaller aquaria between the glasses. Little oblong tanks might be used, and with advantage, instead of the propagating-glasses.

The vessels of the cabinet aquarium may be either rectangular or round—the former shape, for several reasons, being the more suitable; but whether they are square or round there should certainly be some uniformity among them. Propagating-glasses of various sizes can always be used in the cabinet aquarium by fixing them as just described. A great disadvantage of these glasses is that they so much distort the objects which they contain; but if they are used it is wise to have a few common stands at hand for them, which will be convenient in case the glasses have occasionally to be moved. The stands can be easily and cheaply made. For instance, a piece of wood about 6in. square, having a hole big enough to receive the knob of the glasses bored in the centre, and also having two strips of wood (1in. thick) nailed across two opposite ends, will be quite as firm as the ordinary turned stand; or a small and strong wooden box, with a hole cut in the middle of the lid, or if there be no lid, through the bottom,

will answer the purpose very well. In the latter case, the box must be inverted, of course.

Various cheap glass bottles or jars are useful for the cabinet aquarium—for example, the jam or fruit jars made by many firms in this country. They are of fairly clear glass, wide-mouthed, neckless, neatly shaped, and provided with lids, which, when perforated with small holes, make excellent covers. Of course, there are other vessels equally suitable for the cabinet aquarium, and those specified are only referred to in order that some idea may be given of what kind to use. The long clear glasses used by confectioners for the exhibition of sweetmeats in their windows can be utilised with advantage for such purposes as the cultivation of certain aquatic plants and some animals. There are other bottles, too, generally used also by confectioners for keeping their goods in, but not for showing them. These are made of coarser glass than those just mentioned, and they also possess the disadvantage of having a short neck and a mouth of a much less diameter than the rest of the bottle. The neck and mouth, however, can be cut off by a simple method, which will be explained. There is, nevertheless, a great drawback to all bottles and the like for aquarium purposes, and this is that their depth is much too great in proportion to their width. Still, there are circumstances under which they are more useful than wider and shallower vessels.

Rectangular aquaria are by far the best for the cabinet and other purposes. Small ones, such as that illustrated in Fig. 12, can be easily, cheaply, and quickly made, according to the following directions :

For the bottom (E) procure a piece of well-seasoned board 1in. in thickness of any size up to 16in. long and 12in. wide. No tank which is intended for the cabinet aquarium should be broader than the shelf of the cabinet upon which it is to stand.

Cut four strips of stout zinc 1in. wide, and of any length up to 6in. long.

Bend these four pieces of zinc lengthwise at right angles.

This may be done by the help of a carpenter's ordinary vice, or by hammering half of the zinc over the square edge of a hard piece of board. A line should be made down the middle of the strips to guide the bending, which ought to be quite correct.

Make at nearly the extremity of one end, by means of a small awl, two holes, one through each side of the zinc moulding, for the wire as represented at D D.

Before nailing a piece of the moulding to each corner of the board which is intended for the bottom of the aquarium, a

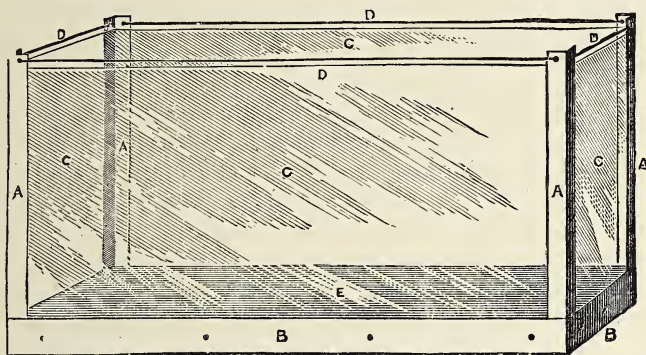


FIG. 12. EASILY AND CHEAPLY-MADE INSECT AQUARIUM.

small portion of the wood should be cut away so that the zinc moulding may be let in until it is quite flush with the edge of the board.

Cut a strip of zinc $1\frac{1}{4}$ in. wide and so long that it will go exactly round the edges of the board for the bottom (B B).

Nail one piece of the zinc moulding at each corner of the board in the place cut for it (A A). See that it is quite upright. Use small French nails, and hammer them well into the zinc. One nail at each side of the moulding will be sufficient.

Nail the piece of zinc, which has been cut $1\frac{1}{4}$ in. wide, quite round the edge of the wood for the bottom. The zinc to the height of $\frac{1}{4}$ in. should come above the board. The nails ought to be put through the centre of the zinc. If the tank is not

more than 6in. long, three French nails in each side will be enough ; one nail at each end, close to the edge of the uprights, and one in the middle.

Window-glass should now be cut to fit the frame just made, and put in its place (C C). The glass ought just to reach the holes in the zinc made for the wire.

Draw four pieces of thin copper or brass wire tightly through the holes made for it, and fasten it neatly (D). Copper wire must be well stretched before it is used. The wire should then hold the glass sides in their places.

Melt in a tin saucer over a lamp four parts pitch and one part gutta-percha. The pitch and gutta-percha must be well mixed before it is fit for use. It should boil for some little time and be stirred with a small iron spoon. Instead of the pitch and gutta-percha the following cement may be used, viz. : One part pitch, one part resin, and a little boiled oil—this last in the proportion of a tablespoonful to $\frac{1}{2}$ lb. pitch. This also must be boiled and well mixed together.

Take what is already made of the aquarium and hold it in the left hand. In the right hand take a spoonful of the boiling cement and allow it to cool a little for a moment or two, or it will crack the glass. Then put the spoonful of cement into one corner of the aquarium, and having returned the spoon to the saucer, with both hands tilt the framework carefully, so that the cement will run just at the junction of two pieces of glass, up to the top of the aquarium and then down again. Continue to do this until the cement ceases to flow. If this be well done the cement will not be seen beyond the edges of the moulding. Treat all the corners in the same way, but do not begin a second corner until the first is quite firm. This cement sets very quickly. When all the corners have been cemented, with the spoon pour sufficient of the mixture on the bottom to cover it, and then the aquarium, after standing an hour, will be ready for use.

After a little practice, several aquaria, such as the one just described, can be made in a morning. If carefully constructed they look very neat, and will not leak, unless perhaps when

placed for a long time within reach of the rays of a very hot sun—a position which is not fit for any aquarium. Even in these circumstances probably the tank would not leak at all, but the pitch would begin to melt. The zinc-work of these small cabinet aquaria may be painted with Brunswick Black or with Aspinall's Enamel.

Tanks made according to the above directions should not be of greater dimensions than 16in. long, 12in. wide, and 5in. deep. Those of the largest size should be placed on the bottom shelf of the cabinet. In fact, these tanks ought to be constructed according to the shelves, and should stand at least 2in. apart when placed in position, in order that they may be easily moved.

The large bottles, which have been already referred to as suitable for the cabinet aquarium, can be cut in half by saturating a piece of thick worsted in paraffin, and tying it evenly round the bottle at the proper place and then setting it on fire. As the worsted burns, the glass will crack in the direction of the flame. The rough edges of the shortened bottles may be rubbed off by using a piece of the stone with which scythes are sharpened, or a fine file.

Among other things, clear, thin, plain glass tumblers are very convenient vessels for the upper shelves of the cabinet aquarium; but the habits and wants of the various animals and plants should be considered before they are placed in any of the many different articles which may be converted into aquaria.

Every tank of the cabinet aquarium ought to be provided with a well-fitting glass cover, for the purpose not only of preventing the escape of its inmates, but also of excluding the dust and of lessening, as far as possible, evaporation; and it is wise to gum a strip of white paper along the bottom of the front of each aquarium, in order that a record may be kept of the times when and the places where its contents were obtained, and any other circumstances of interest in connection with them.

When the stand of the cabinet aquarium is completed, and

all its shelves are judiciously filled with vessels, some clean sand should be procured for the purpose of covering the bottoms of the different aquaria. But those tanks which are intended to contain interesting aquatic plants rather than animals ought to be especially prepared for the reception of such subjects by the placing of mud, loam, or anything else they may require, beneath a layer of the gravel. The aquaria, however, which are to receive various animals will need for the covering of their bottoms only fine gravel or sand, for in such foundations the very useful American weed (*Elodea canadensis*) will readily grow, and provide all that is required of vegetation in the tank. The most convenient way of planting the weed in the small vessels of the cabinet aquarium is to attach to each spray a small piece of lead and drop it in the water. The spray thus weighted will sink rapidly to the bottom of the vessel, and assume there its proper position.

The *Elodea*, or any other suitable weed thus treated, can be easily placed in or removed from any aquarium without either trouble or disturbance. When this method of planting is adopted, it is advisable to fill the vessel with water before the introduction of the weed. As a rule, the different tanks of the cabinet aquarium should be supplied with water and stocked with weed before the animals which they are to contain are bought or sought for.

CHAPTER IV

COLLECTING EQUIPMENT

OF course, it adds greatly to the interest of cabinet or other aquaria if the various specimens can be obtained personally from their native waters. Fish generally should be carried from place to place in well-constructed cans ; and it is wise, if possible, for this purpose to procure as large a can as possible. In such a can, fish may be transported great distances without injury. The can ought not to be more than three-quarters full of water.

When the aquarium-keeper intends, during his hunting expeditions for specimens for his aquaria, to include fish among his other captives, it is a good plan for him to set out provided with a can in which he has placed one or two short, wide-mouthed bottles. He will thus be able to sort his prizes in such a way as will be conducive to both their safety and their comfort. He ought, however, to prevent all movement of the bottles within the can by cutting a piece of tin, zinc, or wood in such a way that it will fit inside the can and go over the mouths of the bottles. If the holes, which are cut in whatever material is chosen, fit the tops of the bottles exactly, the latter cannot move sufficiently to hurt the fish or anything else in the can. The clear glass jars which have a lip but no neck, and which are sold containing jam, are excellent vessels for placing within the carrying can and also upon the shelves of the cabinet aquarium.

Should it not be the intention to catch fish, however, the can ought to be left behind and several wide-mouthed bottles taken in its place. These may be very conveniently carried by placing, say, three of them side by side in a narrow and light wooden box or specially constructed wicker basket.

Good bottles for this purpose are those already referred to as for fruit, etc. They are of a portable size, and their tin covers, which screw on, are very useful for preventing both the splashing of the water into the basket or box and the escape of the inmates. If the receptacle for the bottles is a little deeper than they are, there will be room above them for forceps, brush, mackintosh, magnifying-glass, and any other small appliance which the aquarium-keeper may require.

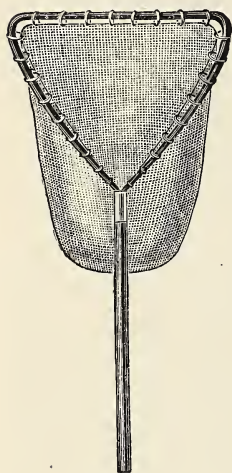


FIG. 13.
COLLECTING-NET.

Fig. 13 represents a very useful net for obtaining aquarium specimens. The frame is of strong iron, which is screwed into a stout wooden handle of about 6ft. in length. The material for the net part may be of what is called mosquito-net, or of that light canvas which is sold for straining milk. The net should not be too deep, and be of the shape represented in the engraving. It ought to be—at any rate, the fore part of it—attached to the iron frame by means of small rings, which prevent to a great extent the wearing away of the net by rubbing against the mud, stones, and bottom of the water. Such a net as this, which should be about 3ft. in circumference, with care will last for a long time.

Another, a much smaller net in every way, but made upon the same plan, will be found very convenient in addition to the one just described.

Besides the nets, there should be taken on the hunting expedition a long piece of strong cord, at the end of which is fastened a kind of hook, made somewhat after the fashion of a tiny anchor. This will be useful for pulling up from the bottoms of ponds, etc., masses of aquatic plants, among the dripping and muddy tangles of which will be found many very interesting creatures.

A very simple arrangement may be made for obtaining almost any number of Entomostraca and other small aquatic animals. It consists of a wide-mouthed bottle, a small metal funnel, and a small indiarubber or leaden tube. The broad end of the funnel is covered with a piece of very fine muslin—so fine that it will hardly allow anything but the water itself to pass through it—and the narrow part of the funnel is attached to one end of the tube. As long as the funnel will go into the bottle, the broader it is the better. The funnel should occupy the same position in the bottle as represented in the illustration (Fig. 14). The bottle ought to have a piece of strong string tied round its neck, in order that it may be easily carried—even while

water is running through the siphon—from place to place. Another bottle should be fastened to the end of a strong walking or other stick, so that water may be taken from the pond, ditch, or stream, both near the edge and some distance from

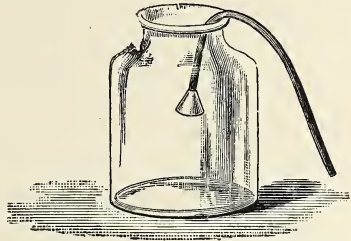


FIG. 14. BOTTLE AND SIPHON.

it, and poured into the bottle possessing the siphon. As soon as the latter is full of the water, which is supposed to contain the minute animals required, the siphon is made to run, and by constant additions of water is allowed to continue doing so until sufficient captives are taken:

When the muslin gets choked—as it occasionally will do—with mud and the like, it may be cleared by gently striking it once or twice against the surface of the water within the bottle. This operation will necessitate, of course, the re-starting of the siphon. As the Entomostraca are attracted to the surface of the water by the shining of the sun, a fine rather than a dull day should be chosen for catching them.

Besides the cans, bottles, and nets, the collector of specimens for the aquarium will find the following articles very useful during his hunting expeditions: (1) A pair of forceps,

(2) a small brush of camel's-hair, (3) a piece of mackintosh, (4) magnifying-glass, (5) wading boots, (6) wire, string, and a pocket-knife.

The forceps are convenient for quickly and gently picking certain animals off the weeds, or out of the mud brought to the banks with the weeds, and placing them into the receptacles prepared for them. Fig. 15 represents two kinds of forceps. The steel forceps may be obtained, for a small sum of money, of a surgical instrument maker. The wooden forceps can be easily made at home by nailing two slender pieces of hard and elastic wood to a small centre block. If the latter pair of forceps are 1ft. long, they may be used also for bringing up objects from the bottom of the smaller aquaria.

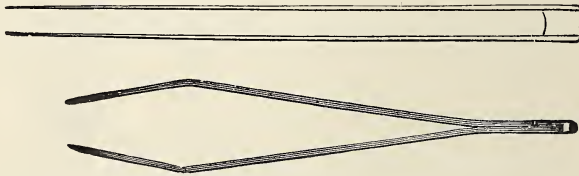


FIG. 15. WOODEN AND STEEL FORCEPS.

The camel's-hair brush is convenient for removing the more delicate animals from the weeds or net, and placing them in the bottles.

The piece of mackintosh is useful for three different purposes ; for the collector to kneel on while he is examining the weeds or mud which he has taken from the water ; for receiving the various animals which fall from those aquatic plants which are shaken over it ; and for wrapping up the weeds which are intended to be carried away. It should not be much less than 1yd. square.

The magnifying-glass is often of great help in making a close and careful examination of both plants and animals, and in deciding what are to be left behind and what taken home.

Of course, it goes without saying that a pair of strong boots are almost a *sine qua non* during the expeditions in

search of aquarium specimens; but those boots in which the collector can wade in the water up to his knees, are not only a great convenience, but are also often the means (by reason of the greater range which they give) of making interesting captures.

A piece of string, some thin wire, and a pocket-knife, should never be left behind, for one or other of them is almost sure to be required for something during the day.

If the aquarium-keeper be prudent he will take care not to overburden himself with bottles and nets, for nothing is so likely to mar the pleasure of a hunting expedition as a long walk home after hard work, with more than one can conveniently carry.

I have many times heard it said that one of the greatest charms of English sport is that one never knows for certain what is going to "get up." This is, in a way, true of hunting for aquarium specimens, for the collector is always wondering what he will fish up next; and after he has begun to use his nets in some well-stocked piece of water, he hardly knows when to leave off or when he has obtained enough prizes. At least, such has generally been my own experience. There are often in ponds, ditches, and streams, what may be called traps. These traps consist of old boots, old hats, pieces of rag, and half-sunk bonnet-boxes or newspapers; and if the collector will take the trouble to examine such things, he will frequently be well rewarded for his pains, for in them or under them a good collection of many and various aquatic animals are often to be found. It is, indeed, a good plan purposely to set these useful traps.

I can easily remember that while I was a small boy I often looked forward to the time when I should be able to possess one very large aquarium in which I could place all the different aquatic animals I might procure; but I have long since learnt by experience that it is impossible for the members of such an interesting (to me) collection to live peaceably together for any length of time—no, not even for one single night. It is wise, therefore, for the collector to return home from his

hunting expedition before it be too late, or before he be too tired to put his prizes into their respective dwelling-places. Should he, however, be indisposed or unable at once finally to assort his captives, he ought to transfer into shallow and well-covered vessels those creatures which he cannot trust, either for their own welfare or for the welfare of their comrades, to remain in the collecting-bottles. The various animals and plants can then be conveniently arranged on the following day.

There is hardly any part of the year which is altogether unsuitable for excursions in search of aquatic animals. I have had successful days even when I have been obliged to break the thin ice which was covering the surface of the water. However, the spring and summer time are the best seasons of all for these expeditions.

CHAPTER V

MANAGEMENT OF THE AQUARIUM

ANY home-made aquarium in the formation of which cement of most kinds has been used should stand filled with water for about ten days, and the water be changed several times during that period, before it is stocked. The cement will thus have an opportunity of giving off anything which would be likely to injure the inhabitants of the tank. When the aquarium has been sufficiently seasoned in this way, empty it, clean it, and put it into its permanent position, taking care that it stands quite firm and is perfectly level in every direction. After this has been satisfactorily arranged, some coarse builders' sand should be procured and thoroughly washed. When this operation has been repeated twice or thrice the sand will be ready for the aquarium. River-sand should also undergo the same careful washing. This cleansing of the sand ought never to be neglected, for without it some decaying matter, either vegetable or animal, will certainly be present, and in time may corrupt the water of the tank, and so cause injury to its inmates.

This clean sand should now be placed in the aquarium to a depth of from 2in. to 4in., according to the size of the tank and the character of the plants which are to be introduced. But if the aquarium is bell-shaped, all its lower portion may with advantage be filled with sand until it reaches that part of the vessel where the sides begin to be vertical. This will both lessen the depth of water and increase the rooting-space for vegetation. Charcoal is sometimes buried in the sand—for it has the power to some extent of counteracting putrefaction and preventing unpleasant smells. Its presence, however, in the aquarium has its drawbacks: if allowed to

float in the water it will look unsightly ; and if sunk in the sand there will be a difficulty in renewing it when its efficiency as a deodoriser has gone. A properly-stocked aquarium needs no charcoal. A layer of loam beneath the sand usually makes the plants grow better.

Suitable rockwork can easily be constructed. It should be of small dimensions rather than the reverse, as long as it will answer its purpose ; for much rockwork takes up valuable space, and does not look well in an aquarium. Care ought to be taken to so arrange it that, while it will afford the necessary shade to the occupants of the tank, it will not at the same time provide them with retreats into which they can retire altogether from their owner's sight ; for, if the animals are able to completely hide themselves, it is very possible that, should they die, their deaths will be undiscovered until the corrupting bodies have done irreparable damage to the whole aquarium.

Rockwork may be made of pumice-stone, coke, melted glass, mica-schist, or other material of a like kind. If the desired shape and size cannot be found in one single piece, two or three pieces may be joined together by means of Portland cement, always remembering that this cement, after it has well set, should be soaked for some days in water before it is placed in its permanent position in the aquarium. Pieces of pumice-stone or coke may be united by means of wooden rivets, each rivet running into the adjoining parts a couple of inches, the holes for which can easily be made with an ordinary awl. Before coke is put in the tank it should be dipped into some liquid Portland cement of about the consistency of ordinary whitewash, keeping the mixture well stirred during the process.

Most plants should be put in their places before the aquarium is filled with water. Those which do not require much rooting-space may be planted in the sand at the bottom of the tank ; but those which need greater depth can be set in small flower-pots. These pots can either be hidden by means of a careful arrangement of rockwork, or they themselves may be made

to resemble it by covering their sides with small pieces of coke, fastened into position with Portland cement. The whole should be then dipped as before described. There is one great advantage in putting plants into pots, inasmuch that, should occasion require, the aquarium can be emptied without materially interfering with their growth. The different aquatic plants suitable for fresh-water aquaria will be described in another chapter.

In an aquarium that is properly arranged and cared for, the water should seldom or never need changing. Its character, therefore, is a matter of much importance. The best water for the purpose is very clean rain-water ; next, that from the " tap." When the aquarium has been made quite clean, its glass has been well polished, the sand in the proper proportion at its bottom has been perfectly washed, the plants have been put in their places, and the rockwork has been placed in position, then—and not till then—should the water be introduced.

There is really only one satisfactory way, so far as I know, of filling an aquarium with water, and that is by means of a very slender siphon. A siphon of large diameter is worse than useless for this purpose ; but should the proper-sized siphon not be conveniently at hand, the water may be introduced in one of the following ways :

1. Pour it very slowly and carefully, by means of a slender-spouted can, against the sides of the tank.

2. Place a jug in the centre of the aquarium, taking care that it does not stand on any plant, and pour the water gently into it until the tank is full ; then remove the pitcher without emptying it.

3. Put the aquarium, if not too large, under a " supply " tap, and regulate the latter so that it allows the water to drip slowly upon a sponge placed on the gravel of the former. The sponge, while being taken out, should not be squeezed.

4. Fill the tank by the help of a watering-can which has a very fine rose.

But however carefully the water is introduced into the aquarium in any one of the above four ways, it will be found not to be perfectly clear. A small siphon only will attain that much-desired end. If one siphon does not work quickly enough, two or three may be used at the same time. A slender india-rubber tube of the necessary length, not thicker than the stem of an ordinary clay pipe, will make the siphon. The smaller the tubing in its diameter, the more satisfactorily will it do its work. The lower end of the siphon should rest on the gravel of the aquarium or upon the rockwork.

When the aquarium has been properly filled in the way just described, it is a good plan, if patience will allow, to postpone the introduction of any animals for at least ten days or a fortnight—the longer the better. During this time the plants ought to commence to grow and give off oxygen. At first only a few occupants should be introduced—say, three or four small fish, and a few snails—and if these do well, one or two more may be added, and so on. When the plants are fairly established, the aquarium will support much more life than when they are only just beginning to grow. If the fish swim near the surface of the water tails downwards and mouths upwards, there are too many in the tank, and unless some are speedily removed, many will die. There should always be too few inmates in an aquarium rather than too many; but if the tank is properly arranged, it is really surprising how much animal life it will support. For instance, I have at the time of writing in a bell-glass aquarium, 19in. in diameter, one gold-fish, one silver-fish, one carp, about a dozen snails (*Planorbis corneus*), and at the least forty small minnows (*Cyprinus phoxinus*). All these fish are seemingly in perfect health, and have been so for about ten months. The plants in this aquarium are *Vallisneria spiralis* and the Cape Fragrant Water Lily (*Aponogeton distachyon*).

The water of an aquarium that is properly balanced and cared for should never require changing, as a rule; but circumstances do occasionally arise in which it is necessary to empty the tank. For instance, the water may have become

corrupted by an undiscovered dead body ; the plants may need renewing, or the rockwork re-arranging ; perhaps the aquarium has sprung a leak, or it is necessary to remove it to some other position. Any one of these circumstances would require the emptying away of the water. This can easily be done by means of a piece of india-rubber tubing, of about $\frac{1}{2}$ in. in diameter, used as a siphon. Before the commencement of the withdrawal of the water, as many of the fish and other inhabitants of the aquarium as possible should be transferred elsewhere. However, it is not probable that all will be caught, for some will hide themselves in the weeds or under the rockwork ; and to prevent their being sucked up, the end of the siphon which is to go in the aquarium should be covered with a piece of mosquito net or similar material.

The position of an aquarium is an important matter, for very much depends upon the regulation of the light. Light is necessary to the growth of the plants, and to the production of oxygen. But too much light will encourage the development of the fresh-water Algæ commonly called *Conferva*. This *Conferva* is a vegetable growth which appears upon the inside of the glass of the aquarium, depriving it of its transparency. It grows also upon the plants, interfering with their welfare, and it will quickly spread, if unchecked, throughout the water, making it thick, green, and unsightly. Care is therefore necessary to guard against both too much and too little light. The rays of the sun should never fall directly upon an aquarium for more than three hours per day.

If they do, not only will the growth of the *Conferva* be encouraged, but the temperature of the water will quickly rise too high. The higher the temperature of the water, the fewer animals will it be able to contain ; besides which, water in this condition very readily becomes impure. The average temperature of a coldwater aquarium ought to be about 50 deg., and, if possible, it should never be allowed to vary more than 10 deg. either way. Sometimes aquaria are placed too near a window—a position conducive to the growth of the plants, but not to the happiness of the fish. Indeed, it is positively

cruel to put fish in an all-glass aquarium and allow the sun to shine upon it during the greater part of the day.

There are many ways of shading aquaria so that they shall not be unduly influenced by light and sun. If the aquarium is round, a sheet of green paper or a piece of American cloth, hung by means of small wire hooks to the edge of the glass, will answer the purpose. This can easily be removed for the inspection of the contents of the aquarium. Of course, such a screen cannot be called ornamental, but it is effective. Flowers, or ferns placed between the aquarium and the window will supply not a little shade. If the tank is rectangular, and all four sides made of glass, the same kind of shading will do, or cardboard may be cut to exactly fit three of the sides, instead. A little protection from too much light and sun may be obtained by having three of the sides made of ground-glass, or by covering these sides (externally, of course) with whitening dabbed on with a sponge, in imitation of ground-glass; or the conferva may be allowed to grow upon the three sides, and the fourth kept clear by using, when necessary, a piece of flannel tied to the end of a short cane.

It has been already mentioned that the water of an aquarium should obtain the necessary oxygen, not only directly from the atmosphere above it, but also from the vegetation growing within it; but there are circumstances under which artificial means of aeration should be resorted to. For instance, the tank may be overstocked with fish, and their owner, unwisely, be reluctant to part with any of them; or the temperature of the water, from some cause or other, may suddenly have risen too high.

Usually, the aerator takes the form of a small electrically-driven pump which forces air through a rubber tube terminating in a porous cane or stone diffuser resting on the bottom of the aquarium. These electric aerators may be purchased from all reputable dealers in aquaria requisites at prices to suit all pockets, the cheaper kinds usually costing about twenty-five shillings.

Aeration may also be carried out by allowing a steady drip

of water to fall into the aquarium for about five hours at a time. The supply of water may be housed in a small tank situated on a shelf above the aquarium, or it may come from a tap. Naturally the aquarium should be fitted with an overflow.

Other simple means of aerating the water of an aquarium will readily suggest themselves to the reader, such as taking a small portion of water from the aquarium and returning it again through the fine rose of a watering-can, or by using an ordinary bicycle pump—but take care that no oil is ejected into the aquarium at the same time.

CHAPTER VI

WATER-PLANTS

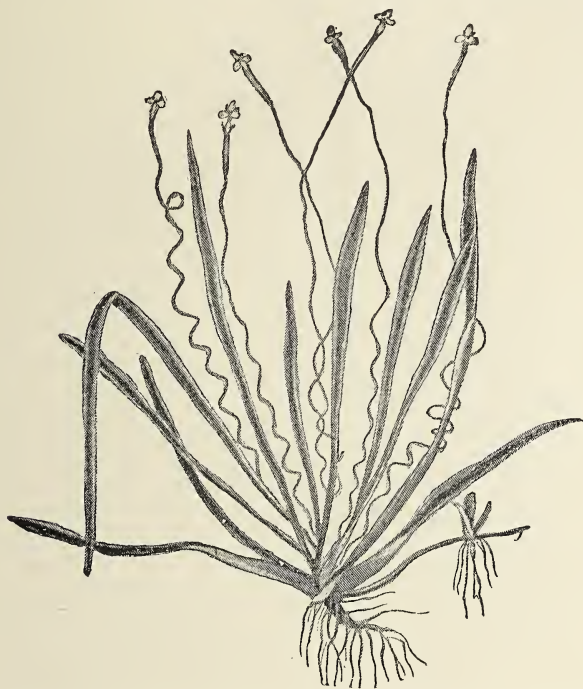
IT has already been explained why aquatic plants of some kind or other should always be present in an aquarium ; and in this chapter a few hints are given as to the choice and management of such vegetation. Half the pleasure of owning and caring for an aquarium would be gone if no plants were necessary ; they give to the tank nearly all its beauty.

Almost every aquatic plant can be grown in the still water of an aquarium, and be made more or less useful there. Some may be introduced chiefly for their beauty, others for their utility. The Italian Water-weed (*Vallisneria spiralis*) has for many years been a great favourite with those who keep an aquarium ; for besides being ornamental and useful it is also exceedingly interesting, inasmuch as it possesses a peculiar method of reproduction, and in its graceful grass-like leaves the cyclosis, or circulation of the sap, may be readily seen by the help of a microscope, just as one may observe the circulation of the blood in a frog's foot or in a tadpole's tail.

Vallisneria spiralis belongs to the natural order Hydrocharideæ, of which there are only three species native in Britain, viz., the Frog-bit (*Hydrocharis morsus-ranæ*), the Water-Soldier (*Stratiotes aloides*), and the Canadian Water-weed (*Elodea canadensis*).

The *Vallisneria* comes from the South of Europe, and is named in honour of an Italian botanist, Antonio Vallisneri. This plant is diœcious, that is, its female flowers grow on one individual plant and its male flowers on another. The female flowers are borne at the end of long spiral stalks, giving to the plant its specific name. These stalks, which increase in length very rapidly, are able to adapt themselves to the

depth of the water in which they are growing, so that their flowers can readily reach its surface. The male flowers are produced at the base of their own plants, and after a time become detached, rise to the top of the water, and float there



ITALIAN WATER-WEED, *VALLISNERIA SPIRALIS* (FEMALE PLANT).

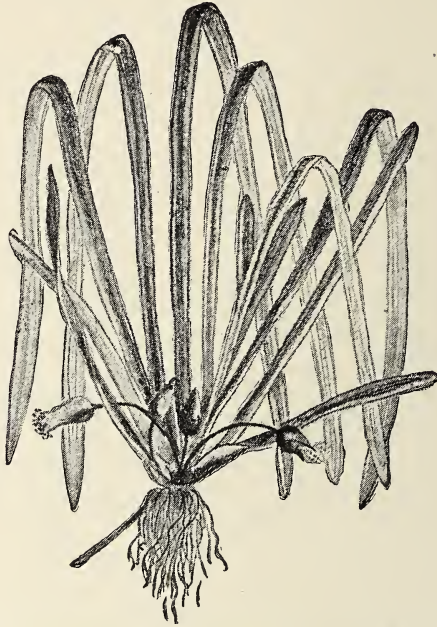
until they fertilise the female flowers with their pollen. After the fertilisation the latter sink to ripen and to grow.

The *Vallisneria* also increases by runners, somewhat similar to the common strawberry. These offshoots run along the bottom of the water until they begin to strike root in the soil, and so a new plant is formed. This plant grows well in the sand at the bottom of an aquarium.

The following precautions should be taken in regard to the

cultivation of *Vallisneria spiralis*, and indeed almost any kind of water-plant :

1. Do not place it in too little light, or it will not flourish ; nor in too much, or it will be choked with confervæ.
2. Do not chill it by putting it in water any colder than that from which it has been taken.



ITALIAN WATER-WEED, *VALLISNERIA SPIRALIS* (MALE PLANT).

3. Do not let any rusty leaves remain on the plants, but cut them off close to the roots.

The *Vallisneria* is one of the best of all water-plants for producing oxygen, therefore it is well worth careful management. The female plant seems to be much commoner than the male, but it is not necessary to have the latter in cultivation, as the former will readily increase by means of offshoots.

The Frog-bit (*Hydrocharis morsus-ranæ*) is a very pretty and suitable plant for the aquarium. It is easily cultivated

and very hardy. Its beautifully-veined leaves, growing on rather long stalks, are kidney-shaped, and its three-petalled flowers are white ; and when seen in masses upon the surface of some pond, it will be readily conceded that the plant has been well named *Hydrocharis* (a beautiful aquatic). The



FROG-BIT (*HYDROCHARIS MORSUS-RANÆ*).

Frog-bit is a floating plant, its roots never entering the soil. Like *Vallisneria spiralis*, it sends out runners ; but these, instead of taking root, put forth small buds, soon to develop into new plants. As the winter comes on, the parent plants decay, leaving their buds and seeds to sink to the bottom, where they remain dormant until the spring, then rising to the surface and taking the place and functions of their predecessors of the previous summer.

The Water-Soldier (*Stratiotes aloides*) is a rather rare native species. Its leaves are numerous, long, narrow, pointed, and serrated; and it bears a rather large pretty white flower at the end of a stalk about 5in. or 6in. long. This plant, like the Vallisneria and Frog-bit, increases by both off-shoots

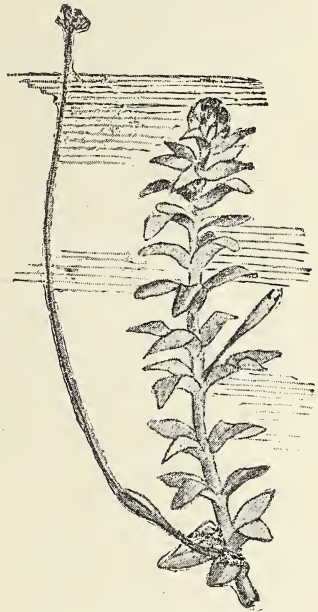


WATER-SOLDIER (*STRATIOTES ALOIDES*).

and seeds, generally the former. Its roots penetrate the muddy soil at the bottom of the water, and the whole plant remains submerged during the greater part of the year, only rising to the surface for a short time during the flowering season. The Water-Soldier, so named from its sword-shaped leaves, grows readily in an aquarium, and is very ornamental

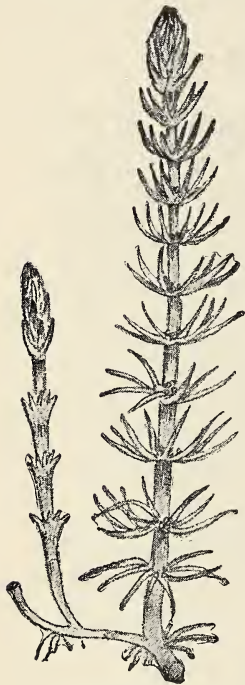
there. It will flourish either planted in the sand or floating upon the surface of the water. In either position it will produce new plants. If it is allowed to float, it will require to be taken out occasionally and carefully trimmed of all dying leaves and decaying matter. When the little plants, which it will bear at the end of long stalks, are of a fair size, they may be separated from the parent and floated in the water, or planted at the bottom of the tank. This plant does not seem to be a great producer of oxygen, but as it is ornamental, unusual in appearance, and a furnisher of shade, it is decidedly worth cultivating in an aquarium.

The Canadian Water-weed (*Elodea canadensis*) is remarkable both for its history in this country and for the manner and great rapidity of its growth. It was first introduced into Britain about the year 1842, and from that date it has extended to nearly every part of England and Scotland, growing in some localities in such profusion as to choke the water-courses, endanger the swimmer by entangling his limbs, and exhaust even the patience of good fishermen. However, the aquarium-keeper, as far as he is concerned, ought to be grateful for its appearance here, for not only is it one of the very best plants for the tank, but also in its tangled masses much interesting animal life is almost sure to be found. Its leaves, varying from dark to light green, according to age, are three or four in a whorl. They are minutely serrated, and are to be found in shape from roundly ovate to oval-oblong ;



CANADIAN WATER-WEED
(*ELODEA CANADENSIS*).

and in them the cyclosis may easily be seen under the microscope. In this country the plant—as the female flower is only found as a rule—increases chiefly by budding and not by seed. The male flower has been discovered, it is said, growing on long tubes somewhat similar to the spiral stalks of the female flower of the *Vallisneria*. The stem of *Elodea* is



MARE'S-TAIL
(HIPPURIS VULGARIS).

long, round, transparent, and very brittle, the smallest portion of which, as long as it contains a whorl of leaves, will send out roots and grow, in a comparatively short time, into an entire mass. It will flourish either floating in the water or planted in the soil at its bottom; however, its specific gravity is so great that it very frequently sinks from its own weight. From what has already been said, it will be readily gathered that the Canadian Water-weed is very hardy, and an excellent producer of oxygen. It will never die if it is carefully pruned of all decaying branches. The snails and some of the fish will eat it; and swans and even horses are said to be fond of it. Indeed, the birds are useful in checking its undue growth in streams and ponds. If the tank has been filled with water before the introduction of this plant, a small stone may be tied to the end of a short spray and sunk where it is intended

to grow, and it will quickly take root; but it must be watched, lest it occupy, through its rapid increase, more than its share in the tank.

In concluding my remarks on *Elodea*, I will venture to remind the aquarium-keeper that he should be exceedingly careful not to be the cause of the introduction of this plant into the streams and ponds of his neighbourhood. All that he

does not require ought to be completely destroyed, and not thrown carelessly away ; for the smallest portion of this most vigorous weed, being conveyed either by accident or otherwise to any permanent piece of water, may quickly become quite a nuisance there.

The Mare's-tail (*Hippuris vulgaris*) is only useful and orna-



SPIKED WATER MILFOIL (*MYRIOPHYLLUM SPICATUM*).

mental in an aquarium until after it has flowered, when it sinks to the bottom, and should be removed. It ought to be planted in a pot containing loam mixed with silver sand and covered with a layer of gravel ; the weed can then be easily taken away, when its duty has been done, without

disarranging the aquarium. As this plant rises several inches above the surface of the water, it should not be introduced into a tank which has a covering. The Mare's-tail is rather common, especially in the ditches of Lincolnshire. It is a ready producer of oxygen, and should be obtained as young as possible.

The Spiked Water Milfoil (*Myriophyllum spicatum*) has long been a favourite with keepers of aquaria. It is common

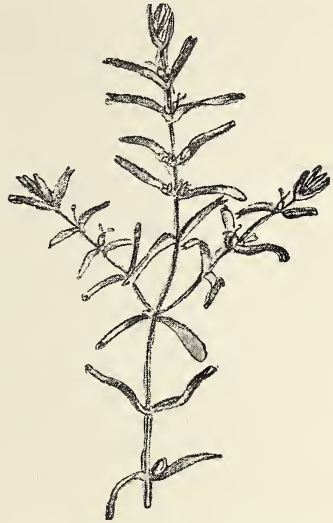


VERNAL WATER STARWORT (*CALLITRICHE VERNA*).

in stagnant water, where it is entirely submerged with the exception of the flowers, which rise a few inches above the surface. Water animals of many different kinds are fond of making the tangled masses of the Milfoil their head-quarters. In the aquarium it looks and grows well, and gives off oxygen freely. The greenish flowers grow in whorls, forming a leafless spike about 3in. or 4in. long; its leaves also grow in whorls of four, and are finely divided into hair-like segments. Most appropriately is it named the Milfoil (the myriad-

leaved). It flowers in July and August. A portion (not a bunch) of this plant may be tied to a stone and sunk in the aquarium : it will quickly take root and grow.

The Vernal Water Starwort (*Callitriche verna*) grows in both slowly-running and stagnant water. The leaves grow in pairs, and are narrower when found in a stream than in a pond. It is a very pretty plant, its leaves forming a mass of emerald-green stars on the surface of the water ; hence its common name. It is entirely submerged, with the exception of the little green flowers which rise above the water in June and July. If this plant is examined it will be readily seen that it takes its generic name (*Callitriche*) from its beautiful hair-like roots, some of which slightly enter the soil at the bottom of the water ; so slightly, indeed, that a small plant, with a little care, may be easily pulled up without the breakage of any of the slender stems. The Vernal Starwort is a great favourite with both female newts and fresh-water shrimps (*Gammarus fluviatilis*), for the former wrap their eggs carefully in the narrow leaves, while the latter find lurking-places in its tangles. There are various opinions concerning the suitability of this plant for the aquarium. Some keepers of aquaria declare that it is useless, as it dies so quickly ; while others assert that it is a ready grower, and consequently a good producer of oxygen. There is truth in both these statements, for if it is tied in a bunch to a stone (as it so often is) and sunk in the water of a tank, the lower part of it will soon die, its leaves turning a sickly-looking yellow ; but if,



AUTUMNAL WATER STARWORT
(*CALLITRICHE AUTUMNALIS*).

for the former wrap their eggs carefully in the narrow leaves, while the latter find lurking-places in its tangles. There are various opinions concerning the suitability of this plant for the aquarium. Some keepers of aquaria declare that it is useless, as it dies so quickly ; while others assert that it is a ready grower, and consequently a good producer of oxygen. There is truth in both these statements, for if it is tied in a bunch to a stone (as it so often is) and sunk in the water of a tank, the lower part of it will soon die, its leaves turning a sickly-looking yellow ; but if,

on the other hand, 3in. or 4in. of the top of each healthy spray is broken off and simply floated in the water, it will quickly put forth some hair-like roots and grow. In these circumstances it will supply a fair quantity of oxygen, and by its utility and beauty will earn a place in the aquarium.

The Autumnal Water Starwort (*Callitriche autumnalis*) is decidedly a rare plant compared to the Vernal Starwort. It grows in similar situations, but it does not, like that plant, ever rise above the surface of the water. Its leaves are narrower and of a darker green. *C. autumnalis* is occasionally found in the neighbourhood of London, and in some of the northern lakes. A few inches of the top of a healthy spray may be tied to a small stone and sunk in the water of the aquarium. No two sprays should be tied together.

The Water Crowfoot (*Ranunculus aquatilis*) is an excellent plant for the aquarium, and one very easily procured, as it is common almost everywhere. It grows in streams and ponds, sometimes nearly covering the latter with its beautiful green leaves and its pretty flowers. The leaves of this plant are of two different shapes: the upper leaves are three-lobed, with rounded notches, and float upon the surface of the water; the lower ones are divided into numerous hair-like segments, and are always submerged. In quickly-running streams the floating leaves are generally wanting. The rather large flowers are white, with many yellow stamens, very like strawberry blossom, and are borne from May to September. The Water Crowfoot is a most useful plant to the owner of an aquarium, for it will grow extremely well in a tank, and in its masses under water much interesting animal life is almost certain to be found. If a healthy portion of this plant is cut off, so that it is just long enough to allow the flowers and the lobed leaves to float on the surface of the water while the severed end touches the bottom, and is then tied to a stone and sunk in the aquarium, it will quickly take root and grow; indeed, so rapidly will it increase that care must be taken lest it usurp the entire tank.

The Ivy-leaved Crowfoot (*Ranunculus hederaceus*) is a very

useful little plant for the aquarium, especially for those which are not deep. In some neighbourhoods this weed is very common, and is to be found growing in shallow water, on the sloping margins of ponds, and on those places from which the water has lately retired. This plant is not nearly so large as the Water Crowfoot, and its flowers are very small. It has a creeping, submerged stem, throwing out roots, and its leaves



WATER CROWFOOT (*RANUNCULUS AQUATILIS*).

are roundly lobed, rising on rather long stalks some little distance above the surface of the water. Any portion of the stem having leaves attached will grow and blossom freely in an aquarium.

Water Lobelia (*Lobelia Dortmannii*) is a very pretty and suitable plant for the aquarium, but it is not readily to be procured, as it is almost confined to the northern lakes, where it grows in thick masses at the bottom of the water. Its flowers are light blue, and grow droopingly upon long stalks, which rise above the surface of the water, and its leaves are

long and narrow and almost cylindrical. This plant may be set in the sand of the aquarium.

The Nymphæa-like *Villarsia* (*Villarsia nymphæoides*), named in honour of M. de Villars, a French botanist, is a very lovely and rare water-plant. It is found in still waters in the neighbourhood of the Thames and in some slow Yorkshire rivers. Its nearly round though almost heart-shaped leaves



NYPHÆA-LIKE VILLARSIA (*VILLARSIA NYPHÆOIDES*).

float at the end of long stalks on the surface of the water. The stem is long and branched. The five-petalled flowers are rather large, yellow, and fringed. It is very hardy, and is easily cultivated in the aquarium, but it should be planted in a pot containing good loam mixed with silver sand. The *Villarsia* can be propagated either by seed or by division of the root, and is a rapid grower. Though this plant is rare it can generally be bought from some London dealers for quite a reasonable sum, and I think the aquarium-keeper will never regret the purchase.

The Buck-bean (*Menyanthes trifoliata*) perhaps can hardly be called an aquarium weed, because it prefers to grow in very damp, boggy soil rather than altogether in water; still, its exceeding beauty tempts one to place it in the tank if possible, and there it will certainly succeed well if properly situated. Few British flowers are so beautiful as those which this plant bears. It should be planted in as large a pot as



FORGET-ME-NOT (*MYOSOTIS PALUSTRIS*).

convenient, and so hidden among the rockwork that the lower part of the pot is in the water. A small plant ought to be chosen. It is a trefoil, that is, three leaflets grow on a common stalk, and "each leaf-stalk has a sheathing base, opposite to one of which rises the beautiful cluster of blossoms." The buds are a bright rose colour, and the open flowers are covered with a white silken fringe, well said to resemble plush. It blossoms during June and July. The Buck-bean is found growing on spongy bogs, and sometimes in stagnant water.

Though there may be difficulty occasionally in finding this plant growing wild, it can generally be bought cheaply enough from some of the larger London dealers.

The Forget-me-not (*Myosotis palustris*) is placed in the aquarium chiefly for its beauty. It is rather common, and is in flower from June until the end of September. This plant



BROOKLIME (*VERONICA BECCABUNGA*)

has a creeping stem, and bright green and rather rough leaves. The flowers, which grow on leafless stalks, are pale blue, with yellow centres. The buds before they expand are pink, and are coiled up in such a way at the top of the flower-stalk as to give to this plant and its relations the name of Scorpion Grass. The *Myosotis* should be set in a pot, and placed among the rockwork of an aquarium. This plant is also called the Creeping Water Scorpion Grass, and is said

to be the true Forget-me-not, though this romantic title has been often claimed for other plants.

The Brooklime (*Veronica beccabunga*) is very hardy, and grows rapidly in an aquarium. Its bright green leaves are oval and roundly notched on their margins. They grow opposite one another, in twos, on a creeping stem, which sends out small roots. The flowers blossom from May to September,



COMMON HORNWORT (*CERATOPHYLLUM DEMERSUM*).

and are generally of a deep blue colour ; but occasionally they are flesh-coloured. The Brooklime is a great favourite with keepers of aquaria, for it is very pretty, common, and useful. A small portion of the plant, containing a short piece of the stem, will begin to grow almost directly it is planted in the sand and gravel at the bottom of the tank. This weed is often found growing in the company of watercress, with which it is sometimes eaten, though the flavour is rather pungent.

The Water-mint (*Mentha sylvestris*) is one of the most

ornamental of water-plants. It is fairly common, and is found growing either in or on the edges of shallow streams, often in dense masses. The leaves are egg-shaped and serrated. The flowers, which are a pale lilac, grow on the upper part of a stem in thick whorls, the top flower of all forming a kind of head. The Water-mint will grow well in an aquarium, and may be planted in a pot, or in rather deep sand at the bottom of the tank. It flowers from July to September, and emits rather a strong scent, which is pleasing or unpleasing according to individual tastes.

The Common Hornwort (*Ceratophyllum demersum*) grows in slow-running streams and ditches. It is not by any means a rare plant; indeed, in some counties it is very common. There is no difficulty in recognising this weed, its appearance is so different from any other. It has narrow bristle-like leaves, growing round a stem in whorls. Each leaf is divided in forks, three or four times, so making a rather dense mass. The green flowers are also whorled, and grow in the axils of the leaves. The fruit has two horns near the base. The Hornwort is useful in an aquarium, and will do well if a small portion is tied to a stone and sunk to the bottom. It grows entirely under water, and flowers in July.

The Bladderwort (*Utricularia vulgaris*) is a rare and very interesting plant. It is found in some of the ponds and slow-running rivers of the southern and eastern counties of England. Its leaves are divided into hair-like segments, to which are attached numerous small bladders of a purplish or pinkish colour. The bladders are for the purpose of so buoying up the plant that its flowers may have the air and light which are necessary to their development, and partly for the purpose of catching food for the plant in the shape of aquatic insects. The bladders, therefore, are not only buoys, but traps: veritable insect-traps formed on the same principle as many a rat- or mouse-trap. The way in is as easy as the way out is difficult. If the bladders of one of these very interesting insect-feeding plants were examined during the flowering season, it would be found that nearly every bladder contained

its prey in the shape of one or more aquatic insects, upon which the plant was either feeding or upon which it would feed. Dr. Taylor in his book, "The Sagacity and Morality of Plants," describes the entrance of these traps as being "set with bristles or stiff plant hairs, and which point inwards, so that insects easily get in, but cannot get out." When the flowering season is over, the bladders fill with water and the whole plant sinks to the bottom of the river or pond. The rather large yellow flowers grow in clusters of six or seven



BLADDERWORT (*UTRICULARIA VULGARIS*).

upon the upper part of the stalk, which is raised several inches above the surface of the water. Towards the end of the year the greater portion of the plant decays, leaving the hardish, oblong terminal buds, about the size of a pea, to lie dormant during the winter at the bottom of the water. In the spring these buds rise to the surface and grow into new plants. The buds may be obtained from the bottom of those ponds where the plants are known to grow, by means of a fine muslin net; or they may be taken as soon as they rise to the surface, in the spring. When procured, they should be placed

in the aquarium, where they will soon become interesting, ornamental, and useful.

U. neglecta, a very rare and interesting water-plant, found in Essex, Gloucestershire, and perhaps other counties of England, has the bladders upon both the stem and its thread-like leaves; while *U. vulgaris*, as implied above, possesses them only on its leaves.

The Water Violet (*Hottonia palustris*) is named after Professor Hotton, of Leyden. In some respects it is like the



WATER VIOLET (*HOTTONIA PALUSTRIS*).

Water Crowfoot, though it certainly has the advantage of the comparison. It is by no means a common plant, but it is found plentifully enough in the ponds and ditches of Norfolk and Suffolk. Dealers in aquarium necessaries are generally able to supply this weed during the season. It will grow well in a tank, but it should not be tied in a bunch and sunk by a stone to the bottom, according to a common practice; it ought to be planted separately, a piece of the creeping root being attached. *H. palustris* has feathery leaves, which grow in tufts under the water, only the upper part of the flower.

stalk rising a few inches above the surface. The five-petalled flowers are rather large, and vary in colour from pink and yellow to almost white.

Amphibious *Persicaria* (*Polygonum amphibium*) is a handsome plant, and will grow readily in an aquarium. It is not uncommon, and is found either in still water or upon marshy land; but when living in the former it assumes a different shape from that which it has when growing upon the latter; indeed, the difference is so great that the varieties might be taken for two distinct species. In the one case, the leaves are broad and smooth, and float at the end of long stalks; in the other, the stem is short and the leaves are narrow and rough. The flowers are rose-coloured. A portion of this plant having a piece of the creeping stem attached (which stem ought to be sending out roots at a joint or two) should be set in the sand at the bottom of the aquarium.

The Flowering Rush (*Butomus umbellatus*) is an exceedingly pretty water-plant for the large tank. It has narrow, three-cornered leaves, which spring from the root, and its beautiful pink or purple flowers grow in a bunch upon the top of a long and circular stem. This plant is found in ponds and slow-running rivers, and blossoms from June to September. The Flowering Rush will grow very well in the aquarium if a small plant (having its tuberous root) is placed in a pot containing loam covered with plenty of well-washed sand.



FLOWERING RUSH
(*BUTOMUS UMBELLATUS*).

The Great Water Plantain (*Alisma plantago*) is a very good weed indeed for the aquarium. Its leaves are of two different shapes: those which grow above the water are of a bright green colour, and something like those of the Common Plantain, while those which remain entirely under water are long and narrow. The lilac-coloured flowers grow on long three-

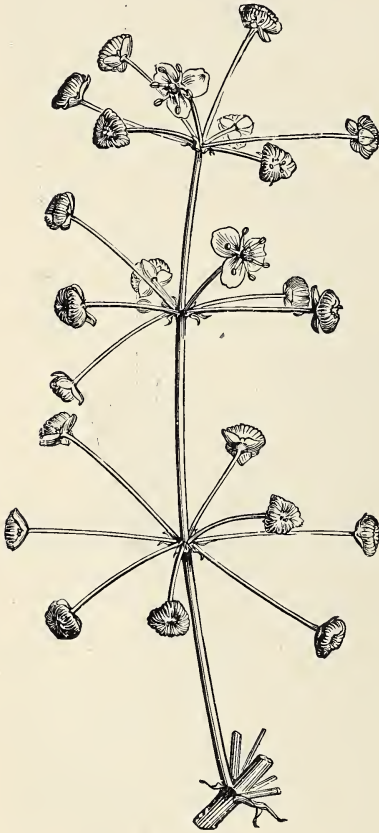
sided stalks, which rise some distance above the surface. This plant is more or less common in ponds and ditches all over England. It can easily be cultivated in the aquarium, where it is both ornamental and useful. There are very few

plants, I think, which so soon begin to grow after having been introduced in the tank. Small plants should be chosen for the purpose: such can generally be found growing very near a large one. They ought to be taken with as much of their native soil clinging to their roots as possible, and then planted in a convenient-sized pot containing loam and gravel.

The Common Arrow-head *Sagittaria (sagittifolia)* is very hardy, and will grow well in the large aquarium. The arrow-head-shaped leaves of this plant will easily lead to its recognition. Its flowers have three white petals, and grow in whorls on stalks which rise about 6 in. above the water. This plant sends out runners ending in tuberous roots.

The Arrow-head is rather

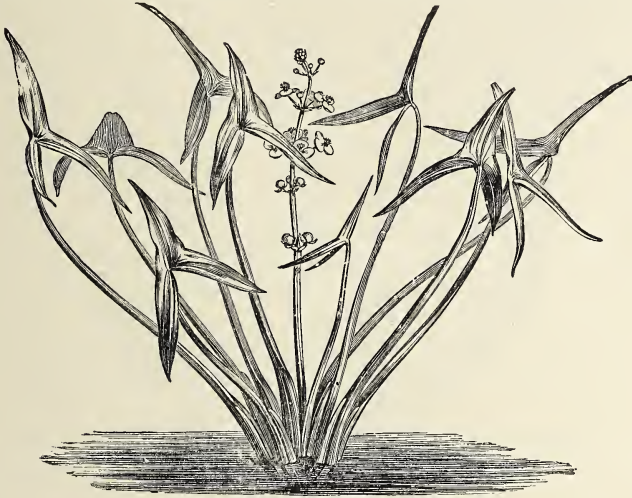
common in lakes, ponds, and ditches, and is often found in the company of the Water Plantain. It should be placed in the tank according to the directions given for the setting of the latter plant.



GREAT WATER PLANTAIN
(ALISMA PLANTAGO).

The Branched Bur-reed (*Sparganium ramosum*) is ornamental in a large tank. Its fruit, which resembles burs, and its long wavy leaves, cause it to be readily recognised. The flowers grow on long, branched stalks, which sometimes rise as high as 3ft. above the water. It should be planted in a pot containing loam.

The Sweet Flag (*Acorus calamus*) is an interesting plant, and may be grown in a pot immersed in the water of an



COMMON ARROWHEAD (*SAGITTARIA SAGITTIFOLIA*).

aquarium, where it will be ornamental. It is something like a large grass or sedge in its habit, but it may be easily distinguished by its curious spadix, which is 2in. or 3in. long, and of a light brown colour. The whole plant gives out a very pleasant aromatic scent, and for this reason it was frequently used many years ago (and is, I believe, even now sometimes) for covering the floors of churches and houses. This plant is common in Norfolk and Suffolk.

The Broad-leaved Pond-weed (*Potamogeton natans*) is common in ponds and ditches, but more so in the former than in the latter. The only drawback that I know of to the

presence of this plant in the aquarium is the liability of some of the leaves to premature decay : in other respects it is most suitable for a tank, as it is both ornamental and a good producer of oxygen. *P. natans* has, as a rule, particularly in deep water, two sets of leaves : the upper ones float upon the surface at the end of long stalks, which are able to adjust themselves to the depth of the pond or ditch in which they are

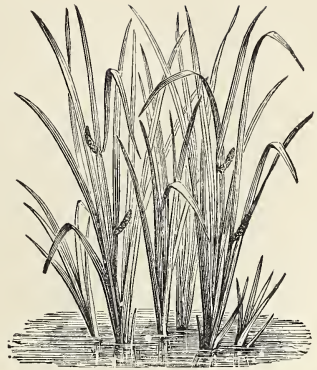


BRANCHED BUR-REED (*SPARGANIUM RAMOSUM*).

growing ; the lower ones are often absent in shallow water. The floating leaves are ovate, and 2in. or 3in. long ; the submerged ones are somewhat similar to long grass. The green flowers grow on small spikes just above the water. This weed may be planted in a pot containing loam and silver sand.

The Close-leaved Pond-weed (*Potamogeton densum*) is quite as useful and beautiful a plant for the aquarium as *P. natans*.

With some people it has the preference for this purpose. Its tapering-pointed leaves are of a lighter green, and, as its specific name implies, are closely placed together. It is, if anything, a freer grower than the Broad-leaved Pondweed, and is consequently a good producer of oxygen. When an occupant of the tank, it should be treated in the same way as has been recommended for *P. natans*.



SWEET FLAG
(*ACORUS CALAMUS*).

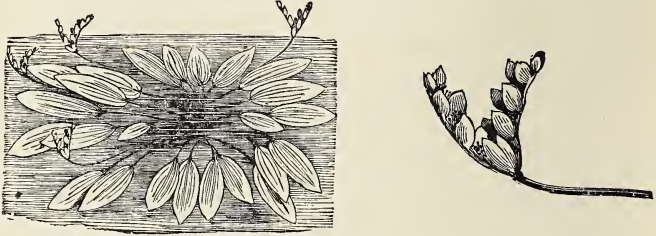
The Cape Fragrant Water Lily (*Aponogeton distachyon*) grows exceedingly well in a large aquarium, and is very graceful, having bright green, ovate, floating leaves on very



BROAD-LEAVED POND-WEED (*POTAMOGETON NATANS*).

long stalks. The groups of white flowers are forked, and float upon the water: they remain in perfection for a long time, and give out a strong, pleasant smell. This plant may be

propagated by division of the root, and can always be bought for a small sum ranging from 1s. 6d. to 3s. It should be planted in a pot containing loam and silver sand mixed. It is



CAPE FRAGRANT WATER LILY (*APONOGETON DISTACHYON*).

a rapid grower and a useful and ornamental plant for the tank. I have found that it will not flower well unless it can

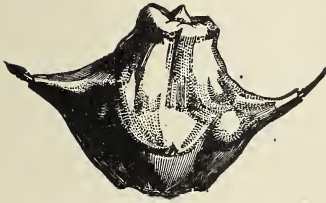


WATER CHESTNUT (*TRAPA NATANS*).

have as much sunlight as is compatible with the welfare of the rest of the aquarium.

The Water Chestnut (*Trapa natans*), though not a native of England, is a great favourite with some aquarium-keepers.

It is a floating plant, common in the lakes and slow-running rivers of some parts of Europe. The flowers are a reddish-white.

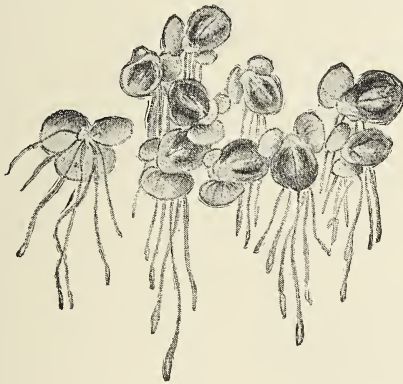


FRUIT OF TRAPA NATANS.

The fruit is large, black, and armed with four spines. The seeds are good to eat, and are sometimes used in soup: they are said to have a taste similar to that of the chestnut, hence the common name. This plant can often

be bought in London for a moderate sum: but perhaps the seed might be obtained more readily.

Though almost everyone knows the duckweed when he sees it, yet very few, comparatively, know what an interesting plant it really is. Four species of duckweed are found in Great Britain, and all are useful and pleasing in the aquarium, for they keep the water shaded at the surface, they form



GREATER DUCKWEED (LEMNA POLYRHIZA).

hiding-places for the smallest animals, they are introduced without trouble, they grow well, and their presence has a pleasing effect. Only a few plants should be placed in a tank at a time, as they multiply rapidly. They increase by

offshoots at the edges of the fronds. The duckweeds are the smallest of all flowering plants, but they blossom very rarely—The Greater Duckweeds not at all in Britain. In winter they sink to the bottom of the water.

The Greater Duckweed (*Lemna polyrhiza*) is rather larger than the rest of the duckweeds. Its fronds or leaves are nearly round, about $\frac{1}{2}$ in. in diameter, thickish, dark green above and purple below, each frond having a number of little roots or fibres growing from beneath. This is a rare plant.

The Thick Duckweed (*Lemna gibba*) has fronds almost round, about $\frac{1}{3}$ in. in diameter, bright green in colour, flat above and round beneath. The fronds have only one fibre each. This plant is occasionally found growing with other duckweeds upon still water.

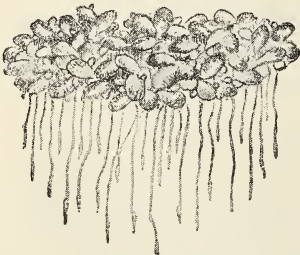
The Lesser Duckweed (*Lemna minor*) is the commonest of all: the fronds are small, ovate, light green above and a lighter green below, with one rootlet to each frond.

The Ivy-leaved Duckweed (*Lemna trisulca*) is fairly common on lakes and ponds. It is about $\frac{1}{2}$ in. long, elliptical, thin, serrated near one end, and of a light green colour. The young fronds grow at right angles to the old ones, and each frond has one fibre.

The *Characeæ* are divided into two genera—*Chara* and *Nitella*—both of which are very useful and ornamental in aquaria, but particularly in those which contain only very small animals. These plants are too



THICK DUCKWEED
(LEMNA GIBBA).

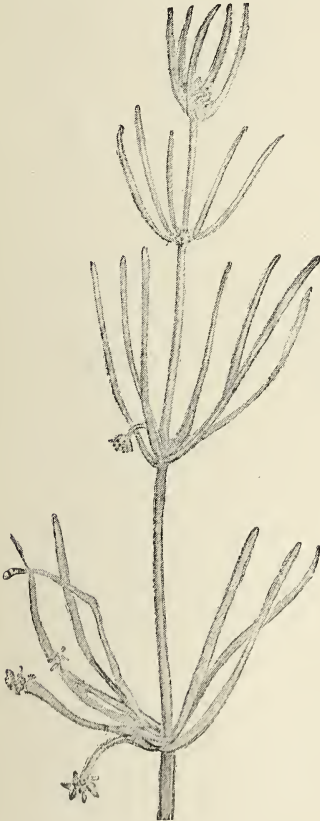


LESSER DUCKWEED
(LEMNA MINOR).

fragile to be placed within the reach of large fish. There are many species of the *Characeæ* in Britain, some of them being common. They grow in ponds and ditches where the water is clear. They have neither true leaves nor true flowers, but they have instead sub-divided branches and a curious kind of fruit. The principal difference between the



IVY-LEAVED DUCKWEED
(*LEMNA TRISULCA*).

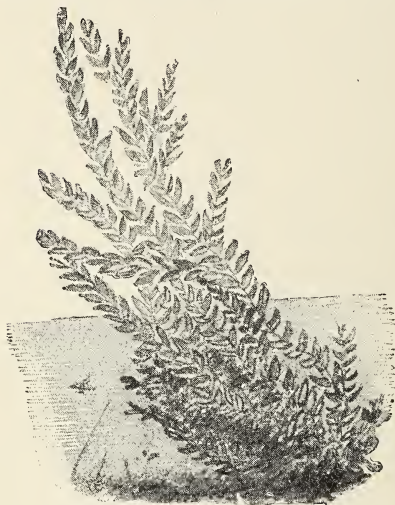


NITELLA TRANSLUCENS.

Chara and the *Nitella* is that the former has a compound stem, and the latter a simple one. These plants, especially the *Nitella translucens*, do not require much light for their development, growing far better when placed at some distance from the window than when cultivated in close proximity to it. A small portion of each plant should be sunk by the help of a small stone to the bottom of the aquarium. Both the *Chara* and the *Nitella* succeed much more satisfactorily when planted in this way than when simply thrown into the water. They grow very quickly, and will in a short time fill the receptacle in which they are placed. These plants are also very

interesting on account of the ease with which the circulation of the sap in their stems may be seen under a good microscope.

Willow Moss (*Fontinalis antipyretica*) is found growing on stones, and altogether submerged in rapid streams and rivers. It can be easily seen through the clear water waving up and down under the action of the current. The plant itself is of a dark green colour, but its new shoots or terminal buds are light green. It is a beautiful and hardy plant, and very



WILLOW MOSS
(*FONTINALIS ANTIPYRETICA*).



CRYSTALWORT
(*RICCIA FLUITANS*).

useful in the tank. It is also of the greatest utility to the aquarium-keeper, for its tangled masses are full of numerous kinds of animal life. A small and suitable-shaped stone covered with a short growth of the *Fontinalis* should be placed in the aquarium.

Crystalwort (*Riccia fluitans*) is a very useful little plant in an aquarium. Its leaves or fronds are repeatedly forked, each segment having at the end a small notch. It is native to the Southern States of America, but may be obtained from most dealers in the spring.

Besides the water-plants thus briefly described in this chapter, there are, of course, others which would also be both useful and ornamental in aquaria ; but enough has been said, I hope, to give the novice in aquarium matters an idea of what kinds of plants to look for, where they may be found, and how they may be introduced into his tanks.

CHAPTER VII

FISHES

THERE are no more interesting and attractive inhabitants of an aquarium than fish. Fish are both intelligent and, to a certain degree, affectionate. No one ought for a moment to doubt their possession of intelligence when he calls to mind the time, thought, patience, and skill which must often be expended before the devices of man can overcome the craftiness of some fish ; when he comes to remember how apt they are to profit by experience, and how ready they are to take advantage of the least clumsiness or carelessness on his own part when, having hooked them, he is attempting to land them ; and when he reads (and believes) that certain fish have been known to come to their feeding-places in the lake in which they live upon the sounding of a gong, and that others (sticklebacks in an aquarium) have been trained to ring a bell when they were wanting food. Nor is it unreasonable to suppose that fish possess affection when sharks hunt in twos ; when pike pair, and if one of them should be captured, the other haunts the spot waiting for the return of his mate ; when sticklebacks carefully build their nests and fight in the defence of their young ; and when bullheads constantly watch and guard their little ones until the latter are able to take care of themselves.

Most fish in captivity will grow quite tame, learn to know their owner, and come to the side of the tank on his approach.

By the help of the aquarium we are able to learn very much concerning the habits and characteristics of fish, which knowledge, without its assistance, we should fail to obtain. It is very pleasant to see healthy fish in a tank when the water is bright and clear, the plants are green and growing, and

everything is quite clean. But, on the other hand, it is distressing to see fish swimming with their noses close to the surface of thick, unwholesome-looking water, vainly endeavouring to get a sufficiency of oxygen; to see plants partly dead and decaying, and fungus growing upon food which, in excess, has been carelessly thrown into the aquarium and left there until it has introduced disease. To see a miserable bird in a dirty cage is bad enough; but it is far worse, I think, to see dying fish in foul water. There are few pets which require such little care as fish, but it is absolutely necessary that they should have some attention, and he who keeps fish and neglects them is just as much guilty of cruelty as he who is summoned for working a horse with sore shoulders.

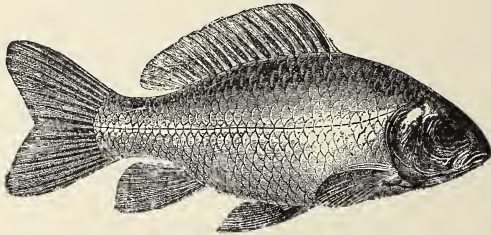
If the aquarium-owner would keep his fish in a healthy and happy condition, he ought to carefully observe the following rules:

- (1) Provide shade for the fish.
- (2) Never let the sun shine for any length of time upon the water in which fish live.
- (3) Never keep more fish than the aquarium can contain in comfort.¹
- (4) Never put large fish in a small tank. Prefer small fish.
- (5) Never forget to feed regularly, and on suitable food.
- (6) Never allow discarded food to remain in the water.
- (7) Remove diseased fish at once, and never introduce strange ones about whose health there is any doubt. Keep them in quarantine for a short time.
- (8) Never permit the presence of armed and bullying fish with unarmed and timid ones—e.g. sticklebacks with small goldfish.
- (9) Never allow the water-plants in their luxuriant growth to fill the whole aquarium, and so interfere with the free movements of the fish.
- (10) Always remove dead and dying weeds, or dead and dying animals of any kind at once.

¹ There are too many fish in an aquarium when they swim with their noses close to the surface of the water.

There are no fish more commonly seen in the aquarium than the Goldfish (*Carassius auratus*), and few are more suited to a life there than they are. They are very hardy, not too active, handsome, of various colours, and easily tamed. Not only do these fish vary in their colour, but also in their fins: some fins are double, others are entirely wanting. Occasionally one fish has two or three tails. I had a Silverfish in my possession for some years whose tail looked, from behind, like an inverted capital Y. This fish was perfectly healthy and very handsome, his scales glistening like mother-of-pearl.

It is a long time since Goldfish were first introduced into



GOLDFISH (*CARASSIUS AURATUS*).

England, and when is a matter of doubt; probably, however, about the year 1611. They originally came from China.

A great many Goldfish are now annually bred in this country, especially in those tanks which receive the waste hot water from some of the great manufactories in the North of England. For the aquarium "cold-water" fish should always be chosen—that is, those which have been born in ponds uninfluenced by artificial heat: they are much hardier than the "hot-water" ones. Not seldom the latter will be found on their backs in the tank gasping for breath and apparently dying. When this is the case, they may be revived by placing them in running water, under a tap for instance, or by putting them for some time in fairly warm water (about 90 degrees). This last remedy—the simplest—is perhaps the most effectual.

“ Cold-water ” fish if properly managed, hardly ever suffer from illness, and rarely die except from accident or old age ; indeed, I have found that the mortality of fish (not Goldfish only) in an aquarium is very far less than that of birds in an aviary. Once while I was in a bird-dealer’s a lady came in and asked for some Goldfish, adding the remark that she could never get hers to live more than about half a year. On hearing this I ventured to ask, as politely as I could, whether she fed her fish. “ Oh, no,” she replied, “ I never give them anything to eat.” As she said this the shopkeeper exclaimed : “ Never feed your fish if you want ’em to live.” That lady’s fish had died the very painful death of slow starvation. And her fish, alas ! I fear, are not the only ones which so die. The fish this man sold were healthy “ cold-water ” fish, and this I knew, for I had bought several of him, which had lived in my aquarium for years, and were alive and well then. Some of my friends also had bought fish of him, with the same satisfactory result. And this lady’s fish died, not because they were unfitted to live in confinement, but because they were improperly cared for. And those people who so often complain that their Goldfish die, may depend upon it that, as a rule, the fault is not in the fish or in the seller of the fish, but in their own mismanagement. Fish, however healthy, must, of course, be regularly fed.

A good food for Goldfish is finely crushed soaked vermicelli. This should be thrown sparingly into the water, and as it sinks the fish will soon learn to take it eagerly. Never give them more than they will eat at the time of feeding. Besides this food, the fish will eat the eggs and fry of water-snails. A little raw meat and a few garden or water worms will be good for them as a change.

Goldfish, in common with all the Cyprinidæ, have the power of living for a time out of water. The reason of this is that the covers of their gills, having bony supports, can be opened by the action of the muscles, and so the fish are able as it were to breathe the atmospheric air. Aquarium-keepers have often recorded instances in which Goldfish have jumped

out of their tank on to the floor, have remained there for several hours before they have been discovered, and then, on being returned to the water, have quickly regained their former health and spirits. A convenient way of carrying these fish a long distance is to wrap them up in damp moss. The late Mr. Frank Buckland says that once having a dozen Goldfish given to him, he placed them in wet grass and then in a cloth in his carpet bag. "There they remained all night." On his arrival in town, during the afternoon of the following day, he placed them in water, and found that six of them were still alive after having been kept a night and half a day in his carpet bag. When first placed in the aquarium they rolled about as if intoxicated, but they soon recovered from the effects of their journey.

When Goldfish, by accident, have been allowed to remain for a long time out of water, they may frequently be revived by administering a little brandy, even if they are apparently quite dead!

Goldfish will breed in a large aquarium: they deposit their spawn among the water-weeds there, to which it adheres. The spawn as soon as deposited should be removed to another tank, or the old fish will eat either it or the fry which are hatched from it. The young fish are hatched, according to the water's temperature, in from four to seven days. They should be provided at first with the smallest animal life for food, such as water-fleas and Cyclops. When about six months old they may be returned to the aquarium, for they will then be quite able to take care of themselves. The young fish at first are very dark bronze or greenish-brown, but gradually as they grow they become either golden or silvery in colour.

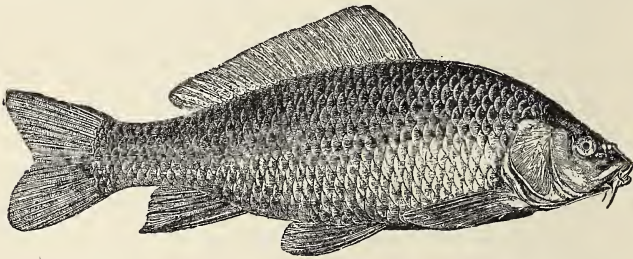
Goldfish can be more easily bred in a small pond in the garden than in an aquarium. The pond for this purpose need not be more than 8ft. or 9ft. in diameter and about 3ft. deep. The sides of the pond ought to slope gradually from the edge, so that the young fry will be able to get out of reach of those old Goldfish which pursue them with cannibalistic

intentions. The pond may be made perfectly watertight by means of a mixture of Portland cement and sand. Before any fish are introduced into the pond it should be filled with water, which ought to be frequently changed during a period of six weeks or two months. The Portland cement will then be deprived of any poisonous properties which would be likely to injure the fish. When the pond has been properly soaked, its bottom should be covered with well-washed sand to the depth of about 6in., and in this sand some *Elodea canadensis* ought to be planted. When this has taken root, and made a fair amount of growth, the fish may be introduced—say, eight male Goldfish and six females. These in favourable circumstances will increase with great rapidity: one female alone will sometimes deposit about half a million eggs; luckily, however, only a small portion of these hatch. The fish during their breeding season should be fed on meat and garden worms as well as vermicelli. The pond ought to be so situated that as little dust and as few dead leaves as possible can enter it. The *Elodea* must be watched, lest it make too luxuriant a growth, and thus prevent the free movement of the fish. No frogs or sticklebacks must be allowed with the Goldfish; indeed, it is better to put no other fish at all into the pond if the Goldfish are wished to breed. Such a pond as this might be made very profitable.

There is certainly no more suitable fish for the aquarium than the Common Carp (*Cyprinus carpio*), for it is very handsome when in good health, its scales looking—as it has been well said by Pope—as if “bedropp’d with gold.” Its form shows that it is admirably fitted for a life in stagnant water; and being the least carnivorous of fish, it is never likely (except driven by absolute starvation) to prey upon any of its smaller comrades in the tank. As it has the largest brain, in proportion, of any fresh-water fish, it is very intelligent, and soon becomes so exceedingly cunning that no fish is more difficult to catch with rod and line in a large pond than an old Carp. It will even with great success dodge the net. How well, then, it is named the “fresh-water fox!” Though

it is one of the most troublesome of all fish to catch, it is one of the easiest to tame when caught.

Cyprinus carpio will live apparently quite contented where any other fish—except perhaps a tench—would very likely die. It seems to be almost indifferent to either heat or cold, for it has been proved that it will survive being placed in water heated to 109 degrees, or frozen up in a mass of solid ice. The Common Carp will also live for several hours out of water, and fishermen sometimes tell us how that after a long and successful day's Carp fishing, they have found their spoil still alive on their return home. On the Continent Carp are even fattened by being suspended in the air in a net



COMMON CARP (*CYPRINUS CARPIO*).

containing damp moss, and in that position they are fed upon bread and milk, put into their mouths with a wooden spoon. At first, however, until they get accustomed to this extraordinary treatment, the net, moss, and fish are occasionally dipped in water. Carp are said to live 150 or even 200 years, but this is not proved. However, at any rate it is certain that they are capable of attaining a great age. Fontainebleau, in France, is among other things noted for its very old Carp, some of them being described as "white with age"; but it is not unreasonable to suppose that this whiteness is not so much an indication of great age as of disease, for fish, especially the Carp, are subject to a vegetable parasite (*Saprolegnia ferox*) which gives to its victims a hoary appearance. This mould or fungus is chiefly caused by the presence of decaying animal matter in the pond or tank. The disease

is contagious. Whenever, therefore, the least appearance of this growth is noticed, the suffering fish should be at once removed from its fellows and be kept quite alone until a cure has been effected. One of the best methods of accomplishing this end is to keep the fish in running water, and this may be done in the following way :

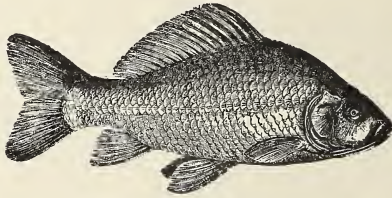
Place the patient in a shallow vessel covered with wire netting or the like, under a gently running tap. The fish should be kept and fed in the running water until all traces of the fungus have disappeared. Fish may be also cured of this disease by being kept in slightly salt water, or kept in warm water, about 75° F. When tanks are properly looked after, there is not much danger of the appearance of this fungus, which is so often a source of great annoyance and loss to aquarium keepers.

It is supposed that Carp were introduced into this country by German monks about the middle of the fifteenth century, and now there are very few old-established ponds in England in which they may not be found. During the greater part of the winter these fish, when at liberty, eat little or nothing, and retire as close as they can to the mud of the water in which they live, or get into some cave-like hollows in the bank, or under weeds or roots of trees. They continue this practice, to a certain extent, even in the aquarium, withdrawing themselves as much as possible from sight, and hardly touching any food. The Carp grows larger and increases more quickly in stagnant than in running water. It commences to breed when about three years old, and the number of eggs deposited by each female fish depends generally upon its size. A Carp weighing 20lb. has been known to contain more than a million eggs. The ova are affixed to water-plants and the like during the latter part of May and the three or four following months.

In a state of nature the Common Carp feeds upon water-plants, larvæ of insects, insects and worms, but in confinement it may be fed upon crushed vermicelli, and on this food it will apparently live quite contentedly. This fish grows,

under favourable circumstances, to a great size, occasionally reaching more than 20lb. in weight, and more than 2½ft. in length and 2ft. in girth. The body is broad and deep, but not ungraceful; the colour is olive-brown, tinged with gold; the mouth is small and toothless, and has two barbels on each side; the lips are fleshy. The head is of a darker shade than the body, and the under-part of the body is of a yellowish-white; the fins are dark brown; there is one long dorsal fin. The tail is large and deeply forked; the scales are also large, and covered with a kind of mucus.

The Prussian Carp (*Carassius gibelio*) is if possible hardier than the Common Carp. It is a great lover of stagnant water, and is therefore well fitted for a life in the aquarium.



PRUSSIAN CARP (*CARASSIUS GIBELIO*).

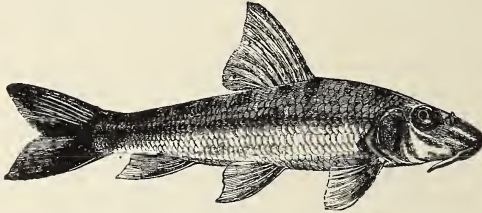
In the country from which this fish takes its name, the breeding and feeding of Carp are an important and very often a profitable business. The Gibel Carp is very good to eat when properly cooked, and it does not taste, it is said, of the water in which it lives. This fish attains no great weight or size. Its habits and character are very similar to those of the Common Carp, and in confinement it should be fed on the same kind of food. It has an equal, if not a greater, power of resisting the fatal effects of an enforced absence from water. The chief difference between the Prussian Carp and the Common Carp is the absence of barbels on the sides of the mouth of the former. All fish of the genus *Carassius* are without barbels. The body is broad and deep, deeper in proportion than that of *Cyprinus carpio*. The head is blunt, and the eyes are yellow. The mouth is small. The scales

have a bronze like tinge, and the fins are red. This fish seldom exceeds 1lb. in weight.

The Crucian Carp (*Carassius vulgaris*), sometimes called the German Carp, is very suitable for the aquarium. It has for a long time been domesticated on the Continent, and now shows several varieties. It seldom exceeds 3lb. in weight. The characters and habits of the German Carp and Common Carp are very much alike. The Crucian Carp is a much rarer fish in England than the Prussian Carp; the latter being found in nearly every part of the country, while the former has been caught, I believe, nowhere but in the Thames. The body is flat and very deep and much curved both above and below. The stiff rays of the dorsal and anal fins are finely serrated. The head is small in proportion to the size of the body. The scales are large and of a light golden tinge. The mouth is without barbels.

The Spiegel or Leather Carp (*Cyprinus rex Cyprinorum*), a variety of the Common Carp, is a most interesting and handsome fish. I have kept a fine Spiegel Carp in the same aquarium with a number of smaller fish of different kinds, and found it to be very gentle and tame. Its movements are generally sedate, but occasionally it indulges in a little violent exercise. It seems to be a very inquisitive fish, apparently taking notice of all that goes on in the room. This Carp is sometimes called the "mirror or looking-glass fish." It is not rare, and is certainly worthy of a place in any fairly large fresh-water aquarium. It may be fed upon vermicelli. This fish, I believe, originally came to this country from Silesia. The body in shape is very like that of the Common Carp; the greater part of it is without scales, and it is soft and leathery. On each side of the central line there is one row of scales, which are large and of a golden colour tinted with silver. There are also a few scales on each side of the fleshy part of the tail, and one or two here and there on other portions of the body. The tail is large and deeply forked. The mouth is small, and has two barbels on each side. It is sometimes called the King Carp.

The Gudgeon (*Gobio fluviatilis*) is a general favourite. It is a favourite with the aquarium-keeper, for it is hardy, handsome, and easily tamed; it is a favourite with the fisherman, for it is a bold biter and provides excellent sport; and it is a favourite with the epicure, for when freshly caught and properly cooked it is most delicious to eat. An old writer says that this fish used to be swallowed alive as a cure for consumption. The Gudgeon is generally found in those rivers in England which possess a gravelly bottom. It may be readily taken with rod and line, or with a net. The fish can be collected together by scraping the bottom of the river with a heavy rake: this raking disturbs and exposes the

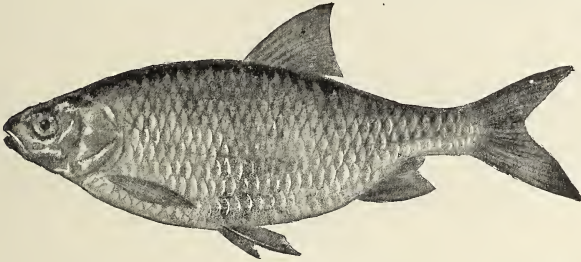


GUDGEON (*GOBIO FLUVIATILIS*).

animal life upon which the Gudgeon feeds, viz. larvæ of insects, water-worms, and the like. As these fish are gregarious, it is wise and kind to keep a few of them together, but they will not die if kept in solitary confinement: they seem soon to learn how to be happy and contented in the aquarium. The bottom of the tanks in which Gudgeon live should be covered with a layer of gravel of extra depth, for without such precaution these fish, being bottom feeders, would interfere greatly with the clearness of the water. The Gudgeon generally spawns about May, and the ova, it is said, take nearly a month to hatch. This fish, while in the aquarium, should be fed upon small garden worms, water-worms, larvæ of gnats, or pieces of raw meat. The body is cylindrical in shape, and olive-brown in colour, and spotted; a dark line runs along the sides. The eye is placed high up in the head, and the mouth possesses two small barbels, one

on each side. The scales are large and the snout is somewhat blunt. This fish sometimes grows 7in. long.

The Roach (*Leuciscus rutilus*), if young, will live fairly well in an aquarium. He is rather a handsome fish, and by no means the "fresh-water sheep" which some people think him to be. He may not have the intelligence of the carp, but he has certainly enough common sense to profit by experience, for he soon becomes so suspicious that it is by no means an easy matter to catch him with rod and line. Roach are found nearly everywhere, and in great numbers; for though trout feed upon their eggs, and pike and perch upon



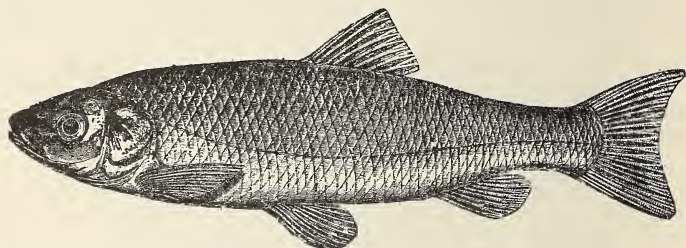
ROACH (*LEUCISCUS RUTILUS*).

their fry, though so many men like to catch them when mature, and though they so often fall victims to more than one disease, they are still able, by means of their wonderful reproductive powers, quite to hold their own in the battle of life. When the aquarium-keeper wishes to procure Roach of the right size for his tank, he should, during the autumn, pass his hand-net along the weedy edges of those streams which run into some river where these fish are known to exist. Roach ought to be kept in a rather large and shallow aquarium, and not crowded there, for they are subject, not only to the fish fungus or mould, but also to another disease which causes their scales to turn black. Roach while in confinement may be fed upon crushed vermicelli.

The depth of the body of this fish is a little greater than the length of the head. It is stoutly built, of a silvery colour on the sides, and of an olive-brown upon the back. In maturity

the fins are red. The lateral line has a downward curve. The mouth is toothless, and rather blunt. The scales are large, and become easily detached. This fish seldom exceeds 1ft. in length and 2lb. in weight.

The Chub (*Leuciscus cephalus*) is a hardy and handsome fish, and will live for a long time in an aquarium under judicious management. He is rather a large eater for his size, and seems to prefer insect food. A small kitchen blackbeetle (so called) will soon tempt him to feed from the fingers. In a natural state he lives upon larvæ of insects, worms, and the tender shoots of water-plants. Chub are found in many of the



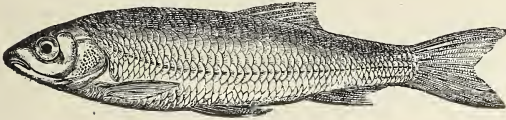
CHUB (*LEUCISCUS CEPHALUS*).

rivers in England, especially in those which have a gravelly bottom. They may be caught with either a fly or a minnow as a bait or by "float fishing." They ought not to be more than 3in. or 4in. in length for the aquarium; but should they be larger than this, it will not be wise to keep fish smaller than they are in the same tank with them. Their great appetites would sooner or later tempt them to devour their companions. A large dace and a small Chub are so much alike that one is often mistaken for the other; but this error need not be made if it be borne in mind that the rear part of a Chub's anal fin is convex, while that of the dace is concave. The Chub is noted for its extreme quickness of sight and for its power of rapidly rising and sinking in the water at will.

The depth of the body of the Chub is a little greater than the length of the head. The scales are large and thick. The lateral line curves slightly towards the ventral fins. The

head is blunt and the mouth toothless ; the lips are very leathery. The colour of its back is olive-brown, of its sides silvery when the fish is young, but bronze-like when the fish is mature. The underpart of the body is silvery-white. The tail is large, dark in colour, and slightly forked. The pectoral fins are olive-green, and the ventral and anal fins bright pink. This fish does not often exceed 5lb. in weight.

The Dace (*Leuciscus vulgaris*) is a lively, graceful, and active little fish, and a great favourite. Its glittering scales are very conspicuous in the aquarium. The Dace is hardy and soon becomes quite tame. As an instance of the hardiness of this fish, I may mention that a young pupil of mine one day brought me two little Dace, not 2in. long. I placed

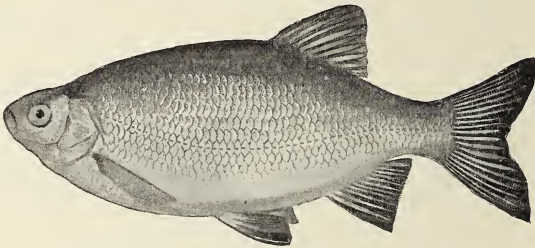


DACE (*LEUCISCUS VULGARIS*).

them in some water in a shallow vessel, which I foolishly neglected to cover, and left the room. On returning about an hour afterwards I found that both fish had jumped out of the water and were on the floor, apparently quite dead. However, I replaced them in the temporary aquarium, and one of them recovered : the other died. The former I kept for three years and then I gave it, together with a goldfish, to one of my sisters, under whose care it lived for about five years longer. The hardy goldfish was the first to die. The Dace lived altogether about eight years in captivity, and during this time it grew from 1½in. to 6in. or 7in. in length, and became so tame that it would take a fly from the fingers. The aquarium in which Dace are kept should be covered, for they are great jumpers. They will live upon vermicelli, a fly or two being given to them now and then as a treat. Dace are generally found in clear, deep water, and may be caught with a hand-net or fly or by "bottom-fishing."

The general appearance of the Dace is very graceful. The depth of its body equals the length of its head. Its colour on the back is brownish-green, on the sides silvery, and on the underpart of the body nearly white. The dorsal and tail fins are brownish-green; the ventral and the pectoral are slightly pink, and the anal fin is white, tinged with green. The tail fin is rather deeply forked. The Dace does not often exceed 9in. in length or $\frac{3}{4}$ lb. in weight.

The Rudd (*Leuciscus erythrophthalmus*) when young will live very well in an aquarium. It is decidedly a handsome fish, handsomer than the roach, with which it is often



RUDD (*LEUCISCUS ERYTHROPTHALMUS*).

confused. I do not know whether Rudd sleep more than other fish, but whenever I took a light into my study at night they were the fish which seemed more certain to be asleep than any of the others. It is rather a curious and interesting sight to see a large and well-stocked tank which has for some time been in a state of darkness suddenly lighted up. Many of the fish will be seen resting on the sand at the bottom of the water. They appear perfectly motionless, but gradually rise under the influence of the light and begin to swim slowly and seemingly sleepily about. Rudd are found in great numbers in Norfolk. When kept in an aquarium they may be fed upon vermicelli, worms, or scrapped raw beef.

The body of the Rudd is shaped very like that of the roach. Its back is brown, and its sides are silvery, tinted sometimes with gold. The scales are rather rough. The eyes and the fins are red, the lower fins being darker than the upper. The

dorsal fin is behind the ventral. This fish does not often exceed 1½ lb. in weight. The late Mr. Frank Buckland has given the following rule for distinguishing the Rudd from the roach: "In the dorsal fin of the roach it will be found that the front ray stands almost even with the front ray of the central fin, but in the Rudd the dorsal fin stands evenly between the anal and the ventral fins. The eye in the Rudd is of a much brighter red than the roach."

The Minnow (*Leuciscus phoxinus*) is a beautiful, hardy, and, as a schoolboy would say, "cheeky" little fish. Though Minnows are generally found in clear and running water, yet there are no fish which are more ready to take kindly to a life in confinement than they. They will live, apparently happily, where one would never expect a fish to exist at all.

I have known two Minnows to live for six weeks or two months in a small bottle, containing less than half a pint of water,



MINNOW
(*LEUCISCUS PHOXINUS*).

and the surface of the water exposed to the air not being more than could be covered with half-a-crown. The Minnows did not die even under these circumstances, but were killed by a Water-boatman (*Notonecta furcata*), which lived in the bottle with them. These fish will live almost equally well in the smallest vessel worthy of the name of an aquarium, or in the largest tank. They can be caught in nearly every pond, river or stream. They may be taken in a small hand-net, which should be sunk a little way in the water where these fish are seen swimming about in shoals. In the centre of the net a piece of bright red braid or cloth should have been tied. When the Minnows, urged by their curiosity, have come in some numbers to examine the gay colour, the net ought to be suddenly raised in the air, and if adroitly done, it will be found to contain not a few captives. Another way to catch the Minnow in the hand-net, is to run it along under the overhanging banks of the stream or pond, or among the weeds (especially if the weather be cold). A glass fly-catching

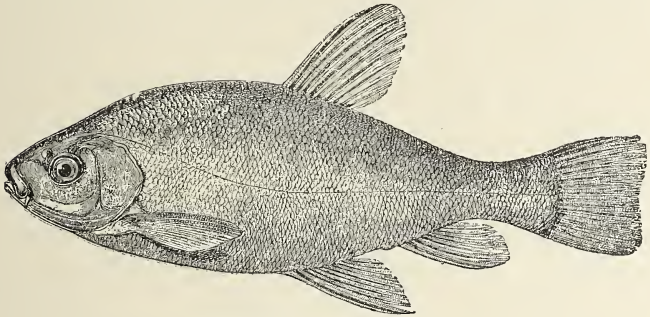
bottle is very useful for taking these fish, if a piece of red flannel be fastened to the inner end of the cork, and the opening of the vessel be placed facing downstream. The Minnows seldom find their way out again when once they have entered the bottle.

Minnows very soon become tame enough to feed from the fingers. They will live upon vermicelli. It is pleasant to see a small shoal of these active little fish busily picking up their food as it is thrown to them in the aquarium. They will also eat flies, small worms, and pieces of meat. Sometimes their boldness and impudence cause them to be quite a nuisance in the tank, for when a portion of food has been carefully dropped in front of some shy-feeding fish, a "cheeky" little Minnow will very likely dash suddenly forward and greedily devour that which was meant for his more retiring companion. Minnows are longer-lived than most people imagine them to be. Specimens have been known to live for as long as thirteen years.

In the springtime the male Minnow becomes tinged with green and red, and when thus coloured it is difficult to find a more beautiful little fish. Minnows spawn where the stream or river has a gravelly bottom. The ova hatch in about ten days. It seems very wonderful that Minnows should be as numerous as they are, when one considers how many enemies they have. Almost every fish will, at times, devour them. Man has also found that they make delicious food when properly cooked. The body of the Minnow is a little less in depth than the length of its head. The colour of the back is olive-brown, the sides being lighter in shade and spotted. The colouring, however, of these fish varies a good deal according to the localities in which they are found. The dorsal fin is just over the space between the ventral and anal fins. The tail is somewhat deeply forked, and there are dark spots at its base. This fish does not often exceed 3in. in length.

Though the carp and the minnow are so extremely hardy, I believe the Tench (*Tinca vulgaris*) is hardier than either. It

will live for a very long time out of water ; in fact, it is said that when this fish has been brought to the market, and has failed there to obtain a purchaser, it has been taken back again and returned to the water whence it came. Tench are sometimes found in rivers, but more frequently in weedy and muddy ponds, and often in the pits of disused brickfields. The muddier the water, the better the flavour of the fish. The habits of the Tench are very like those of the carp—both fish growing larger and increasing more quickly in stagnant water than in running, and both getting, during some portion



TENCH (*TINCA VULGARIS*).

of the winter, as far into the mud at the bottom of the water in which they live as possible. The Tench has been often called the “physician fish,” from the idea that it has the power, by means of the sliminess of its skin, of curing the diseases of all other fish. And it has been said that the pike, out of gratitude to the Tench for his skill in healing, will refrain from devouring him. Gratitude is so rare that one would be glad to discover it even in a fish ; but we do not really find it there, at least so far as the pike is concerned, for that “fresh-water shark,” notwithstanding his reputation of being possessed of the “grace of courtesy,” will not hesitate, if pressed by hunger, to make a dinner of his “kind physician.” On one occasion, in an aquarium of mine, a pike took, not his medicine, but his “doctor.” In the Tench’s power of healing himself and other fish I do not for a moment believe. On

another occasion a Gibel Carp was sent to me, and was placed in the same tank with three Tench. Now, had these fish their reputed gift of healing, I do not understand how it was that they did not prevent their new companion from showing signs of fungus, which it did shortly after its arrival. As Tench delight in stagnant water, they are very well suited to a life in the aquarium. Their natural food consists of larvæ of insects, worms, and the tender shoots of some water-plants. In confinement they will live upon vermicelli, to which should be added a little animal food occasionally.

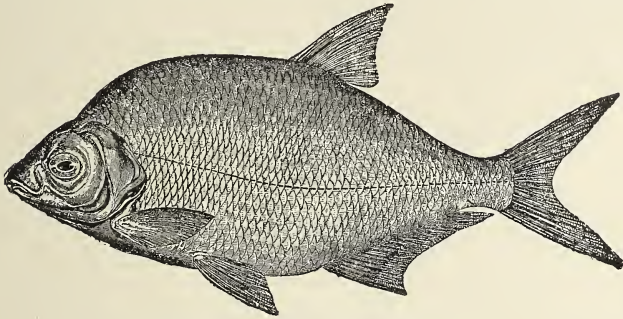
The Golden Tench or Golden Schlei (*T. v. aurata*), a variety of the Common Tench, is a very handsome fish and a great acquisition to an aquarium. It originally came to this country from the Continent, and now it is quite acclimatised in England. Specimens are sometimes more pinkish than gold, not infrequently spotted with black.

Tench, either the Golden or the Common, will increase very rapidly in suitable ponds. Two males should be allowed to each female. The males are distinguished from the females by the large size of their ventral fins. The mouth of the Tench is blunt, very leathery, toothless, and possesses a small barbel at each corner. The scales are very small, and are covered with a thick mucus. The dorsal fin is just opposite the ventral fin. The former and the anal fin are without bony rays. The tail fin varies in form according to the age of the fish, being at first concave, then truncate, and finally convex. The colour of the Tench which is really very beautiful when closely examined, is difficult to describe. Perhaps the most approximate description is dark green and golden. The lips are flesh coloured, and the fins darker than the body. The Tench does not often exceed 6lb. in weight, or 18in. in length.

Both the Common and the Golden Tench may be readily bought in London—the former, when small, for about 4d. each, and the latter for about 2s.

The Carp-Bream (*Abramis brama*) is rather a good-looking fish, but it is not so easy to keep in health in an aquarium as

any of the fish already mentioned. It should be obtained when young, and placed in a tank which presents a large surface of water in proportion to its size, and which also possesses plenty of freely-growing plants. Worms, insects, and the tender parts of water-weeds are the natural food of the Carp-Bream. It is a hearty eater. In the aquarium it will feed upon vermicelli. Personally I have a great regard for the Carp-Bream ; not because it is a very good fish for the aquarium, for it is not, but because it used to provide me with such famous sport when I was a boy. The usual weight

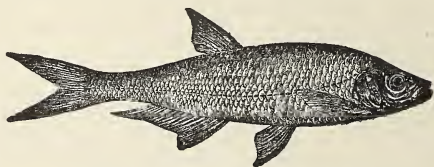


CARP-BREAM (*ABRAMIS BRAMA*).

of this fish when full grown is from 4lb. to 7lb., but sometimes it has been taken weighing upwards of 14lb. The late Mr. Frank Buckland mentions a Carp-Bream which weighed 11½lb., measured 2ft. 2in. in length, and which a gentleman asserted that he had placed in the pond in which it was caught fifty years before. Upon the Continent the Carp-Bream is more highly esteemed as food than in this country ; but I believe that in some of our large towns great numbers of them are eaten during Lent and the Hebrew Passover. These fish are found in many of the rivers, lakes, and canals of both England and Ireland. They spawn during May, the eggs of a single fish sometimes numbering more than 120,000. The body of the Carp-Bream is deep, flat, and much curved above and below. The lateral line is rather low down. The mouth is small, toothless, and without barbels ; the snout is blunt ;

the scales are rough and have a yellow tinge, which becomes a brown tinge with age ; the pectoral and ventral fins are tinged with red, and the other fins are slightly brown ; the dorsal fin is small, and the anal fin large ; the tail is deeply forked.

The White Bream or Bream-flat (*Abramis blicca*) is more difficult to keep alive in the aquarium than the carp-bream. It is a pretty fish, its silvery and glittering scales showing off well in the tank. It is very subject to fungus, but in a well-arranged and well-cared-for aquarium it will live in health, and will certainly be an ornament there. The tank in which it is placed must have been some time established, or this fish



BLEAK (*ALBURNUS LUCIDUS*).

will not do well—at least, such has been my experience. There will, of course, be little or no difficulty in keeping the White Bream in a mechanically aerated aquarium. This fish can be distinguished from the carp-bream by its longer scales and smaller size. The habits and habitat of both fish are alike. The White Bream is rather common. It takes the bait of the fisherman in such a manner as to make the float lie flat upon the water instead of going under its surface. Young carp-bream and White Bream are not by any means difficult to catch in their native waters. If, however, they cannot be conveniently procured in this way, they may generally be purchased cheaply enough from some of the London dealers in aquarium requisites.

The Bleak (*Alburnus lucidus*) is a very active and beautiful little fish, with bright glittering scales, and looks exceedingly well in an aquarium ; but unfortunately it is not by any means easy to keep alive in confinement. It should be placed,

either in a large and shallow tank which is well stocked with growing plants or in one possessing a constantly-playing fountain. As Bleak are great jumpers it is necessary to cover the aquaria in which they are confined. These little fish abound in many of the rivers of England, swimming near the surface in the swiftest part of the stream. Their natural food consists of flies, midges, and other insects, and various decaying matter ; but in the aquarium they should be fed upon vermicelli, to which flies may be added when they can conveniently be obtained. Though while at liberty in the river the Bleak is said to help to purify the water by feeding upon decaying substances, the aquarium-keeper must not think that he is providing food for his fish by allowing such matter to remain



STONE LOACH (*NEMACHEILUS BARBATULA*).

in the tank. It is wise never to presume upon the presence of any scavengers in the aquarium, but constantly to attend to the cleanliness of the tank, as if there were no such animal. The scavengers will find plenty of food, notwithstanding all the owner's care. Bleak can be caught by fishing for them with a fine line and a very small hook, baited with a fly or gentle : the hook should be quite hidden by the bait. The Bleak is the narrowest British fresh-water fish, its body being shaped very like that of a sprat. The colour of the back is a faint brownish-green, and the rest of the body is a glittering silvery-white. The dorsal fin is small and the anal fin large. The lower jaw projects beyond the upper. The Bleak is about 7in. long when full grown.

Many people who keep aquaria declare that the Stone Loach (*Nemacheilus barbatula*) is a delicate fish and will not live for any length of time in confinement ; and they are right, for it will not continue very long in health in an ordinary deep

tank. In such an aquarium it will be often seen, especially towards evening, rising in its curious newt-like motion to the surface of the water, and after obtaining what oxygen it can, sinking again quickly to the bottom. Sometimes, in order to remain as near to the surface of the water as possible, it will rest upon the top of the rockwork or upon the broad buoyant leaves of some aquatic plant. Such conduct as this shows that the poor fish is uncomfortable, that his surroundings are not suited to his requirements, and that sooner or later, unless it be removed, it will die. As long as the Loach remains contentedly on the bottom of the tank, the aquarium-keeper may be sure that the water contains all the oxygen necessary for the welfare of his fish. In this way the Loach is useful as a gauger of the condition of the tank. Few deep aquaria, however, are so well balanced that Stone Loach within it will remain in perfect health. As these fish are generally found in shallow running water, it is reasonable to suppose that tanks of the least depth and the greatest area are the most suitable for them; and in an aquarium about 4in. deep, 18in. long, and 12in. wide, I have found them to live in perfect health, and apparently quite happily. I have never seen them come to the surface of the water in a tank so constructed. Such an aquarium as this can be made with hardly any expense in less than two hours; short directions for making it have already been given in Chapter II. A few rather large and flat stones should be placed upon the bottom of the aquaria in which Loach are kept, for on and under these the fish will frequently lie.

Loach are easy to catch. A short hunt among the stones of the stream in which these fish are found will soon drive a few from their lairs. When disturbed they swim only a short distance, then sink to the bottom and remain motionless there. After a fish has been "marked down," it may be snared with a horsehair tied to the end of a short stick, or filliped with the fingers, or driven by a splash, into a hand-net held just in front of it. The net should touch the bed of the stream, or the fish will very likely escape by getting under

it. The natural food of the Loach is larvæ of insects and the like. In captivity it should be fed upon blood-worms, small garden-worms, and tiny pieces of raw meat. This fish appears to discover the presence of its food by smell rather than by sight. In an aquarium made to suit its convenience, the Loach will soon become tame enough to feed from the fingers, and will as quickly prove itself to be a most interesting little fish. The flesh of the Stone Loach is highly esteemed as a great delicacy. The body of this fish is almost cylindrical in shape. The mouth is surrounded by six barbels. The colour of the back is a kind of olive-brown, which becomes lighter in shade on the sides. The whole fish is more or less covered with dark spots. The dorsal fin is placed over the ventral fin. The dorsal and tail fins are brownish and marked with little dark dots arranged in lines; the other fins are tinged with red. The tail fin is slightly concave. The Loach has the power of using its intestines as a supplementary means of respiration. The body is covered with mucus. This fish rarely exceeds 5in. in length.

The Spinous Loach (*Cobitis taenia*) is not nearly so common as the Stone Loach, and is found where the water is muddy rather than clear. Of the two fish the former is perhaps the hardier. Both, however, should be treated in precisely the same way while kept in confinement. The colour of the Spinous Loach is a kind of orange-brown. On the sides there is a row of brown spots, somewhat similar to those often found upon the sides of the minnow. The barbels are short. There is a small spine below each eye: the fish is able to raise these spines at pleasure. This fish, in common with the Stone Loach and another loach (*Misgurnus fossilis*), has the power of using the intestines as supplementary breathing organs. The Spinous Loach does not exceed 4in. in length, and is not much esteemed as food.

The Golden Orfe (*Leuciscus orfus*) is a very beautiful and interesting little fish, and is in every way suitable for the aquarium. It originally came to this country from Austria. While in captivity it should be fed upon vermicelli and

occasionally small garden-worms. A friend of mine has told me that he has more than once seen his Golden Orfe devour young minnows. My Orfe, though I never saw it take minnows, at first preferred worms to vermicelli, but it afterwards showed a decided preference for the latter. The Golden Orfe is a hardy and lively little fish, and very quick and graceful in its movements. The length of the head of this fish about equals the depth of its body. Its back and the upper part of its sides are orange in colour, which colour gradually becomes silvery as it nears the lateral line. The fins are white and slightly tinged with silver. The tail fin is rather deeply forked.



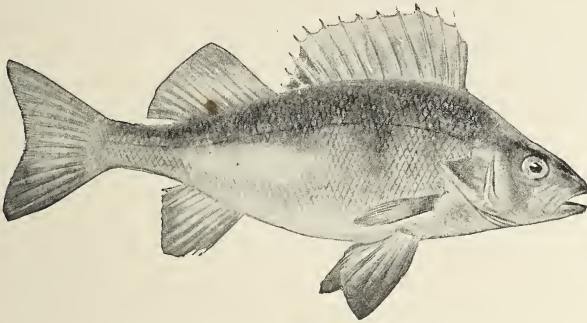
GOLDEN ORFE (*LEUCISCUS ORFUS*).

The eyes are unusually full and beautiful. The head is small, and the snout blunt. This fish does not exceed 3lb. in weight. Small Golden Orfe can generally be bought in London for about 1s. 6d. each.

The Common Perch (*Perca fluviatilis*) is an extremely handsome fish and very suitable for the aquarium. It is hardy, and if properly cared for readily adapts itself to a life in confinement. The only drawbacks to the Perch as an inmate of the tank are its voracity and a proneness to devour its companions. These drawbacks, however, may be easily overcome in one of the following ways: (1) By only keeping very small fish of this species, considerably smaller than the rest of their comrades; (2) by keeping them in a separate aquarium; (3) by dividing off a portion of the tank for them

by means of a sheet of glass. This glass division is occasionally very useful if the aquarium is large. It is easily arranged and by no means unsightly. The best method of keeping it in position is by small lead clips fixed to the top edges of the aquarium.

A piece of perforated zinc, cut the right size and fixed in the same manner, is another method of making a partition; but it does not look so neat as the glass, nor is it so good for the fish. These divisions may be made when the tank is full



COMMON PERCH (*PERCA FLUVIATILIS*).

of water and stocked, care of course being taken that the place chosen for the partition is free from plants or rock-work.

The Perch is one of the most intelligent of all the fresh-water fishes, soon learning to know its owner and its feeding time. In a very little while it will become tame enough to take food from the fingers. It is, however, rather nervous and easily frightened while in captivity. Perch are found in most of the rivers, canals, and lakes of Great Britain; it is somewhat rare in the North of Scotland. As these fish are bold biters, they are not by any means difficult to catch; but unfortunately they are generally hooked in such a manner that it is often a very difficult matter to free them without seriously hurting them. The best way to procure Perch for the aquarium is to catch them with a hand-net, according to the directions given for taking roach; for the young of the former

as well as of the latter during the autumn ascend those streams which run into the rivers and canals where these fish are found, and retire into the weeds and under the banks. The fish thus caught will be of a suitable size and free from injury. The Thames is noted for its very beautiful Perch. Perch are able to live out of water almost as long as the tench and the carp. They can be carried a considerable distance by wrapping them up in wet grass or moss. As Perch swim in shoals, two or three should be kept together in the aquarium.

Perch deposit their eggs during the latter part of April and the beginning of May. The eggs are laid in strings or ribbons, which are sometimes 4ft. or 5ft. long. These strings of spawn are very interesting, the ova being placed closely side by side in what appears to be a kind of tube. At first sight it seems impossible that a fish the size of an ordinary Perch could contain such a string of eggs; but a closer examination will show that what takes place in the case of the spawn of frogs and toads is repeated in that of the Perch. Each egg is surrounded by a membranous envelope, which absorbs a great quantity of water as soon as it is exuded from the fish. The ova are hatched in about ten days. Perch will spawn in a suitable aquarium, depositing their strings of eggs among the weeds and rockwork; and if the old fish are withdrawn from the tank, the fry can be easily reared. The little ones, of course, should be supplied with as much small aquatic animal life as possible. Perch usually begin to spawn when they are three years old. They are most prolific. Mr. Frank Buckland has said that he and his secretary counted 155,620 eggs in a fish which weighed 3lb. 2oz., and 127,240 in another 2lb. 11oz. in weight; while Yarrell records that 280,000 ova were found in a fish weighing only $\frac{1}{2}$ lb.

When at liberty, Perch feed upon insects, worms, and fish; and in captivity they may be fed upon garden-worms, minnows and pieces of meat. It is wise to get them to partake of the last as soon as possible. Perch ought not to be crowded in the aquarium, and care should be taken that the water in

which they live does not rise much in temperature. These fish are so handsome and interesting that it is quite worth the trouble and expense of providing a tank especially for them. A full-grown Perch does not often exceed 2lb. in weight.

The length of the head of this fish about equals the depth of its body. The back rises rather suddenly, giving a "high-shouldered" appearance, and the fleshy part of the tail as suddenly becomes very slender. There are two dorsal fins; the front one has fourteen bony rays, developed into sharp pointed spines, and the back one (which is situated almost directly over the anal fin) has soft rays. The colour of the back is greenish-brown, the sides are golden, and the under part of the body is white. Six broad dark green stripes run vertically down the sides. The lateral line is high up on the side, and follows the curve of the back. The ventral, anal, and tail fins are bright scarlet; the posterior dorsal fin is greenish, slightly tinged with red. The tail fin is small, and slightly forked. The mouth is large, and the teeth small and pointed backwards.

Though a very handsome fish, the Pope or Ruffe (*Acerina cernua*) is not so easy to keep alive in confinement as its near relative the common perch. The reason of this may be that it is nearly always found in running water, and hardly ever in stagnant. Ruffes are very often caught while gudgeon are being fished for. They are bold biters, but are seldom taken in such numbers as to make it worth while to carry them home for food. The flesh is, however, highly valued upon the Continent. The Ruffe is really a very beautiful fish, and, when in good condition, his scales seem to glisten with all the colours of the rainbow. Though he is so handsome, he has, however, such an inexpressibly sad-looking face as almost to make one miserable to look at him. While in captivity he generally swims, with dorsal fin erect, close to the bottom of the tank. He is a great eater, and must be supplied with suitable food or he will certainly die. When at liberty, he feeds upon insects, worms, and the like, and in the aquarium he ought to be fed upon the same until he can be

induced to take raw meat. All the carnivorous inhabitants of the tank should be fed, where possible, upon meat instead of living animals ; for continually feeding one's captives upon live minnows, tadpoles, worms, and the like, must tend to make one callous to the feelings and fears of one's fellow-creatures ; though I think the sufferings of the minnow when seized by a pike, or the pains of a tadpole while in the clutches of the pupa of a dragon-fly, are extremely slight, for not only are they cold-blooded, but it is mercifully ordained—I believe—that all animals more or less lose all sensation when being preyed upon. Livingstone has recorded that when under the paws of a lion he was unconscious of either fear or pain ! The Ruffe should not be kept with fish smaller than himself, or very likely he will devour some of his companions ; neither should he be placed in an aquarium where there is even the slightest approach to crowding of its occupants, or he will be one of the first to die. The chief differences between the perch and the Ruffe are that in the case of the former, the dorsal fin is divided into two fins, the one with spines, the other without ; while in the case of the latter the two fins are joined into one ; the Ruffe, too, is without the vertical bands of the perch, and the perch is without the spots on the dorsal fin of the Ruffe. The general appearance of the Ruffe certainly seems to justify the erroneous idea that it is a cross between the gudgeon and the perch. It is said to have received its name from the want of smoothness of its scales. This fish does not often exceed 5in. in length. It spawns during March and May among the weeds of streams and small rivers.

The Black or Small-mouthed Bass (*Grystes nigricans*) is now acclimatised in Britain, owing to the efforts and enterprise of certain noblemen and gentlemen. The Black Bass is common in the lakes and rivers of Canada and the United States, where it affords excellent sport to the fisherman. It is a bold biter, full of fight, and very good for table purposes ; the flesh, it is said, tasting very much like that of the whiting. No fresh-water fish that we have in this country, with the exception of the salmon, is capable of providing more amuse-

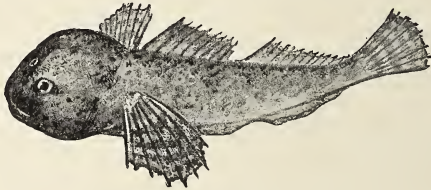
ment for the angler than the Black Bass. It will take minnows, flies, or worms, and as it grows sometimes so large as to weigh 7lb. or 8lb. it generally affords no small amount of excitement and requires not a little skill to land it safely. The Black Bass, I find, makes an excellent fish for the aquarium; for it is handsome, hardy, intelligent, and easily tamed. Of course, owing to its predaceous habits, it must not be kept in a tank among small defenceless fish, or the aquarium-keeper will find them gradually disappear. I keep my Black Bass in a divided part of a tank which is 2ft. wide, 2ft. 11in. long, and 1ft. deep, his separate compartment being 11in. wide and running the whole breadth of the tank. The division is of glass. The Bass has for companions two English perch (*Perca fluviatilis*) nearly its own size. The three perch (for the Bass is a perch) agree very well together. I notice, however, that the English fish do not venture to dispute with him the possession of a minnow or worm. The Black Bass does not make a sudden dash at its prey, like the pike, but hunts it down with persistence, as a greyhound does a hare.

Black Bass spawn about May or June, and prepare for the reception of their ova a kind of nest, which they scoop out in the gravel or mud at the bottom of the water in which they live. The parent fish protect the eggs and fry, and accompany their little ones for some time after they are able to leave the nest. I see no reason why Black Bass should not be induced to breed in a large aquarium.

Like the carp and the tench, the Bass retires during winter to the bottom of the pond, lake, or river in which it lives. The Black Bass while in confinement should as soon as possible be encouraged to eat pieces of raw meat. One of these fish about 6in. long will devour several small minnows a day. A specimen of mine has taken five within a few hours.

The length of the head of the Black Bass about equals the depth of its body. It is not so "hog-backed" as the English perch. The mouth is rather large and cruel-looking, and the under-jaw projects a little beyond the upper. The front dorsal fin has nine spines, the tallest of which is in the middle,

the others gradually decreasing in height towards each end. The back dorsal fin, which is the taller of the two, is joined to the front one in a way which is somewhat similar to the junction of those of the ruffe (*Acerina cernua*). The spines are very sharp, and blackened near their points. They are not so often carried erect as are those of the common perch (*Perca fluviatilis*). The back dorsal fin is nearly always erect and vibrating. All the fins are large in proportion to the size of the fish, and are continually in motion, especially the pectoral fins. The tail fin is large, powerful, slightly forked, and black along its edges. All the fins are dusky at their bases, becoming of a light greenish tinge towards their



BULLHEAD (*COTTUS GOBIO*).

extremities. The anal fin has a sharp spine. The general colour of the fish is a dark olive-green. Sometimes the body is marked with black spots or blotches. The sides of the head are a dusky kind of white, on which are two broad reddish stripes running parallel with the mouth. The scales are small.

The River Bullhead, or Miller's Thumb (*Cottus gobio*) is a very interesting little fish, and will live well in an aquarium. It may be caught in the same places and in the same way as the loach. After turning over a few of the rather large and flat stones of those streams in which Miller's Thumbs are known to exist, one or two will be almost certainly discovered. Upon the removal of the stone, the cunning little fish will remain perfectly motionless, trusting, no doubt, to its chameleon-like power of assuming the shade of the gravel upon which it is resting. Now is the opportunity of the aquarium-keeper, for, if he be quick, he can either catch the Bullhead

in both of his hands, or he can throw it with one hand into a net held in front of the fish with the other. If the Bullhead is allowed to escape it will dart away with such quickness to some other retreat that it will be almost impossible to follow it with the eye, especially when the water has been disturbed by the ineffectual attempt to throw it into the net. It is wiser, therefore, to hunt for another fish rather than waste time in looking for the one that has just evaded capture.

The Bullhead will live more happily in a shallow aquarium than in a deep one. It is a great eater, and when at liberty feeds upon the larvæ of insects, worms, and the fry of fish. In confinement it will be satisfied with small garden-worms or pieces of meat, and will soon learn to take its food from its owner's fingers. The Bullhead is a plucky little fish. I once witnessed an interesting struggle between one and a young axolotl. I had given the latter its morning worm, which it immediately began to swallow, beginning at one end, when a Bullhead darted from its retreat under a stone, and seized the other end of the worm. This action on the part of the fish commenced a furious struggle between it and the axolotl. As the reptile was the stronger of the two, the fish was literally tossed about in all directions, sometimes to the right side of its opponent, sometimes to the left, and sometimes it was turned completely upside down; nevertheless, the plucky little fish continued to hold on until the worm of contention parted in the middle, and each combatant got a portion of the prey. The fight between the batrachian and the fish seemed to last for quite half a minute.

Miller's Thumbs are said to guard their ova and their little ones, but I have never been able to witness this evidence of parental care on the part of these fish. Perhaps they might be induced to breed in a suitable aquarium, since they so soon become quite tame.

The Bullhead has a flat and broad head and a wide mouth. The body (seen from above) is very wedge-like in shape. There are two dorsal fins; the front one is short and something like the front dorsal fin of the perch; the back one is

very long, and extends quite close to the base of the caudal fin. The pectoral fins are large and powerful in proportion to the size of the fish. The anal fin is also very long, and is just under the long dorsal fin. The ventral fins are rather small in comparison to the other fins, and upon them the fish often raises itself from the bed of the stream or aquarium. The tail fin is slightly convex. The eyes are rather close together on the top of the head, have golden irides, and are very bright. The colour of the fish varies, but it is generally of a yellowish-brown, blotched and spotted with black. The underpart of the body is nearly white. There is a small spine on each side of the head.



THREE-SPINED STICKLEBACK (*GASTEROSTEUS ACULEATUS*).

The Three-spined Stickleback (*Gasterosteus aculeatus*), though very beautiful and interesting, ought never to be confined in the same aquarium with any other fish. If it be placed in a suitable and separate vessel during early spring, it will afford much amusement, interest, and instruction. The male fish will have then put on his strikingly beautiful courting dress, the colours of which almost equal in variety and brilliancy those of the rainbow. He is, especially when excited during a fight with a rival, or elated over a victory, a most lovely little fellow—his colouring under such circumstances becoming brighter and more iridescent than ever. Sticklebacks may be caught in most of the ponds, ditches, and slow-running streams of this country.

If it be wished that the Sticklebacks should breed in confinement, a pair should be caught during the latter part of April, and placed in an aquarium which is well stocked with growing plants and which contains a great quantity of minute animal life, such as water-fleas and cyclops. These insects

will serve as food for the young Sticklebacks. Of course, no other fish but the pair should be placed in the tank. The male may be distinguished during the courting season by his crimson breast and emerald-green eyes. Almost immediately after entering his new home, the little male will choose for himself a corner or some other part of the aquarium, and begin to hunt for suitable materials for the construction of his nest. These materials consist of small vegetable fibres and other substances of the like kind. The nest, when completed, varies somewhat in shape, but it may be described as rather like a hedge-sparrow's nest, having a top and a hole in the side for a door. It is generally about $1\frac{1}{4}$ in. in length. The building materials are kept together by a kind of mucus or cement, which comes from the fish as it draws its body over and about the nest. Sometimes if the fibres and other substances are not heavy enough to keep in their proper positions until the cementing operation is completed, the clever little nest-builder will weight it down with sand or minute particles of gravel, which he will collect in and discharge from his mouth. Such is the energy and skill of the little fish that the nest is frequently finished within a few hours. Immediately it is completed, the fish sets out in search of his wife. With all the address of which he is capable he persuades her to inspect the little nest which he has built. He then pressingly invites her to enter the door, in order that she may lay her eggs within. In a few minutes the eggs are laid, and the fish, instead of backing out by the way she entered, makes for herself a door in the opposite side of the nest. The eggs just deposited, only a few in number, are of a yellowish-pink colour and about the size of a German rape-seed. A slight current of water now sets in between the two doors of the nest, which is of great benefit to the ova inside. The male now becomes more vigilant than ever, and jealously guards the nest and spawn. The little fish spends the greater portion of his time in re-arranging the eggs, and in fanning them with his fins as he balances himself obliquely before a door of the nest. After a short time the

young fish may be seen moving slightly within the eggs—that is, supposing they are closely examined—and in about a month (according to the temperature of the water) from the day they are deposited the fry are hatched. At first they are so small and transparent that it is not an easy matter to see them. With the appearance of his offspring, the male Stickleback's cares seem to increase, and though he worked so hard during the incubation of the ova, he has to work much harder now ; for not only has he to guard his little ones from the attacks of his discarded wife, but he has carefully to confine them entirely to the nest. Should they, however, elude his vigilance for a moment and escape from the nursery, they are either quickly driven back or are seized in their protector's mouth and forcibly returned. Old Sticklebacks are exceedingly fond of Stickleback^s fry, and should the father of the little ones die or be taken away, his wife will immediately act the part of a cannibal and much enjoy the acting.

The eggs of Sticklebacks are very large in proportion to the size of the fish which lay them ; and in comparison with the quantities of eggs deposited by many other fish they are very few in number. As the eggs are so large, so plainly seen, and such tempting food to fish generally and even to the Sticklebacks themselves, they must be protected in some way or other. For this purpose, therefore, the male Sticklebacks are instinctively taught to build nests and to guard their eggs and little ones to the utmost of their powers. Indeed so great is the strain of the building, the necessary fighting, the incubation of the ova, and the nursing of the fry, that the plucky little fellows often leave off living at the end of their labours. In no circumstances can the Stickleback be described as a long-lived fish ; he rarely attains a greater age than three years—oftener it is much less, especially in an aquarium.

In a state of nature these fish are exceedingly destructive to the fry of other fish. For instance, it has been recorded (I believe by Dr. Günther) that one of these Sticklebacks,

while in a tank, devoured seventy-four young dace, each about $\frac{1}{4}$ in. long, in five hours. Two days afterwards the same little glutton ate sixty-two more, and then seemed quite ready to continue his feast. During this huge gastronomic feat this Stickleback was under close observation.

The Stickleback in a natural state feeds upon small aquatic insects, water-worms, eggs and fry of fish. In captivity he may be fed upon tiny portions of worm and pieces of meat. (Before worms are cut up they should be killed by dashing them down upon the ground or pavement. Their death then must be quite painless.) Sticklebacks soon become very tame, and are nearly always bold enough to charge one's finger or one's pencil if placed too near the jealously-guarded nest. They are intelligent and amusing little fish, but I venture to repeat they should not be kept in confinement unless they can be provided with an aquarium entirely to themselves. In any other circumstances they will be a source of annoyance and loss to their owner and of great discomfort and even misery to their companions.

The Stickleback has three strong and sharp spines on the middle of his back in place of the usual dorsal fin. There is a fin behind the spines. The body is rather long and compressed: it is without scales, but is more or less protected on the sides by small plates. The ventral fins have one strong spine each, but no other rays. The anal fin is opposite the dorsal fin, and is about the same shape and size. The caudal fin is slightly convex. The male fish lose their brilliant colours when the breeding season is over. The general colour of Sticklebacks varies greatly according to the condition of the water in which they live. I have found specimens of them almost black. The Three-spined Stickleback is from 2 in. to 3 in. long.

The Ten-spined Stickleback, or Nine-spined Stickleback (*Gasterosteus pungitius*) is one of the smallest of British fishes, hardly ever exceeding 2 in. in length. It is often found in brackish water, and will live in either a fresh- or a salt-water aquarium. This fish also builds a nest, but affixes it to

aquatic plants rather than building it upon the gravel at the bottom of the water. The nest in shape is very like a barrel, and is about 1in. long. The male fish during the breeding season instead of becoming crimson, golden, and green, assumes a "velvety-black." The habits and character of the Nine-spined Stickleback are very like those of the Three-spined. The fish has nine spines in front of the dorsal fin; I have never found one with ten spines. The spines are small and fine. It is not so stoutly built as the Three-spined Stickleback, nor is its body protected by plates, but is quite smooth. The fleshy part of the tail is very slender. The ventral fins each consist of one bony spine and no other rays. The caudal fin is slightly convex.



TEN-SPINED STICKLEBACK (*GASTEROSTEUS PUNGITIUS*).

The Common or Yellow Trout (*Salmo fario*) is a very beautiful and popular fish, and one that will live in an aquarium. The tank in which it is kept should be of rather large dimensions, and ought to present a great surface of water in proportion to its size; it must also contain a quantity of growing aquatic plants. But Trout, however well they may be cared for, and however suitably the aquarium in which they are confined may be constructed, will lose a great deal of the beauty and brilliancy of their colouring. There are, perhaps, no fish whose colouring and form are influenced so much by food and locality as Trout. For instance, it has been said that "the Trout of Lynn Ogwin, almost the whole bottom of which is formed of grass, have, when first caught, a brilliant emerald gloss over their golden and yellow tints." And if the bottom of the water in which Trout live is black, the fish will be very dark. Sometimes, when the same lake or river varies in character as to the bottom soil, the Trout

taken from the same water, but from different parts of it, will also vary in colour. That it does not take long for a Trout to change the shading of his colouring, may be easily proved by placing a captured fish for a few minutes only in a large white basin of water, and he will be seen to grow pale under the influence of the colour with which he is surrounded. However, I believe that any fish will alter the shading of its colours under similar circumstances. I can remember my astonishment when I first saw an instance of this chameleon-like power on the part of fish. A good many years ago I had asked a Thames professional fisherman to net me some gudgeon for an aquarium. A day or two after I had made the request he brought me the gudgeon, but more than my tank could conveniently hold. However, not wishing to send them back, in case some of those which I had retained for the aquarium should die, I placed the surplus fish (for the time being) in a large sponge bath. There they remained for more than a week, and at the end of that time they had become almost white. Since then I have often had occasion to keep fish temporarily in a bath (quite a good receptacle for them), and have not failed to notice the great influence which the white interior has had upon the colouring of the different species of fish—a black bass, for instance, becoming in a day or two anything but a black bass in appearance.

Though a Trout will live fairly well in the stagnant water of a well-formed, well-arranged, and well-cared-for aquarium, it will, of course, live better in a tank which is artificially aerated.

The natural food of the Trout is larvæ of insects, aquatic insects, flies, fresh-water shrimps, young snails, worms, minnows, ova and fry of fish. It has been often seen to eat its own ova soon after it has deposited them. In confinement it may be fed upon minnows, worms, many kinds of aquatic insects, flies, and especially fresh-water shrimps. These last form one of the very best foods, making the flesh of the fish of the much-desired pink colour; they may be bred for it according to directions which will be given in another

chapter. The quantity of minnows which a tame Trout (about 7in. long) of mine ate was surprising.

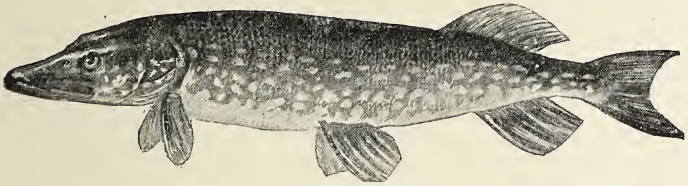
Trout 3in. to 5in. in length are of a suitable size for the aquarium. Fish of such dimensions may be readily obtained from dealers.

Trout fed upon suitable food will grow from 1lb. to 10lb. in weight within four or five years. As the Trout is so subject, owing to locality and food, to considerable variety of both form and colour, it is somewhat difficult to describe. However, as a rule, it may be said that its body is rather long and compressed at the sides, its head thick, its muzzle wide and blunt, and its eyes large. The upper part of its body is of an olive-green colour, the sides are lighter in shade. The underpart is often of a yellowish-white. Its back and sides are nearly always (more or less) beautifully spotted with red. There are two dorsal fins, which are far apart; the first has soft rays, and the second, which is much smaller, is without rays, and adipose. The front dorsal and caudal fins are spotted with black. The other fins are yellowish and edged with black.

Charr (*Salmo aplinus*) are nearly always found in the deepest part of large lakes, excepting during the breeding season, when they ascend the rivers and streams to spawn. Some of the Charr spawn during February, others during autumn. Many years ago, while going down one of the London streets, I saw in an aquarium-dealer's shop some very beautiful little fish in a large tank. On stopping and asking what they were I was told that they were Charr. As the fish were new to me I bought two of them. When I got home I put them in a large and rather deep tank, which was well stocked with growing weeds, and there they lived quite healthily, and apparently perfectly happily, for nearly two years. At the end of this time I changed my house, and during the trouble and inconvenience of moving, the Charr and other fish were placed, rather early on the day of "flitting," in a large disused aquarium which had been carried into the garden of the new house. Late in the evening I

went with a lantern to catch the fish and put them in a tank inside, but in my hurry and in the darkness I caught all the fish but the Charr. When next I saw them they were frozen up in a mass of ice. These were the only Charr I ever kept in confinement, and they might, I think, have lived for years but for my carelessness. During the time I had them they fed upon the eggs and fry of water-snails, small aquatic insects, and occasionally vermicelli. They were always very lively and active.

Charr, like trout, vary in form and colour with the locality. It has been said that in some lakes they are nearly as round as eels, while in others they are as flat as herrings. The chief



PIKE (*ESOX LUCIUS*).

difference between the Charr and the trout is that the underpart of the body of the former, during the breeding season, acquires an orange or bright red tinge; and that on the central bone in the roof of the mouth of the Charr, called the vomer or vomerine bone, there are only a few teeth, while the trout has two complete rows. The Charr has reached 2lb. in weight, but generally it is not more than from $\frac{1}{4}$ lb. to $\frac{1}{2}$ lb.

There have been more extraordinary stories told concerning the Pike (*Esox lucius*) than any other fish; and anyone who would believe them all must possess a power of "taking in," as the schoolboy would say, equal to that of the fresh-water shark himself.

Small Pike or Pickerel can easily be kept in an aquarium, but of course it is almost unnecessary to say that they should have no companions. Even two Pike, especially if one were much bigger than the other, would not be safe together. I have seen it seriously stated that Pike will not touch tench,

perch, or goldfish. And the reasons given for the Pike's very unusual reluctance to dine upon his fellow-fish are that he is never ungrateful enough to forget that the tench is the curer of all the ills the piscine tribe is heir to ; that he dare not attempt to swallow the perch and his formidable "fixed bayonets," and that the goldfish is quite safe because of his colour. But I am quite sure that if a hungry Pike had these three fish for his companions in an aquarium, it would not be very long before he and his friends became so closely acquainted as to arrive at a state of perfect unity ! Most fishermen know quite well that the Pike is often ready to take both perch and tench ; and as for the goldfish, there can be for Pike no more deadly bait. There are, however, circumstances in which, with care, Pike may be allowed companions while in confinement. The circumstances are these : If when a young Pike is first caught he is placed in an aquarium with other small fish also just caught, he seems to look upon them as companions of his misfortune, and will not touch them, at any rate for some days. Directly he begins to get very hungry, a strange fish should be placed in the tank, and he will, if the owner will stand far back, most likely immediately pick this one out from the rest and devour it. If this manner of feeding is carefully continued, never allowing the Pike to become very hungry, his companions may be safe. I have thus kept a Pike among several young roach and perch.

The Pike soon becomes very tame, and will learn to know the tank in which his food is kept and the net with which it is caught. Directly the net is taken in his owner's hands a curious hungry gleam is seen in his eye, but he himself remains almost motionless. It is very interesting to watch this gleam appear as the fish's master takes the net, and to see it as quickly disappear if he should put it down unused. The Pike will not be very long in confinement before he will allow himself to be touched with a pencil or even a finger.

Pike, as everyone knows, are tremendous eaters. They are well described as omnivorous, for they will—some of them—take anything, e.g. the hand of a boy when bathing, a mule's

nose, or a swan's head. A clerical friend of mine told me that on one occasion when he arrived at some water where he was going to fish for Pike, he found one jumping about upon the bank. He immediately secured it, and when he examined it he found that it weighed 17lb., and that it contained within its stomach a water-vole and a moorhen. The fish is supposed to have jumped upon the bank while capturing the bird, and had not had time to get back again to the water before he was caught.

The growth of Pike, of course, greatly depends upon the amount and quality of the food they are able to obtain. Mr. Cholmondeley Pennell, in the "Badminton Library," quotes a letter, published in the *Field*, in which it is said that "Mr. Kinsey, of Melbourne (Derbyshire), put a Pike into a well when a few inches long. Food was given to it for several years, but it grew very slowly, and at last reached 3lb. It lived fourteen years, and latterly became very tame—so much so as to take food from the hand." Another Pike kept in confinement in the Zoological Gardens, Regent's Park, is said to have only increased 1½lb. in ten years. On the other hand, where Pike have been better fed, they have been known to increase in weight as much as 4lb. every year until they arrive at maturity, when they generally begin to get lighter.

Pike commence to spawn when about three years old, and deposit their ova during March and May among the aquatic plants growing in those streams and ditches which they are able to ascend. During the breeding season these fish are generally seen in pairs. The young are hatched in about a month. The late Mr. Frank Buckland found in a fish which weighed 32lb., and which measured 3ft. 8in. in length, no less than 595,200 eggs.

When at liberty Pike will feed upon almost anything which they find alive in the water, providing that it is not altogether too big. They will not, however, swallow a toad. Sometimes they will take fish nearly as large as themselves, devouring as much of their prey at one meal as they can,

and trusting to their great powers of digestion to be able to finish it at another ; their mouths, for the time, being turned into larders. The principal food of Pike, however, is frogs and fish of all kinds. In captivity these fish may be fed upon minnows and lob-worms. I have never been able to induce any of my tame Pike to eat dead fish or raw meat.

Pike, small enough for the aquarium, may be caught either in a net, or by fishing for them with a large worm placed upon a single hook. Pike can be separated from other fish in the same aquarium by means of the glass division already recommended for Perch.

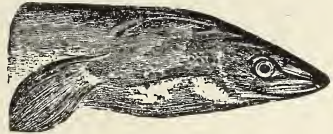
The "Water-wolf," as this fish is well called, is really very handsome. It has a long and rather compressed body, uniform in depth from just behind the eyes to the commencement of the dorsal fin, when it suddenly becomes much narrower. The scales are small, and the lateral line is not very distinct. The dorsal fin is placed very far back, and just over the anal fin. The caudal fin is broad, strong, and rather deeply forked ; the pectoral and the ventral fins are small. The head is broad, long, and depressed. The jaws are capable of great distension ; the upper one being "duck-billed," and the lower projecting. The mouth contains numerous strong and very sharp teeth, all pointing backwards. The colour of the head and back is olive-brown. The sides are lighter in shade, and are beautifully mottled with green and yellow. The underpart of the body is silvery-white. The dorsal, caudal, and anal fins are dark brown, the pectoral and ventral fins being of a lighter brown. The former three fins are blotched and spotted with dark green. Trout and Pike are subject to a parasite (*Argulus foliaceus*).

There are few fish, with the exception, perhaps, of the Lampern, which will give less trouble in an aquarium than the Sharp-nosed or Common Eel (*Anguilla vulgaris*). Its movements when swimming are exceedingly graceful, and its wants are few and supplied without difficulty. The only drawbacks to its presence in an ordinarily-arranged tank are its readiness to devour, if it be of any size, very small fish,

and a disposition to disarrange a little of the sand and gravel at the bottom of the water.

The Eel should be procured when very small—about 5in. long is a suitable size for an aquarium. Eels of so short a length, however, are not often taken with a hook, and, besides an Eel caught in this way is likely to be more or less injured. I have often caught Elvers (as young Eels are called) by passing, during autumn, a hand-net along the weedy edges of slowly-running streams. Not seldom at the same haul have I secured along with Elvers, fry of perch and roach.

In the autumn, adult Eels migrate towards the mouths of those rivers in which they live. During this migration they are supposed to spawn: very little, however, is known of their spawning. Not only do Eels migrate towards the mouths of rivers, but also from one piece of water to another. They are able to take these overland journeys by reason of their well-known power of living, without ill-effect to themselves, for a long time out of water, and because, owing to their snake-like form, they can travel at a considerable pace along dew-covered grass. Some time ago I saw an Eel, about 18in. long, which had been dug up by a man who was making a surface-drain across a field. It was not found in water but in moist clay. It was very lively. The nearest stream was about 50yds. away from the spot where it was discovered.

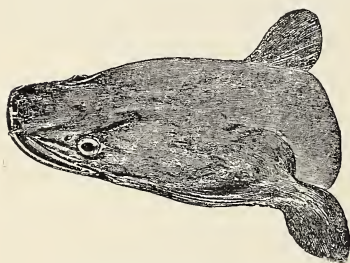


SHARP-NOSED EEL
(*ANGUILLA VULGARIS*).

Eels are very fond of burying all their bodies, with the exception of their heads, in the soft mud at the bottom of the water. They have been known to live twenty or thirty years in an aquarium, and they soon become tame enough to take food from the fingers. During winter, especially if their tank is in a cold room, they are very likely to pass a great portion of their time in a state of torpidity—at any rate, they will take hardly any food; but when the weather becomes

warm they will make up for lost time by becoming rather greedy, readily devouring worms, and if the Eels are of any size, small minnows, roach, and the like. If well fed they grow quickly.

An Eel is exceedingly interesting in many ways. For instance, there is the remarkable contrivance by which it is enabled to keep its gills moist during the time it is out of water. Each gill is inclosed in a kind of pouch or bag, and within these bags or pouches the fish can retain water for the purpose of moistening its gills during its overland journey-



BROAD-NOSED EEL
(*ANGUILLA LATIROSTRIS*).

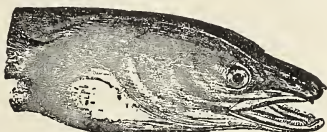
ings. Then, again, as the fish often live under stones, mud, and sand, its eyes must be protected in some way, so it is provided with an arrangement which may be likened to a pair of spectacles; and again, some people are said to carry their hearts in their pockets, but an Eel carries one in its

tail, called a lymphatic heart, the pulsation of which may be seen under a microscope. Eels can be killed by striking them upon their tails. As they are able to ascend perpendicular surfaces, the aquarium in which they are confined should be securely covered.

The Eel in shape is very like a snake. The scales are small and embedded in the skin. It has no ventral fins, but it possesses pectorals. The dorsal, caudal, and anal fins are joined together, the dorsal one commencing some distance behind the pectorals. The eyes are beautiful. The body is very slimy, and beneath varies in colour from silvery-white to golden.

The Broad-nosed Eel (*Anguilla latirostris*) is almost as common as his Sharp-nosed relative. It is distinguished from the latter by its broad head, blunt nose, thick skin, and its proportionately thicker and slimier body.

The Snig Eel (*Anguilla mediorostris*) is said to be common in Hampshire. Its nose is neither blunt nor sharp. It does not grow so heavy as the common Eel, but it is described as being very delicious eating. Unlike its relatives, it feeds during the day. All Eels, however, are occasionally day-feeders, but the Snig Eel is especially so. The three different species of Eel should be treated alike in the aquarium.



SNIG EEL
(*ANGUILLA MEDIOROSTRIS*).

The Lampern, or River Lamprey (*Petromyzon fluviatilis*) is a curious little fish, though by no means beautiful, and has much attraction for the aquarium-keeper, for it has a very remarkable structure, it gives no trouble, and is very graceful while in motion. The Lampern is found in many of the rivers and streams of England, especially in the Severn, Trent, and Thames. When the water is quite clear these fish can often be seen clinging in masses with their leech-like mouths to stones, while the rest of their bodies waves up and down with the current. The Lamprey is shaped somewhat similar to



LAMPERN, OR RIVER LAMPREY (*PETROMYZON FLUVIATILIS*).

an eel, being round for about two-thirds the length of its body, when it gradually flattens towards the tail.

The mouth of this fish is very curious, and something like that of a leech; when open it has been well described as "circular and terminal, so that the fish appears as if the head had been cut off." The lips are fleshy. This mouth, and these lips, and a piston-like tongue, form a kind of powerful sucker, by which the fish is able to cling firmly to stones, rocks, and the like. On each side of the head there are seven openings in a horizontal line which lead to an equal number of bronchial cells or gills. When the fish is not clinging to

anything with its mouth, water passes through the mouth to the gills ; but when the Lampern is adhering to a stone, the water, being unable to enter by the mouth, passes to the gills through these openings in each side of the head. There is a small aperture or hole in the middle of the back of the head just in front of the eyes : this is a nostril, and water does not pass through it (as some writers say) to the gills when the mouth is fixed to any foreign body. Such a passage of water is impossible, as there is no direct communication between the nostril and the gills. The mouth is well provided with teeth. There are neither pectoral nor ventral fins : there are caudal and dorsal fins of a certain kind, but as they have no rays proper they can hardly be called true fins. The Lampern swims with a lateral undulatory motion. Where the streams are very rapid, it frequently rests by anchoring itself with its mouth to a stone. When wishing to spawn, this fish scoops a shallow hole at the bottom of the water, about 15in. or 16in. in diameter, for the reception of its eggs. The Lamprey removes the stones by fixing itself to them by the help of its suckorial mouth, and then swimming backwards down the stream, drops them at some distance from the spot that has been chosen for the ova.

It has been said that the Lampern feeds not only upon dead fish, but also upon living ones : the latter, it is recorded, have frequently been caught showing the marking of the rasping of the Lampern's teeth. However, none of the Lampreys which I have from time to time kept in aquaria have attacked any of the fish which were confined with them—at least, so far as I know. Indeed, I have found that "Seven Eyes," as he is sometimes called, is very peaceful, spending most of his time under the sand and gravel. He generally chooses the same spot as his lair, and when he is wanted he can be roused by a gentle probing with a stick. He often attaches his suckorial mouth to the glass sides of the aquarium, thus forming a very interesting object. As he can easily climb by the help of his mouth, the tank in which he is confined must be covered. The natural food of

the Lampern is said to be aquatic insects, worms, and dead and live fish.

The fresh-water Lamprey is from 6in. to 1oin. in length, and is of a dark olive-brown on the upper part of its body and silvery beneath. This fish can be caught in a hand-net when seen in masses, as already described, or when making its way alone up the stream. I have also taken it by passing the hand-net along the overhanging sides of the stream or river.

The Calico Bass (*Pomoxys sparoides*) can be easily distinguished by means of his photograph from the Black Bass



CALICO BASS (*POMOXYS SPAROIDES*).

(From a Photograph by the Author.)

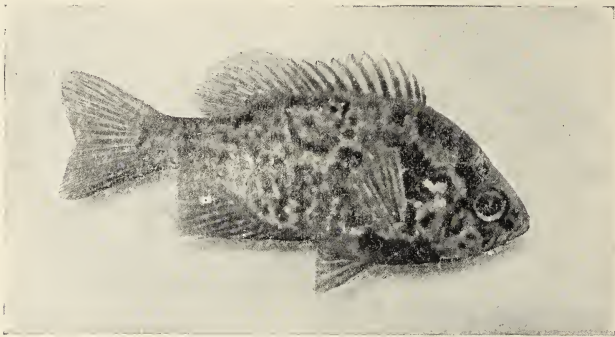
just mentioned. It is a lively and beautiful little fish, and well adapted for a life in an aquarium. This Bass is also useful for table purposes, being a fish of an excellent flavour. Like the small-mouthed black bass, it is a very suitable species for stocking ponds. It is, however, small in comparison to its somewhat distant relative just mentioned. It can be bought in this country for about half-a-crown, and may be fed while in confinement upon garden worms and pieces of raw meat.

In a state of nature "it is found from New Jersey to Georgia, in the Great Lake region, and through the Mississippi and Ohio Valleys."

The Rock Bass, or Red-Eye (*Amblopsis rupestris*), is another species of Bass occasionally imported into this country and

sold for aquarium purposes. It is a useful food fish, and grows to a length of from 10in. to 12in. It is found in the Canadian Lakes and as far south as Louisiana. It is sometimes advertised for sale, and costs about 1s. 6d. While in captivity it should be treated as suggested for the other Basses.

The Common Sun-fish (*Eupomotis gibossus*) belongs to the same family (*Centrarchidæ*) as the fresh-water basses, and is a very beautiful, though common (in America) little fish. It is



THE COMMON SUN-FISH (*EUPOMOTIS GIBOSSUS*).
(From a Photograph by the Author.)

also known as "Pumpkin-seed" and "Sunny." It should not, of course, be confused with its huge namesake of the salt-water.

The Sun fish is very suitable for the aquarium because of its great beauty. However, owing to its pugnacious disposition, it should never be kept with smaller, weaker fish. The illustration gives a good idea of both the shape and the markings of this interesting fish. It is vividly coloured with green, brown, and pale blue. It can be easily distinguished from other American Sun-fishes by the bright scarlet spot or blotch on the gill-covers.

It is extremely hardy while in captivity, if kept out of the reach of frost, which proves fatal to it. Its food should

consist chiefly of small worms. Young specimens may be bought generally for about 9d.

The Common Sun-fish will breed in this country in ponds, provided that they are deep enough to allow it to get well out of the reach of frost.

The Cat-fish (*Amiurus nebulosus*) is a member of the *Siluridæ*, a large family of fresh-water fishes which includes the "Wels"



CAT-FISH (*AMIURUS NEBULOSUS*).
(From a Photograph by the Author.)

(*Silurus glanis*), the largest fresh-water fish of Europe, with the exception of the sturgeon.

The chief characteristic of the Siluroid fishes is that the "skin is either naked or armoured with bony scutes, but scales are not developed."

The family of the *Siluridæ* (which numbers about 120 genera, natives of both the Old and the New World) has been divided by Dr. Günther into eight sub-families, and of these the *Proteropodes* is that to which the genus *Amiurus*, containing some twenty species, belongs. All the members of this genus possess eight barbels.

The Cat-fish (*A. nebulosus*) is known locally as the " Bull-head " and the " Horned Pout." It is a very hardy little fish, and lives well in an aquarium. It is of a sluggish and retiring nature, hiding itself during the daytime and becoming lively towards night.

This Cat-fish grows usually to a length of about roin. When fishing in North America, I found that this was the easiest of all fish to catch. It gives fair sport, and is considered by many to be very good eating.

This Cat-fish has a dorsal fin, which is short and placed a little behind the pectoral fins ; an adipose fin ; small ventral fins situated near the middle of the body ; a large and rounded



THE BOWFIN (*AMIA CALVA*).
(From a Photograph by the Author.)

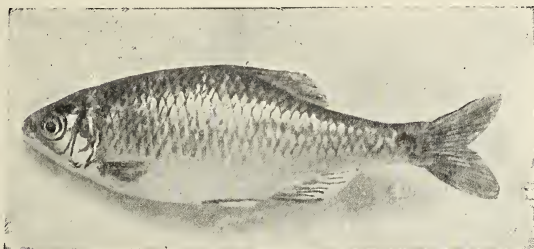
anal fin, shorter than the tail, which is only very slightly concave. The colour and skin of the fish are like those of the Eel.

A. nebulosus would do very well in the ponds of this country, and would also provide good sport for children and others and supply wholesome food. In captivity it may be fed on worms.

The Bowfin (*Amia calva*) is a member of an order (*Ganoidei*) of fishes which is gradually becoming extinct, and is indeed the only living representative of the sub-order (*Amioidei*). The *Amia calva* is also known as the " Mud-fish," the " Dog-fish," and the " Marsh-fish."

It is exceedingly tenacious of life, and is able to exist for more than an hour out of water. It frequently, especially when living in foul water, comes to the surface to breathe, occasionally making as it does so a bell-like sound. The

Bowfin is a native of the fresh waters of the United States, and has been imported into this country in considerable numbers. It breeds during the month of May, and deposits its numerous small eggs among the water-plants, to which they adhere. The eggs and the young fry are guarded by the male fish. The *Amia calva* feeds upon crustaceans, aquatic insects, frogs and other batrachians, as well as small fish. Owing to its great liking for the last named it has been placed among the "fresh-water sharks." The illustration gives a good idea of the general appearance of this fish, whose body is long and compressed behind. Its head is broad and



THE BITTERLING CARP (*RHODEUS AMARUS*).
(From a Photograph by the Author.)

its snout short. Its cycloid scales are rather large and covered with a thick mucus. The animal's colour is a dark green, generally marked as in the illustration. It possesses a very long dorsal and a rounded caudal fin. While in captivity the Bowfin may be fed upon large garden worms and small frogs and fish. It is an interesting fish to possess.

The Bitterling, or Bitter Carp (*Rhodeus amarus*) is one of the smallest of European fresh-water fishes, the male being, when fully grown, about 3in. long, while the female is only 2in., or even less. Its appearance suggests a cross between the Common and the Prussian Carp. The dorsal fin commences at the middle of the back and ends a little beyond the centre of the anal fin. The pectoral and ventrals are of equal size, the anal fin being nearly as large as the dorsal. The caudal fin is moderately concave. The vent, which is surrounded

by a kind of scaly sheath, is midway between the anal and ventral fins.

The male, during spawning times, assumes very beautiful colours, for which it has received the name of "Rainbow-coloured Fish." The gill-covers, back, and sides are of a beautiful violet colour, while on each side of the body, beginning at the centre of the caudal fin, is a bright green stripe reaching nearly to the middle of the body. Behind the gill-covers there is a silvery patch spotted with violet. The anal fin is a bright red edged with black. Altogether, the Bitterling during summer is one of the most beautiful of European fishes, as well as one of the most hardy.

The female, though not nearly so beautiful as the male, is, nevertheless, a handsome little fish. Her back is greenish-brown and her sides silvery. The line running from the centre of the caudal fin towards the middle of the body is of a blackish colour, and sometimes is absent.

She has a curious possession in the shape of a long tube, which is used as an ovipositor.

The size of the Bitterling and its bitter flavour debar it from being useful as food for man. As a bait for other fish it rarely has any attraction, except for eels, and sometimes Perch.

It is widely distributed throughout the centre of Europe. It is not found as a native in Great Britain.

The Bitterling may be bought in England at prices ranging from 6d. to 1s.

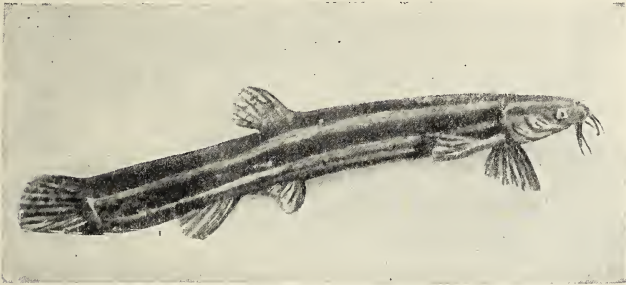
As food it will take, while in captivity, vermicelli, small worms, and ants' eggs.

The Thunder, or Mud-fish (*Misgurnus fossilis*) is also known as the Pond Loach or Weather Fish. It is a very large Loach, which for some reason is so sensitive that it becomes highly excited during the approach of a storm, evincing its excitement by leaving the mud at the bottom of the water, in which it prefers to live, and swimming about most energetically near the surface. The people of the country of which it is a native look upon it as a kind of barometer, and for this

reason keep it in a glass vessel indoors. Hence it has obtained the names of "Thunder Fish" and "Weather Fish."

It often discharges air with a kind of "popping" noise. When I first obtained specimens of this fish and placed them in an aquarium, I could not understand for some time whence this curious sound came. This, no doubt, has been the experience of many others.

This fish, like all Loach, has a very elongated body, a small head and eye, ten barbels around the not large mouth—four of which are attached to the lower jaw. All the fins are rounded. The dorsal fin is placed in the middle of the back,



THE THUNDER OR MUD-FISH (*MISGURNUS FOSSILIS*).

(From a Photograph by the Author.)

and directly opposite the ventral fins. The pectoral fins are larger than the latter; and the anal fin is of the same size and shape as the dorsal. The caudal fin is as deep as the deepest part of the body, and is convex.

The scales are small—the largest being on the sides. The appearance and the feel of the fish remind one of an eel.

The head is covered with blackish streaks. A broad dark brown band runs along the lateral line, and above and below this band the sides are yellow, which is bounded at the abdomen by a blackish line. The lower parts are orange spotted with black. A white line, on the under surface, extends from the throat to the vent, which is rather prominent and which is placed a short distance in front of the anal fin. The fins are dark brown spotted with black. The iris is a rich yellow.

This fish, though found in rivers and lakes, seems to prefer ponds and slow-running streams which have muddy bottoms. It is essentially a mud-fish. This hardy Loach should be fed on aquatic insects, water-worms, garden-worms, and the like. It sometimes exceeds 1ft. in length. It may be bought in London at prices ranging from 6d. to 1s. each. This Loach is found in France, Holland, Germany, Belgium, and in Russia. It is not found in Great Britain nor out of Europe.

The Dog-fish (*Umbra krameri*), related to both the Garfish and the Pike, is a beautiful and interesting little fish. It has



THE DOG-FISH (*UMBRA KRAMERI*).
(From a Photograph by the Author.)

received the name of "Dog-fish" from its manner of swimming, the ventral and pectoral fins moving alternately like the feet of a running dog.

The genus *Umbra* contains two species, one a native of the Old World, the other of the New. The former is found only in Southern Europe.

The Dog-fish generally lives in still water, and consequently does well in an aquarium. When fully grown it is about 3in. in length.

The rather long dorsal fin commences at the middle of the back, and contains fifteen or sixteen rays. The caudal fin is rounded and nearly as long as the head. The anal fin has a short base, and terminates just opposite to the end of the

dorsal fin. The pectoral and ventral fins are equal in length, the latter reaching as far back as the vent.

The head, which gives the fish its distinctive character, is covered with scales except on the nose and jaws. For the size of the fish the scales are large, they are circular in shape, and overlap each other. The lateral line is marked by a light yellow or reddish streak which is placed rather high up on the side. The colour of the body is a pretty reddish-brown, growing darker in the back and lighter towards the abdomen. The head and body are covered with dark brown spots. The caudal and dorsal fins are brown, while the other fins are of lighter colour. The eye is large and beautiful.

The males are said to be much rarer than the females, and may be distinguished by their smaller size and "projecting papilla" near the anal fin.

These fish will deposit their large eggs while in confinement. Some superstitious fishermen regard the fish as poisonous, and consider that to catch a Dog-fish means ill luck.

This fish, in confinement, will eat tiny worms, aquatic insects, water-worms, and small pieces of raw meat. It is exceedingly hardy.

CHAPTER VIII

THE DIFFERENT VARIETIES OF GOLDFISH AND HOW TO BREED THEM

THOUGH our interest, and really the beginning of our knowledge in aquarium matters, is little more than fifty years old, the Chinese and Japanese, in their own clever way, have carried on the keeping and breeding of fish in confinement for many centuries.

It is said that in China at the present day there is some sort of an aquarium, containing two or more goldfish, in nearly every house. These fish, however, are not as a rule the common kinds with which we are so familiar here, but animals of good or extraordinary shape and of most beautiful colours. It is only comparatively recently that the good fish of China and Japan have found their way into our country.

The following are a few of the varieties which clever oriental breeders in their enthusiasm and perseverance have produced :

The Shubunkin is a gorgeously coloured fish, having the sides brightly mottled with yellow, blue, rose, and black, while the under parts are silverish-white.

The Comet is generally a large sleek fish, growing sometimes to more than a foot in length. In colour it resembles the common Goldfish. It has a very long, forked tail.

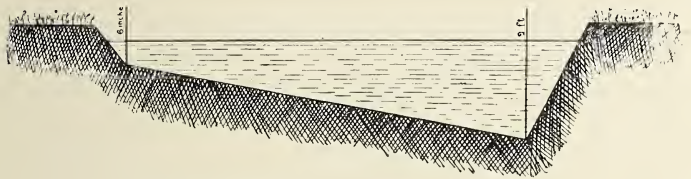
The Lionhead is a fish of curious shape. Its gold-coloured body is almost globular and lacks a dorsal fin. On its head numerous excrescences form, which give the fish a weird appearance ; it has a double tail or caudal fin. In consequence of its peculiar shape and fin development, the species has much difficulty in maintaining its equilibrium. It is rare and expensive, and best kept in heated tanks.

The Japanese Fantail is a lovely fish. The body is deep and chunky, the dorsal fin high, the tail and anal fins being double. It is usually of a rich golden colour.

The Telescope Fish is more of a curiosity than a beauty. It has obtained its name from the curious formation of its eyes, which project forward in a kind of telescopic fashion. The fins in size are often out of all proportion to the body, the tail being much longer than the body and of most delicate construction. In colour this species is usually golden.

The Veil-tail has a body like that of the Fan-tail, but its tail is long, drooping and lace-like. Good specimens of this species command high prices; succeed best in a greenhouse tank or living-room aquarium.

The Moor is a "black" Goldfish with telescope eyes and a



SECTION OF SPAWNING OR REARING POND.

double or veil-tail. This fish is very handsome. Young specimens, however, may be obtained quite cheaply. There are other varieties besides those just described.

To breed Goldfish successfully in ponds, three at least should be prepared. They need not be large, but they must be (a) of a suitable depth so that (b) they can be filled and emptied at will, the outlet being well guarded; (c) the amount of water they contain can always be under control; (d) they cannot overflow; (e) and there can be no chance of escape of fish from them.

Those ponds allotted to spawning and rearing purposes should be constructed so that they gradually slope down to a depth of 2ft., as suggested by the drawings. They need not be longer than 10ft. nor wider than 5ft. They should be kept empty and well-cleaned during the winter. This will

lessen the chance of the many enemies to the spawn and fry being present in the spring.

The third pond is provided for those fish which have grown so big that there is no danger of their being eaten by their larger relatives, and for the wintering of all the fish. This pond should be a little larger than the other two—varying from 2ft. in depth to at least 4ft. The ice in winter time, of course, must be broken as soon as possible after it has formed.

The ponds should be supplied with water from a reliable spring, from the tap, or from any other source from which water of good quality can be obtained without fail throughout the year.

Goldfish will breed when they are a year old, and sometimes when they are only nine months; but it is wise to choose as parent fish those which are between two and four years old. If of the latter age there should be four males to three females; or if of the former, four males to six females, but if the females are much bigger than the males, then there should be six males to three females. It is wiser, however, to choose fish of a like size.

It is only during the breeding season that the sexes can for certain be distinguished from each other. The males at this time develop on their gill covers tiny protuberances which give a rasp-like feeling to the finger when rubbed over them. When the breeding season is over they disappear.

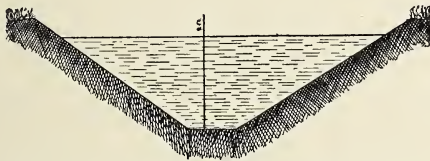
The female, near her spawning time, has an extended appearance about the neighbourhood of her ovary, which is situated immediately below her spinal column and on either side of her air-bladder.

If the spawning-pond be of the size suggested above, it may with advantage be divided down the centre by a wooden frame, carefully made to fit, and covered with fine-meshed wire netting. This must stand so high out of the water that the fish cannot jump over it. In each division a set of breeding fish can be placed.

As soon as the difference between the sexes can be distinguished the chosen fish should be placed in the spawning-

pond. And in the same pond there ought to be several rather large bunches of the Canadian water-weed (*Elodea canadensis*), loosely and securely tied, floating about. If this plant cannot be obtained, any other plant which will grow while floating, and which has something of the same character, will do. But should no aquatic weed be at hand bunches of long grass, or even of soft hay, might answer the purpose. The bunches must float—and if possible near the deep end of the pond; indeed, it will be more convenient if they are fastened by a piece of string to the bank.

When the fish are about to spawn they become very excited, dashing about among the weeds, the male or males closely following the female; and as the latter deposits her eggs the former discharge their milt, which can easily be seen in the



SECTION OF SPAWNING OR REARING POND.

water because of its milk-like appearance, portions of which are absorbed by the ova, and so they are fertilised. As the eggs are covered with some mucus-like substance they are capable of adhering to almost anything with which they come in contact, thus they stick to the weeds or their substitutes.

The eggs are about the size of a pin's head and of a yellowish colour. The usual spawning time is from about four o'clock in the morning to about nine, and in this country generally extends from April to August. Whenever it is thought that the fish have spawned, the bunches of floating weed should be drawn to the land and carefully examined.

If eggs are observed on the weed, a bucket ought to be half-filled with water from the pond, and with a pair of scissors the portions of *Anacharis* or other weed to which the ova are adhering should be cut off and gently placed in the bucket.

After returning the bunches of plants to the pond, the bucket should be taken to the house and the eggs put where they are intended to hatch.

Large aquaria should have been prepared and placed in some fairly sunny window. Water taken from the pond of *exactly* the same temperature as that in the pond, must be put in the vessels prepared for the hatching of the eggs. About one hundred eggs should be allowed for each gallon of water. The eggs must not be separated from the weed when deposited in their quarters. The fry will appear in from three to seven days, according to the temperature of the water and the condition of the eggs.

Every day any unfertile eggs should be gently removed, or their presence in the water may tend to the development of fungus, particularly if its temperature be not high.

For twenty-four hours after they leave the egg the fry need no food. They exist on the yolk which is still in a bag attached to their bodies. After this time they commence to feed on the tiny animal life which will be sure to be present in the water in which they were hatched. However, this natural food will not be in large enough quantity to feed so many little fish. It is wise, therefore, to introduce "baby-food" in the shape of fine oatmeal or pea-flour, cooked to a paste, and swilled round in the aquarium containing the fry.

When the little fish are about four weeks old they should be fed on tiny water-fleas (*Daphnæ*) or cyclops.

Now the larger of the fry, which will be chiefly those hatched first, should be caught with a net and placed in the rearing-pond at such a time as the temperature of the two waters is the same.

The rearing-pond should only contain such water-plants as the Lily (*Nymphaea alba*), or others of a similar kind. These are wanted, not so much for oxygenising the water as for supplying shade and protection for the small fish. The plants should be placed at the deepest part of the pond.

The pond being free of other weed will allow the fish to be the more readily under observation, and the presence of

any of their many enemies then can be the more easily detected.

As these fish grow they should be removed to the winter pond if no large fish are kept there. This pond may be well stocked with aquatic plants, such as *Elodea* and the Water Lobelia (*Lobelia Dortmanii*).

In time the young fish may be persuaded to eat small garden-worms, water-worms (*Tubifex rivulorum*), crushed vermicelli, stale bread dried in an oven and powdered, and the like.

Great care must be taken not to crowd the fish nor, until they are fairly well-grown, to associate those of very different sizes. As "the garment must be cut according to the cloth," so fish must be hatched according to the size and number of the ponds.

When Goldfish are to be bred and reared in aquaria indoors, the tank which contains the parent fish should be under fairly close observation, and when a female seems (judging from appearances) to be near the time of her spawning, her companions of her own sex ought to be removed, and so lessen the chance of the eggs on their arrival being devoured.

The aquarium in which the breeding-fish are kept should contain plenty of growing weeds, e.g. *Elodea*, *Potamogeton densum*, and the Water Ranunculus.

As soon as the fish have spawned they must be removed to another and properly-arranged aquarium, where they will presently again deposit their eggs. The eggs left behind will hatch in due time, and the young fish will find plenty of food present in the water. As this is consumed, other food must be introduced, according to directions already given.

As the young fish grow, and if the number of aquaria is limited, they may be kept in wooden tubs, pans, baths, or any other fairly large and shallow vessel; of course care being taken that they are fitted and managed in the same way as ordinary aquaria. There must be no crowding, no neglect, and no ill assortment of sizes if success is to be attained. The surplus fish should be disposed of at the first opportunity.

It is, perhaps, wiser to breed the better kind of Goldfish, such as the Fantails indoors in aquaria, than out of doors in the ponds. These fish have a little more difficulty in spawning and are slightly more difficult to rear than the commoner varieties, but they are certainly well worth the extra trouble.

Goldfish will spawn several times during the season.

CHAPTER IX

TROPICAL FISH-KEEPING

KEEPING and breeding tropical fresh-water fish is a hobby which may be indulged in by rich or poor alike. The cost of maintaining a twelve gallons capacity tank at a temperature of about 75° F.—the best temperature for most “tropicals”—is very small, working out at approximately 4d. per week by gas or oil heating. Electricity, though less trouble, is naturally more expensive.

Silver incubator burners screwed into flat biscuit tins make efficient and economical aquarium heaters. For small tanks holding about five gallons of water, the tiny lamps which may be obtained at a 6d. stores are quite suitable. However, so long as the temperature of the water is not allowed to fluctuate more than 5 degrees daily, it does not really matter by what method the aquarium water is kept warm.

The minimum temperature in which to keep “tropicals” with safety is 65° F. Very warm water, say over 103° F., is definitely dangerous. During the summer months little or no artificial heating is required. Warm water aquaria should always be kept covered with a sheet of glass, for “tropicals” are great jumpers. Also, the glass cover helps to conserve the heat and lessen evaporation.

Besides a few cold-water plants such as *Vallisneria spiralis*, *Ceratophyllum demersum*, Frog-bit and Duckweed, which will grow well in tropical aquaria, there are others—indigenous to the warm places of the world—which enhance the appearance of the tropical aquarium considerably. Among these choice specimens of aquatic *flora* may be mentioned the rare and beautiful *Cryptocorynes* from Southern Asia, the dainty floating *Salvinias* from Brazil, the exquisitely coloured *Cabomba*

rosæfolia from Cuba, the *Heterantheras* from Central America, and the unique *Marsileas*, or aquatic Four-Leaf Covers from Australia.

The best combination of plants for a tropical aquarium is made up of the following named specimens: *Vallisneria spiralis* and *Sagittaria natans* for supplying an abundance of oxygen; two or three roots of *Cryptocoryne Griffithii* for ornamental purposes; and any of the *Marsileas*, *Heterantheras*, *Cabombas* or *Ludwigias* for side plantings. For floating plants any of the following are eminently suitable: *Utricularia minor*, *Salvinia natans*, *Pistia stratiotes*, *Ceratopteris pteroides*, *Riccia fluitans*, Frog-bit and Duckweed.

With the exception of the last three named, all these plants are true tropical varieties. Snails are not really necessary as scavengers in a tropical aquarium, the clearing up being performed far more efficiently by a pair or so of small tropical cat-fish. All the same, if snails are really desired, the best species to use are undoubtedly the Red Ramshorn (*Planorbis corneus* var. *rubra*) and the little Australian variety scientifically known as *Isadorella pyrimidata*. These snails seldom do any damage to the plant life.

Livebearing fish are known variously as Killifish and Tooth-Carps. Given the right conditions, these fish are very easy to breed because actual sex-connection takes place between the males and the females, the long, tube-like anal fins of the males becoming transformed during sexual excitement into a coupling organ. Once a livebearer female has been fertilized by a male she may drop up to eight lots of young, each lot averaging about five to a hundred tiny fish. As livebearers are inclined to make a meal of their offspring, it is essential that their aquarium be thickly planted so that any young dropped will be able to find safe hiding places until they are large enough to take care of themselves.

Soon after they emerge from their mother's vent, livebearer babies are capable of enjoying a good meal, and take dust-fine dried food sprinkled on the surface of the water. The fry are sexually mature at about eight weeks and may be sexed quite

early by noticing their anal fins, which (as already mentioned) in the males are long and tube-like. Also, the males are usually possessed of very vivid colours. Some interesting crosses or hybrids may be produced by mating closely related species to each other, such as Black Platy males with Green Swordtail females, or Red Swordtail females with Black Platy males and so on *ad infinitum*. Hybridizing is only one of the many interesting and exciting branches of our hobby.

The following named livebearers are all quite easy to keep and breed—they breed at all seasons. Moreover, they are all possessed of brilliant colours. All are members of the *Cyprinodontidæ* family.

The Guppy or Rainbow fish (*Lebistes reitculatus*) comes from Venezuela and the West Indies generally. It is probably the most widely-known and popular of tropical aquarium fish. The male, which seldom exceeds 1 in. in length, is marked with all the colours of the rainbow: blue, orange, purple, red and green predominating. It is interesting to note that no two males are ever alike in the distribution of their colour "spots."

The female grows to about double the size of the male and is rather deep in the body, especially near the abdomen. Just above the anal fin is a dark marking, which increases in "blackness" just before she delivers young. She is not vividly coloured like the male, but is of a dull, greenish-olive hue. Guppies thrive well on most dried and flesh foods, delighting in scraped raw beef and minced, washed liver. An occasional feed of live-food keeps them in good condition.

The Mexican or Green Swordtail (*Xiphophorus helleri*) is found in large numbers in the vicinity of Vera Cruz. The male is a very handsome fellow, long and sleek with a greenish-olive body. Two zigzag brick-red stripes ornament the sides, extending from just behind the eyes to the beginning of the unique, sword-shaped tail. This remarkable appendage, really the continuation of the bottom caudal rays, may be coloured pea-green, yellow or Cambridge-blue. However, whatever colour is in the tail, the edges are always lined with black.

The female is plumper in the body than the male, and her colours are very subdued. She does not possess a "sword" tail, her caudal extremity being transparent and rounded. Mexican Swordtails readily eat the foods recommended for the Guppy, and also a large amount of vegetable matter, such as the roots of duckweed, chopped, boiled spinach, the soft part of tomatoes, and mashed, boiled carrot. There are several coloured varieties of the common Swordtail, which have been developed by selective breeding and hybridizing with members of the large platy family. The latest Swordtail on the market is white with ruby-coloured eyes. It was produced quite recently by a clever American breeder, now deceased, named Augustus E. Traeger.

The Platys or Platyfish are a large, colourful group from Mexico. One of the most popular members of the family is the Red Platy (*Platypæcilus maculatus* var. *rubra*). This little fish, which seldom exceeds $2\frac{1}{4}$ in. in length, is coloured bright blood red. Not-so-good specimens may be deep orange-red or a subdued mahogany colour. The blood-red one, though, is the type to procure for breeding purposes.

The male is not quite as long or as fat in the body as the female, and his tube-like anal fin is tinged with pale blue. Platys thrive best on a mainly vegetarian diet. However, they should also be fed every few days on scraped raw beef, minced fresh shrimp, and crushed biscuit—dogs' or digestive.

Platypæcilus variatus, though closely related, is quite distinct from the above. It has been wisely named *variatus*, for individual specimens differ greatly in size and colouring, some having red tails and yellow dorsal fins, while others have fins which are just a dull greenish-olive hue. The body colour is usually greenish-yellow or greenish-blue, with numerous other tints showing through. A peculiarity of this fish, which measures, when fully grown, about 2 in., exclusive of tail, is that the male has a dark marking above the anal fin, such as the females have when heavy with young. Feed the same as recommended for *P. maculatus*.

Pæcilistes pleurospilus, a not-so-common species from

Central America, does not grow quite as large as the platy. It is, however, an exceedingly attractive little fish, with its light, olive-brown sides ornamented with seven dark spots—all in a line—and brownish fins. The female, like most livebearers, is a trifle larger in the body than the male. *P. pleurospilus* is easy to feed, taking with equal relish proprietary dried foods, most live foods, and scraped raw beef.

The Striped Mud Fish (*Limia vittata*) is a native of Cuba. It is brownish-yellow in colour, with some dark markings on the sides. The male is small, measuring only about 1¼ in. when fully grown. The female grows nearly twice his size. This fish eats the same foods as recommended for *P. pleurospilus*. Very easy to breed.

The Sail-Fin Molly (*Mollienesia latipinna*) has a wide geographic range, being found in places as wide apart as Mexico and Louisiana. It is, and always will be, one of the aristocrats of the tropical fish world. The silverish-grey male, which measures about 3 in. long when fully grown, is notorious for his extremely large, sail-like dorsal fin. In certain lights, the sides of the body reflect many beautiful shining lights of green, purple and blue. The much plainer female has a dorsal fin of normal proportions.

Mollies will not flourish in small tanks and do not breed so readily as will the foregoing species. They like a mainly vegetarian diet and thrive best on *Algæ*, cooked oatmeal, cooked and finely cut spinach or cabbage, and cooked, mashed carrot. Naturally, they will appreciate a feed of live- and flesh-foods occasionally, say three times a week. A gravid female should not be moved about or unduly worried, for any shock at this time usually results in the death of mother and young.

The Black Molly is a highly developed sport of the *M. latipinna*. Good specimens, which command high prices, are velvety black all over, with the exception of the top edge of the dorsal fin, which sometimes is tinged with yellow or orange-red. Black Mollies are sometimes called Midnight Mollies.

Egg-laying or oviparous fish are not quite so easy to breed as the livebearers. The eggs expelled by a female during sexual excitement are fertilised externally by the milt or semen ejaculated by the attendant male, or males. The period of hatching out differs with some species, but on the whole, the eggs of *most* species usually hatch out in three days, especially if the tank water is maintained at a temperature of approximately 80° F.

The newly hatched out fry look like the tiniest of tiny, clear glass beads, with a short length of hair attached. For the first three or four days of their existence, the baby fish live on the nourishment contained in their yolk sacs, which are attached to the undersides of their bodies. Directly these sacs become absorbed, the fry begin to look around for food, which they find in the shape of tiny, living water *animalculæ*, commonly known by aquarists as *Infusoria*. *Infusoria* must be supplied, a cupful per day, until the fry are large enough to take baby water-fleas (*Daphnæ*), and later on, proprietary dried foods of a very fine grade. The microscopic forms of life necessary for the fry's "first food" may be cultured by anybody who cares to follow out these directions :

Procure a few 2lb. jam jars, or some similar shaped receptacles, and fill each to the top with warm water. Into each jar sprinkle a small quantity of any of the following : dried lettuce leaves, chopped dry hay, uncooked lentils, or the dried leaves of some water plant. Place the jars in a warm, dark place, and in less than ten days the water in each jar should be teeming with *Infusoria*. Water containing *Infusoria* looks as if a greyish-white dust is floating about in it. A drop of this water, examined under a microscope, will be seen to contain many wee, wriggling, worm-like creatures. As one draws on the supplies of *Infusoria* from each jar, aquarium water may be added to make up the deficiency and maintain the culture.

Sexing egg-laying fish is not so easy as sexing livebearers, for the males do not possess a gonopodium or coupling organ. Sexual differences in egg-layers usually manifests itself in

the very vivid colouring of the males and the subdued colouring and plumper bodies of the females. Sometimes, too, in some species, the dorsal and caudal fins of the males are much larger and more elaborate in structure than those of the females. Unfortunately, there are quite a large number of species, such as the beautiful Angel Fish (*Pterophyllum scalare*) from Brazil, the sexes of which resemble each other so closely in form and colouring that only an expert can distinguish them. The safest way of pairing up fish, the sexes of which resemble each other closely, is to place several adults in a tank by themselves and to watch their behaviour.

If a pair of fish are seen to be acting in a strange fashion, say nudging each other, or indulging in what may be termed (to use an Americanism), "petting," then one may be pretty certain that the fish are a true pair, and may be netted and given a tank to themselves. That is, of course, if it is the desire of the aquarist to breed them. Like the livebearers, the list of egg-layers in the succeeding pages have been chosen because they all are vividly coloured and not—with one or two exceptions—very difficult to breed.

The Paradise fish (*Macropodus opercularis*), from Indo-China, was one of the first "tropicals" to be introduced into Europe. A few were taken from a brook near Canton, China, early in 1868, and brought to France by M. Simon, who was French consul at Ningpo. M. Carbonnier, however, is usually credited with introducing the fish into France, owing to the fact that M. Simon placed the collected wild specimens in that gentleman's care; and it was in his aquarium that the fish first spawned—a great event in those far-off days. About ten years later the species was introduced into America by Adolphus Busch of St. Louis.

The male Paradise fish is very, very beautiful. The sides of his body are ornamented with alternate vertical bars of crimson and red. Along the back and top of the head are many tiny black spots. The gill-covers are blotched with bright blue; the anal and dorsal fins are dark blue, long and flowing; the rather short, feeler-like breast fins are blue near

the body, shading off to red near the tips; the very long, forked tail fin is *bright* red.

The female is not so vividly coloured as the male, and her fins are rather short. During the breeding season (April to September) her sides bulge, indicating the presence of eggs within. Both male and female are about the same size, measuring approximately 3in. long, exclusive of tail. Breeding this fish is very easy and highly interesting, for the male builds a curious bubble-nest on the surface of the water to receive the female's eggs.

Spawning takes place directly beneath the nest, the male wrapping his body round that of the female in such a fashion as to squeeze out the eggs. Most of these, being lighter than the water, float upwards towards the nest, but the few which remain suspended in the water are hurriedly gathered together by the male in his mouth and blown out into the centre of the nest. As soon as spawning is over it is best to remove the female to another tank, for the male, who is naturally of a pugnacious character, usually endeavours to "beat up" his better half.

Although notoriously unkind to the ladies, the male Paradise fish is an excellent father, looking after his offspring until they are big enough to look after themselves. Unfortunately, one can never tell when a seemingly devoted fish parent may have an attack of "nerves," acute hunger or jealousy, and begin to devour his, or her, own fry. It is advisable, therefore, to remove the father to fresh quarters when the little fish are about nine days old. Paradise fish prefer a mainly carnivorous diet, thriving best on scraped raw beef, tiny earth-worms, swatted house-flies, tiny green caterpillars and the like. They are hardy and live many years in captivity.

The species is a member of the order *Labyrinthici*. Labyrinth Fish, as all members of the order are commonly called, are possessed of a special organ situated just beneath the gill-covers, which enables them to breathe atmospheric air. Thus it will be readily realised that Labyrinth Fish are not dependent upon the oxygen dissolved in the water, and may

be kept in small aquaria without suffering any harm, except, of course, the dangers of fighting, disease, etc., breaking out through lack of space.

The Veil-tail Siamese Fighting Fish (*Betta splendens*) may be obtained in various colours. The best-known variety is called the Cornflower-Blue. Other shades of fish which have been produced by clever oriental and occidental breeders are lavenders, greens, blues, pinks and purples. The latest development is a black fish produced by Mr. Jacuruso, an American enthusiast. Although Fighting Fish may now be obtained in so many different colours, nearly all specimens have bright-red breast fins. If two Fighting Fish males be placed together in the same tank they will fight to the death, so never, on any account, place two males together in the same container unless, of course, it be divided in the middle by a sheet of glass, making two compartments. The females have very subdued colours and much shorter fins. *Betta splendens* should be fed the same foods as recommended for the Paradise fish. They breed in the same way, too, and are air-breathers.

The Dwarf Gourami (*Colisa lalius*) is another nest-building labyrinth fish from Northern India. Its body is rather deep for its size (about 1½ in. long) and very thin through. It is striped similarly to the Paradise fish, with alternate vertical bars of crimson and blue. The red-spotted dorsal and anal fins are long, though not flowing. The ventral fins are longer than the body and feeler-like. The tail is rounded and of normal proportions. The female is not so pretty to look at as the male, and she is usually rather small. As well as bubbles, the male incorporates pieces of aquatic vegetation in the construction of his nest. The young of Dwarf Gouramies are rather difficult to rear, since they are so small and require the smallest of live-foods until they are a fair size.

The Giant Striped Gourami (*Colisa fasciata*) grows to about double the size of the Dwarf Gourami. Otherwise, it resembles its little relative very closely. Most aquarists, however, think the dwarf the prettier of the two, owing to the fact

that its stripes are very clearly defined, whereas those of the Giant variety are smudgy and do not run evenly down the sides.

The Two-Spot Gourami (*Trichogaster trichopterus*) comes from Siam and the Malay States, and measures about 5in. long when fully grown. It is a pretty fish with a greyish-silver body ornamented with a number of thin, vertical dark-brown stripes on the sides. Its common name of "Two-Spot" is derived from the fact that two dark brown spots are present on the sides; one near the tail, the other just behind the gill openings.

The Mosaic or Leer's Gourami (*Trichogaster Leeri*) is a recent introduction from the Malay Peninsular. It is a fish of outstanding beauty, its body being marked all over with "mother-of-pearl" dots. In common with the other Gouramies, it has long, feeler-like ventral fins. During the breeding season the male, which measures about 4in. long, has a bright red breast. All the Gouramies mentioned above readily take dried foods, flesh foods, live foods—even *Hydra*, the aquarist's nightmare—and cooked, soft, minced vegetables, such as spinach, cabbage, carrot, turnip-tops, and the pulpy part of tomatoes.

Leaving the air-breathers and bubble-nest builders we turn to a very important group of fish known scientifically as *Characins*. Most Characins come from tropical South America—the specimens listed below are all indigenous to Brazil.

The Flame Fish (*Hyphessobrycon flammeus*) has the front portion of its little 1½in. long body coloured light olive-green; the hinder part and the fins are vivid "flame" red. Two vertical dark bars are present on the "shoulders." Sexing this fish is rather difficult, for both male and female are similarly coloured; hardy, but difficult to breed. Will eat most foods.

The Rosy Characin (*Hyphessobrycon rosæceus*) is about the same size as its relative, *H. flammeus*, and quite as beautiful. Its body is pale pinkish-red, with the dorsal fin blotched with

black. The other fins are suffused with red. The sexes may be distinguished from each other by noticing the dorsal fins of a number of fish. In the males, the dorsal fin is carried very high and is practically all black. This species is easy to feed, but rather difficult to breed.

The Head-and-Tail-Light Fish (*Hemigrammus ocellifer*) is another small *Characin* of rather unusual colouration. The body is silverish-blue with a large spot at the base of the tail. Half of this spot is bright, shining, coppery-red; the other half is jet-black. Above the eye is another coppery-red marking. As these coppery-red markings shine like tiny lamps, the name of Head-and-Tail-Light Fish was adopted as a common name for this species. It is also known as the Beacon Fish.

The Hatchet Fish (*Carnegiella marthæ*) was named by the distinguished American ichthyologist, Dr. G. S. Myers, for Miss Margaret Carnegie and for the scientist's wife, Martha Ruth Myers. It is a fragile looking, extremely deep-chested little fish, measuring only about 1½ in. long. It is as thin as a wafer. In colour it is silver, sprinkled with small black markings. Although so delicate looking, the *C. marthæ* is quite hardy and will eat almost anything. It always swims near the top of the water and when pursued by large fish can skim or "fly" above the surface of the water for a considerable distance. Moral: keep the aquarium well covered.

The Barbs are a handsome family, peaceful and hardy.

The Dwarf Barb (*Barbus phutunio*) comes from India and only measures a little over 1 in. long. However, it more than makes up for its lack of size by its exquisite colouring. The body is silverish, with dark markings on the centre of the scales. Several large black spots ornament the sides. The gill-covers are pinkish; the fins are pale orange. Males and females are rather hard to tell apart, but during the breeding season (spring and summer) the females look fatter in the body. This species has a tiny mouth and likes its food crushed small; satisfied with most kinds of fish food.

Barbus partipentazona is a real beauty. Its body is silver

with jet-black markings on the sides. The dorsal fin is black near the body and bright red near the tip. The stomach has a slight tinge of pink on it. This Barb grows just a little larger than the dwarf barb, and is just as easy to keep and feed. The males may be distinguished by their dorsal fins, which have more red colour in them than those of the females.

The Harlequin Fish (*Rasbora heteromorpha*) is indigenous to the Malay Peninsula. It attains a length of about $1\frac{1}{2}$ in. ; the sexes are very similar in appearance. The general body colour is pinkish-grey with a dark, blue-black, wedge-shaped patch on the hinder part of the body, which, just after the ventral fins, tapers away abruptly towards the tail. The dorsal fin is held high and is of a bright red colour. This fish thrives best on a diet of live and flesh foods. Of dried foods, those of a fine or medium grade suit it best.

The Zebra Fish (*Brachydanio rerio*) is very common in the rivers of India. It is clothed, like a footballer, in horizontal steel-blue and silver stripes. Even its fins are striped! The male has a tinge of yellow on the belly. Both sexes measure about $1\frac{1}{4}$ in. Zebra Fish are quite easy to breed. The female lays her eggs over low-lying masses of vegetation. Very shallow water and plenty of plant life are recommended for breeding this fish. Also remove the parents to another tank as soon as they have finished spawning. Zebra Fish are very clever indeed at eating their own eggs. The species is very hardy and will eat almost anything palatable to fish. A shoal of these piscine beauties is an unforgettable sight.

The Angel Fish (*Pterophyllum scalare*) from Brazil is the king of tropical aquarium fish. His stately movements and great beauty win him admirers everywhere. The body is disc-like, a trifle longer than high, and bright silver, with an overlaying sheen of gold. Four or five vertical black bands ornament the sides. These bands may disappear completely if the fish be frightened or subjected to a very strong light. The dorsal and anal fins are wing-like and very long; the caudal and ventrals are drawn out into fine filaments. The ventral fins are suffused with Cambridge-blue. The eyes are

shining black, with an inner rim of gold and an outer rim of blood-red.

Angel Fish are usually sold in three sizes, called respectively "young," "half-grown," and "large." Large Angel Fish measure about 5in. long and 7 to 8in. deep from the tip of the dorsal to the tip of the anal fin. Young Angel Fish may be purchased for approximately 2s. each. One may gather the size of advertised fish by their price. Up to about 3in. long they are worth approximately 1s. 4d. an inch. After that every $\frac{1}{2}$ in. of their body (exclusive of tail) is worth about 5s.

Angel Fish like deep, well-oxygenated water and plenty of live and flesh food. The species is very difficult to pair up and breed.

All the above named fish, with the exception of the Paradise Fish and the Siamese Fighting Fish, which never can be trusted, should live together quite peacefully, making a very pretty living underwater picture for a living-room, children's nursery or hall.

The most common disease that attacks "tropicals" is known as White Spot (*Ichthyophthirius*). This disease is diagnosed by tiny white spots which appear all over the body and fins of the afflicted fish. Naturally only a few spots are visible the first two or three days. A severe chill, occasioned by a sudden drop in the temperature of the tank water, is the usual cause of this disease attacking a fish. It is always fatal if allowed to pursue its course unchecked, the stricken fish dying in about five days after contracting the disease. To treat, add a five per cent. solution of Methylene Blue, obtainable for a few pence at any large chemist's, to the tank water until it assumes a distinctly bluish tinge. Also increase the temperature of the water to approximately 85° F. Treated thus, a cure should be effected in less than nine days. A few days after the spots have disappeared, gradually bring the temperature of the water down to its former level. Fungus (*Saprolegnia*) may be treated likewise, always with considerable success.

CHAPTER X

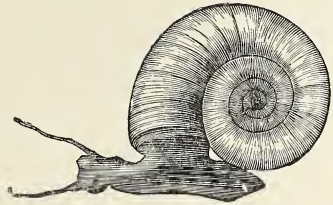
OTHER INHABITANTS OF THE AQUARIUM

BESIDES fish, there are many other creatures which make interesting subjects to keep in a cabinet aquarium. It is never advisable to place fish and aquatic insects, etc., together in the same tank for fatalities are sure to occur sooner or later. For example, fish seldom allow snails to live their simple lives in peace, and many of the larger beetles make a habit of sucking the life-blood out of the fish. Under-water life is just like life on land. Something is always preying on something else. It is always the survival of the fittest, and as (like a well-known London dealer has already expressed) the home aquarium is not intended to be a battlefield, the aquarist should arrange his pets carefully, keeping the bad characters in solitary confinement, or among their own kind, and allowing the docile, trustworthy creatures to live together.

The Mollusca (*mollis* "soft") form one of the sub-divisions of the animal kingdom whose members are characterised by having soft skins and fleshy bodies, but are without bones or joints. Molluscs are either naked or are covered with a shell of one or two valves. The shell is composed of carbonate of lime and animal matter, which is secreted by the skin or mantle of the creature. The Mollusca are divided into the *Encephalous* (possessing a head) and the *Acephalous* (without a head). In the former division are placed the *Gasteropoda* (belly-footed), or Univalves, etc., and in the latter the *Conchifera* (shell-bearing), or Bivalves. The fresh-water Univalves are commonly called Snails, and the fresh-water Bivalves, Mussels. It is, however, with the Snails that the aquarist is most concerned.

The shells of some snails are flat-coiled, like the *Planorbis corneus*, while those of others are oval-oblong, like the *Limnæa stagnalis*, or ear-shaped at the opening like the *Limnæa auricularia*. Some snails shells are much larger in diameter than a half-crown, especially those from South America and scientifically known as *Ampullaria*, while those of others are as small as a big pin's head. Some snails are able to close the aperture of their shells with an operculum, and others, during an enforced absence from water, with an epiphragm. Some snails are either male or female; others are both male and female; others again, when young, have the sexes distinct, but as they grow older, each individual becomes both male and female.

Some snails are oviparous and others are ovoviviparous (the eggs being hatched within the oviduct of the parent).



PLANORBIS CORNEUS.

Some snails are *pulmobranchiate* (possessors of lung-like *branchiæ* for breathing the atmospheric air) and others are *pectini-branchiate* (possessors of comb-like *branchiæ*, adapted for respiration beneath the water). Some snails have their eyes placed upon short footstalks at the base of their tentacles, while others have their sessile there. The tentacles of all the species are situated above the mouth, and are used for touching, and perhaps also for smelling. The oviparous snails deposit their ova in masses, which are in shape either cylindrical or elliptical, or orbicular or round. The eggs in some of the capsules are as few as from three to six, while in others they are as many as from 80 to 130. These egg-masses are affixed either to stones or to leaves or stalks of water plants. More often than not snails in captivity choose the glass sides of aquaria to lay their eggs. The eggs are hatched, according to the different species, in from 10 to about 26 days.

As the tastes of the various species of Mollusca differ, some

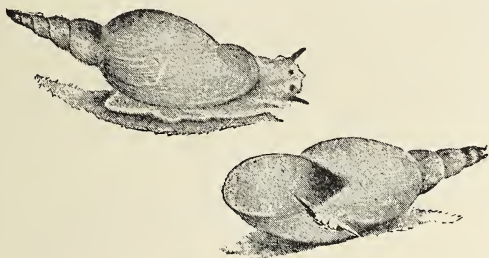
species preferring to eat the healthy growing plants, others the decaying, others confervoid growth, and a few delighting to partake of a little animal food as a relish to their vegetable. It will readily be seen that while some water-snails are harmless enough in a tank, others are injurious there, inasmuch as they will be likely to destroy or hurt the weeds which are so necessary to the welfare of the aquarium.

There are few, if any, snails more suitable for a tank than *Planorbis corneus*. It is hardy, quite large, and not given to destroying useful vegetation. It subsists largely upon decaying matter and confervoid growth. It is usually found in muddy lakes and ditches. To look at it is quite handsome. The body is blackish-brown above and greyish underneath. The mouth is brownish-red. The tentacles are long and elegant. The shell is flat-coiled in shape, almost black, with some reddish-brown markings on the sides. There are five or six whorls, and the sutures are rather deep. The shells of good-sized specimens measure about 1 in. in diameter. The species lays its eggs, contained in an orbicular capsule, at almost any period of the year. The eggs hatch out in about 30 days, much sooner if the tank-water in which they are contained is maintained at a temperature of about 65° F.

A red variety of *Planorbis* known as *P. corneus* var. *rubra* comes from Germany and is extremely popular with fancy Goldfish enthusiasts. Its body is of a lovely pinkish-red colour and its shell is reddish-brown. This snail breeds prolifically in rather warm water at a temperature of, say, 70° F., and the young are always worth looking after, since they are of some commercial value, dealers always being ready to buy nice Red Planorbis from the amateur breeder. Besides decaying vegetable matter, this species is very partial to lettuce. In the Planorbis both sexes are united in the same individual.

Limnæa stagnalis is found in most stagnant bodies of water all over Britain. It is sometimes called the Fresh-Water Whelk. This species should never be placed in a tank containing choice plants for, like all the *Limnæa* it is a great eater of vegetable matter, and if left alone will soon clear a tank of

all its plant-life. It will also eat dead worms, dead fish, bits of meat, etc. It is quite easy to recognise. The whelk-like shell is greyish in colour and about $1\frac{1}{2}$ in. long. There are from six to eight whorls, the body whorl being much larger and more swollen than the others. The spire of the shell



LIMNÆA STAGNALIS.

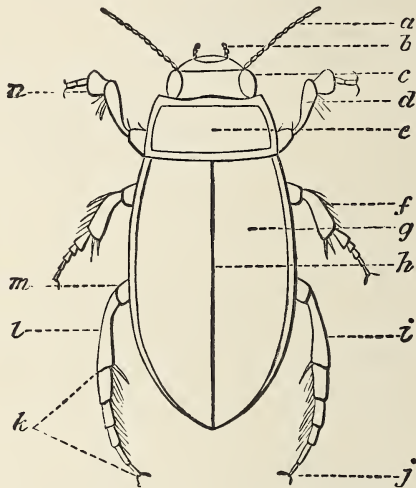
tapers gracefully to a fine point. The body of the creature is yellowish-grey with a bluish-green tinge and mottled with brown and white. The tentacles are flat and triangular. The eggs are laid, like those of *P. corneus*, in an orbicular capsule. They hatch out in about 30 days.



LIMNÆA AURICULARIA.

L. auricularia is not so easily found as the foregoing species. This is a pity, for it is much kinder to the plants than *L. stagnalis*. The shell is almost round, and of a light yellowish-horn colour. There are four or five whorls, the body whorl being much larger than all the rest of the shell. The spire is short and the apex is much pointed. The species lays only about 80 eggs, these being enclosed in a somewhat elliptical capsule.

The various water-beetles, too, make interesting aquarium pets. For example, take the Tiger-Beetle (*Dyticus marginalis*), the terror of the fish-keeper and the dread of the ladies. This inch-long, olive-brown beetle is carnivorous by nature, feeding on young fish, tadpoles, earthworms, young frogs, newts, aquatic insects, scraps of raw meats, etc. It is found in most ponds and ditches, especially those overgrown with

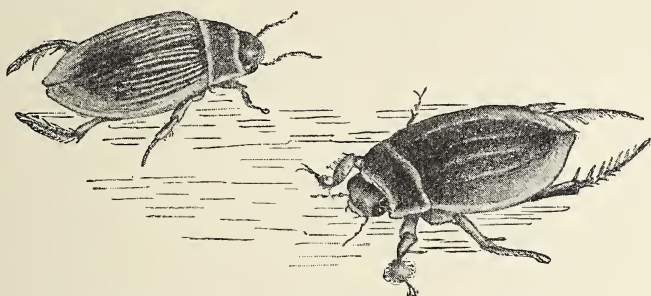


ENLARGED OUTLINE OF MALE WATER-BEETLE (*DYTICUS MARGINALIS*)
a, Antennæ; *b*, Maxillary Palpi; *c*, Eye; *d*, Fore-Leg; *e*, Thorax;
f, Middle Leg; *g*, Elytron; *h*, Suture; *i*, Hind-Leg; *j*, Claw;
k, Tarsus or Foot; *l*, Tibia or Shank; *m*, Femur or Thigh; *n*, First
 three Joints of Foot, widened into a Plate possessing Suckers under-
 neath.

aquatic vegetation. They have powers of flight, and frequently travel, chiefly during the evening, from one piece of water to another.

As stated above, the body of this beetle is olive-brown, shiny and smooth, and the eyes do not project. The hind legs are long and fringed, and the feet are broad and also fringed. The antennæ are long and slender. The males are distinguished by having the first three joints of the fore tarsi developed into a round sucker and by having smooth elytra,

while the females have no widening of the tarsi and possess wing-cases which are furrowed or sulcated. These beetles breathe atmospheric air, and to accomplish this they are obliged to come frequently to the surface of the water. Their manner of respiration is very interesting. The upper part of their abdomen is provided with breathing tubes or spiracles, which are hidden by the elytra when the insects are not flying. The back of the abdomen is nearly flat, above it when shut the elytra form a kind of arch, and thus enclose the spiracles in a chamber into which water cannot enter to wet the wings enclosed within.



DYTICUS MARGINALIS (MALE AND FEMALE).

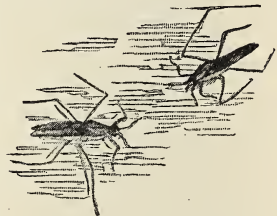
The air so obtained can enter the spiracles as the beetles require it, and thus they are able to remain in the depths of the water until all the supply of air has been exhausted, when, of course, they have to return to the surface for more. A large sweet jar or a one-gallon capacity all-glass tank is large enough to house a pair of these beetles. Always remember, though, to keep the top covered with a piece of glass or perforated zinc, otherwise the beetles may escape. The eggs of these beetles are laid in aquatic plants by the help of a long tube called an ovipositor, possessed by the female, and are hatched in about a fortnight. The larvæ, popularly known as Water-Tigers, are fiercer than their parents, causing the greatest havoc in a pond or aquarium containing small fish.

Hydrophilus piceus, sometimes called the Silver Water-

Beetle, and also the Great Water-Beetle, measures about 2in. long when fully grown. The colour of this beetle is olive-black, with yellow spots along the margin of the abdomen. The antennæ are reddish. The male of this species is distinguished from the female by having the last joint but one of the tarsi of its fore feet divided into a kind of triangular plate. The species is mainly herbivorous, but occasionally partakes of a little flesh food. It is not to be trusted with creatures smaller than itself, or with fish. Its tank should contain plenty of growing plants. Like *D. marginalis*, they breathe atmospheric air, which they obtain by raising their antennæ above the surface of the water. The antennæ conduct the air to the hair-like surface of the lower part of the thorax, and thence to the spiracles. The glistening bubbles of air which become tangled in the hairlike surface of the thorax account for the beetle's common name of Silver Water-Beetle.

The *Gerridæ*, or Pond-Walkers, are found on most rivers, streams, ponds and ditches. All the members of this genus have a fine, hair-like covering beneath their bodies. They use their fore pair of legs for seizing their prey—they are carnivorous—their intermediate pair for rowing themselves along the surface of the water, and they steer by means of the last pair. Their antennæ are four-jointed, and their wings are carried so close to their bodies that there is some little difficulty in detecting them. Their eyes are prominent, and their beaks, when not wanted, are kept folded back beneath the forepart of their bodies.

G. lacustris, the commonest of the species, is about $\frac{1}{2}$ in. long, with a dark, slate-coloured body with yellowish markings on the

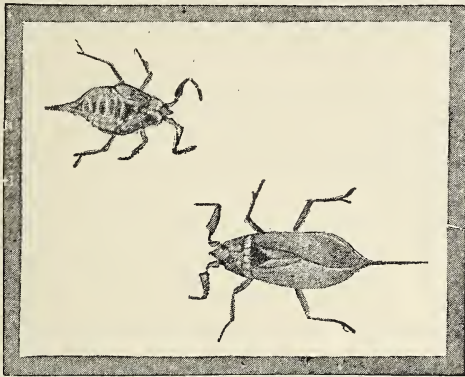


GERRIS LACUSTRIS.

sides. *G. najas*, the largest species, can be easily recognised by its great size and long legs. It is found upon running water and is very difficult to catch in a net. When

confined in a small tank the top must be kept well covered. Feeding them is not very easy ; a piece of meat suspended at the surface of the water may be eaten. So, too, will freshly swatted flies and the larvæ of mosquitoes. *G. najas*, however, much prefer to practise cannibalism, devouring the smaller members of their tribe.

Velia currens, a very common pond-walker, is quite happy living in a small aquarium. It is very clever at getting out of small holes, so the aquarist must make sure that its aquarium



LARVA AND PERFECT INSECT OF NEPA CINEREA.

is always kept well covered. It may be fed like the foregoing species on flies, mosquito larvæ, raw meat, etc. To look at it is not quite $\frac{1}{2}$ in. long, of a dark brown colour with two orange stripes along the back. *V. currens* is sometimes called the Water-Cricket.

Nepa cinerea, the Water-Scorpion, is common in most ponds. It readily escapes detection, however, owing to its colouring, which resembles the mud upon which it is so fond of resting. It measures about 1 in. long, is very flat, and the abdomen is coloured red. At the end of the body there are two long and slender appendages, more than $\frac{1}{2}$ in. in length, which are used for breathing. These caudal appendages, when placed close together, have the appearance of only one appendage. They have given the insect its common

name of Water-Scorpion. It is no scorpion, however, but a bug. The insects respire by means of these filaments. Feeding the Water-Scorpion is very easy, for any young fish, baby tadpoles, or aquatic insects introduced into its container will be seized in the powerful forelegs and "sucked" dry with the powerful beak. They have four other legs which they use for crawling about the aquatic vegetation or swimming. They have wings and can fly quite well.

The Water-Boatman (*Notonecta glauca*) is extremely active and makes a good aquarium pet. It is a wonderful swimmer, and always swims upon its back, propelling itself through the water with its oar-like legs, which extend at right angles to its body. If you look at its picture, you will see how oar-like its legs really are. It is not a large creature, seldom measuring more than $\frac{1}{2}$ in. in length. Its body is convex, slightly keeled above and flat below. It is yellowish in colour with a dark, triangular marking



WATER-BOATMAN
(NOTONECTA GLAUCA).

on the back. Catching it is always a ticklish business, for it can dive at express speed and has an uncommon knack of sensing danger.

It is a very voracious creature and is best fed on young fish, tadpoles, and other small inhabitants of our ponds and streams. The "beak" with which it extracts all the nutriment it can from its victims is very sharp and strong and quite capable of inflicting a nasty wound on the human hand. Sometimes the Water-Boatman spreads its wings—it has wings—and as a precaution the aquarist should always keep its container well covered. Another Water-Boatman worth the aquarist's attention is *N. maculata*. This variety may be distinguished from *N. glauca* by its black banded and spotted body.

The insects belonging to the genus *Corixa* are often enough erroneously alluded to as Water-Boatmen. Why this should be is a mystery, for the twenty or more species of *Corixa*

swim with their backs uppermost and their body-shape differs considerably from species of the genus *Notonecta*. *Corixa Geoffroyii* is a very common species, found in most ponds and ditches. It is about $\frac{1}{2}$ in. long, with a dark brown body peppered with tiny yellow spots, hardly visible to the naked eye. The legs are yellow. The species has wings and comes to the top of the water to respire. The *Corixa* eat scraped raw beef and chopped earthworms with relish.

Certain rather fragile-looking insects may be seen in summer-time flying, apparently with difficulty to themselves, over the surface and in the neighbourhood of fresh water, or may be found concealed among the weeds and trees growing on its banks. These insects are commonly called Caddis-flies. They are very like moths, with unusually long antennæ. Their chief colours are either brown or black. Some of them



CORIXA GEOFFROYI.

are as much as 2 in. across their expanded wings, and these (the large insects) generally fly at night. A few of the Caddis-flies are so much like moths that it is no easy matter to make a distinction. However, as a rule, the former may be distinguished from the latter by remembering that the wings of the Caddis-fly are covered more or less closely with a kind of hair, while those of the moth are adorned with powder-like scales; hence the one is a trichopterous (Gr. *thrix*, a hair, and *pteron*, a wing) insect, and the other a lipidopterous (*lepis*, a scale, and *pteron*, a wing). The Caddis-fly can also be known from a moth by its antennæ and mouth-organs. Its antennæ are proportionately longer than those of a moth, are carried more horizontally, and are filiform or thread-like, whilst those of moths are generally plumose or feathery.

The females of the Caddis-fly deposit their eggs upon stones near to, or half in, the water, upon aquatic plants, or even occasionally, under the water itself. The eggs are inclosed in a gelatinous envelope, and hatch in a few days. The young

larvæ remain in the glutinous mass for a short time before they venture to brave the dangers of their watery world. They are elongated, and more or less cylindrical in shape, and of a yellowish-white colour. Their bodies are soft, with the exception of the head and the thoracic segments, which are horny. They have branchial filaments, placed either in bunches or singly (according to the species) on the sides of their bodies, six legs, and strong jaws. These insects, which are in themselves so defenceless, would soon fall victims to fish and other aquatic animals were they not endowed with an instinct which makes them about the most interesting inhabitants of the fresh-water aquarium. Under the influence of this instinct, they build for themselves houses, portable in most cases, but stationary in others, in which they are more or less secure from the attacks of their numerous enemies. These houses are formed in various shapes, and are made of various materials, according, as a rule, to the species of the larvæ which constructs them. Sometimes the materials depend, to a great extent, upon the locality. The caddis-cases, as they are generally called, are made of pieces of stick, leaves, sand, small stones, shells of molluscs, moss, rushes, seeds, and the like. These cases are formed either of all one kind of substance or of two or more different kinds. But whatever material is used, the larvæ generally manage to make these places of refuge of the same specific gravity as the water, so that they may have no difficulty in moving from place to place. The insects fasten their building materials together by the help of a viscous secretion, which on exposure hardens into a kind of silk. The insides of the caddis-cases are also lined with this silk-like substance. The larvæ are able to cling most tenaciously to their tubes by means of small hooks placed at the extremity of their bodies, by the third pair of legs, which are often longer than the rest, and in many species by the help of three smaller humps situated upon the first segment of the soft part of their bodies. So firmly, indeed, will these creatures hold to their cases, that to attempt forcibly to drag them out would only end in their being pulled

in half—or, at any rate, in their death. But they may easily be dislodged by inserting the stalk of a leaf or a very thin piece of stick into the end at which is the extremity of the insect. This part of the tube is generally of smaller diameter than the other, and the animal will nearly always, after a little tickling, evacuate its fortress. Sometimes the larvæ will voluntarily leave their cases; but whether they have been driven out of their homes, or have left of their own accord, they will generally return to them upon the first opportunity.

It is a very interesting sight to see these clever little architects and builders at work. Upon being taken from their



LARVÆ OF DIFFERENT SPECIES OF THE CADDIS-FLY IN THEIR CASES.

cases and placed naked, along with suitable material, in a saucer or other vessel, they will readily make new tubes. They can be persuaded to construct their dwellings of pieces of coal, bits of glass, beads, filings of metal and other things of a similar kind. Some caddis-worms work much more quickly than others, but the speed of construction frequently depends upon the materials at hand.

There are in Great Britain about 160 different species of Caddis-flies.

The worm of *Phryganea grandis* makes a cylindrical case of almost equal diameter throughout, and forms it of portions of leaves and other vegetable matter arranged spirally. This larva and its case are generally found in ponds or very slow-running streams. The insect, in common with many others, has the habit of turning itself while within its tube, so that it can protrude its head at either end. *Phryganea grandis*, about the largest British species, is a little more than $\frac{3}{4}$ in.

long, and its wings, when expanded, are at least 2in. from tip to tip. It is one of the commonest and handsomest of the Caddis-flies. It may be known by its ash-coloured anterior wings, brown posterior wings, and yellow-ringed antennæ. Like all its relatives, it folds its wings alongside of its body when at rest.

The larvæ of *P. obsoleta*, *P. striata*, and all of the family, make the same kind of cases as that of *P. grandis*. *P. minor* is the smallest member of the *Phryganeidæ*. It is rather a handsome insect. Its anterior wings are spotted.

The larvæ of the large and well-known family of the *Limnophilidæ* make cases very varied in their construction. They



PHRYGANEA GRANDIS.

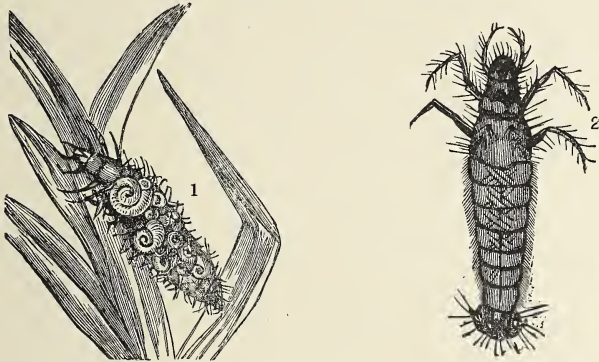


CASE OF THE LAVA OF
LIMNOPHILUS
RHOMBICUS.

may be found either in stagnant or quick-running water. The case of the *Limnophilus rhombicus* is rather common and cumbersome. It is made of pieces of vegetable fibre, pieces of stick or twigs of various thickness, bits of grass, and portions of moss. These are all cut about the same length and laid transversely, giving the whole case a bristling appearance.

The cases of the larvæ of the Caddis-fly *L. flavicornis* are very varied, and often uncommonly beautiful and interesting. Some of them are most regular in their construction and others exceedingly irregular. Occasionally they are made of the same kind of materials which are used by the larvæ of *L. rhombicus*, with the shell of a small species of *Planorbis* added here and there. Not infrequently are they constructed entirely, or almost entirely, of these shells, which are so closely and skilfully packed together, that as many as forty or fifty shells may be counted in a single case. The larvæ of *Limnophilus flavicornis* will use other shells besides those of

tiny Planorbes in the formation of its tube. Not only will it press into its service small univalves of any kind it may happen to meet with, but even bivalves, such as the *Sphærium corneum*, other *Sphæria*, or some of the *Pisidia*. It seems to be quite careless whether it makes use of the right or left valve, or both valves of one of these molluscs. Nor does it stop to find out before it "annexes" a shell, whether the owner of it has left or not; for it is by no means an unusual thing to find a caddis-case composed of shells in which the animals still live. This is rather hard upon the poor molluscs,



(1) LARVA AND CASE, AND (2) NAKED LARVA (ENLARGED) OF LIMNOPHILUS FLAVICORNIS.

for they have to be carried about as their captor wishes. It is a very good plan for those who are collecting fresh-water shells to examine the cases made by the larvæ of *L. flavicornis*. Of course, it will be readily seen that the tubes formed of such a variety of materials must often be very irregular, as well as apparently cumbersome.

The larvæ of *L. lunatus* make a case of sand or vegetable material, to which they attach long pieces of stick, which project at either end. These long bits of wood seem to act as balancers. This case is generally found in stagnant or very slow-running water.

The larvæ of *L. vittatus* make a curved case of fine sand. It may be likened in shape to an elephant's tusk.

The larvæ of *L. pellucidus* make cases chiefly composed of whole leaves, laid almost flat against each other. The "worm" itself is enclosed in a tube within the leaves. This is by no means an uncommon case in some parts of the country. It is generally found in stagnant water.

The larvæ of the genus *Stenophylax* live in streams, and make their tubes of tiny pebbles. Sometimes when the water is very swift, the cases are fastened slightly to large stones. If the collector will take the trouble to examine the lower part of large stones in quick-running streams, he will frequently find bunches of very small gravel attached to that part. So firmly are they fastened that it requires quite a strong pressure of the finger or thumb to remove them. These bunches are fixed cases of the Caddis-worm. The larvæ of Caddis-flies found in quick-running water are not suitable for the aquarium.

As the Caddis-worm grows, it enlarges its case by making an addition to the larger end. When this is done, the case is shortened at the other end. While the Caddis-worm is moving from place to place, it protrudes its body just sufficiently to use its legs, and when it is attacked by an enemy it withdraws itself deeply into its tube. Most of these larvæ may be considered herbivorous, though at times they are not unwilling to partake of a carnivorous diet. They will occasionally eat a portion of worm, pieces of beef or mutton, sometimes very young fish. A few of the Caddis-worms are thought to be entirely carnivorous, feeding as a rule upon other aquatic larvæ. However, it is well to take for granted that the Caddis-worms which are suitable for the aquarium are herbivorous. These little creatures should not be placed in a tank in which choice weeds are growing, or they will certainly do a great deal of harm; and the best way to keep these very interesting insects is to place them in small aquaria where they may be easily seen at their work, and in which small quantities of weeds may be put as required. Caddis-worms should not be kept together in great numbers, or they will interfere with one another. They will live for a long

time in the aquarium, often apparently without eating anything at all. When they do not feed, the period at which they will enter the pupal state is considerably postponed. Caddis-worms of various species may be found at almost any season of the year.

As the time arrives at which it is necessary for the larva to enter the pupal-hood, it in most cases makes preparation for that change by fastening its tube to a stone or water-plant, and covering the open ends of it with a kind of silken net, so constructed as to keep out all enemies, and let in the water necessary for respiration. Sometimes this grating is made with the help of pieces of stone or vegetable matter. Occasionally a larva closes up one end of its case in the manner just described, and with the head protruding at the other end digs a hole in the bottom of the stream, in which it almost half buries its tube vertically. When it has done this it is supposed to change its position in the case before it becomes a pupa. The insect's appearance as a pupa is very different from that which it had as a larva. Its wings, legs, and antennæ are then placed close to the sides of its body. The pupa's only movements while in the case are said to be oscillations from side to side. After spending a few weeks in the pupal state it breaks the covering at one end of its tube and swims very swiftly to the surface of the water ; then it mounts some protruding stone or aquatic plant, and remains there while the pupal envelope splits, and it—a perfect insect—is free. Some pupæ, however, do not leave the surface of the water, but float there until they emerge fully-developed Caddis-flies.

The members of the *Epheméridæ* (Day-flies) family of the *Neuroptera* are chiefly remarkable for the extreme shortness of their lives when they attain the imago or perfect state. Some of them, when they have reached that condition, only live for a few hours—being born, so to speak, after sunset and dying before sunrise ; while the longest-livers, the patriarchs of the family, exist but for a day or two as a rule. though in captivity it is said that they have been kept alive

for a week or even more. Appropriately, then, are they named *Ephemeridæ*—beings whose length of life is limited to a day. The larvæ of these insects, however, live from one to three years, according to their species.

Day-flies, or rather May-flies, as they are commonly called, are very delicate-looking creatures, generally possessing four minutely-reticulated wings and two or three extremely long *setæ*, or tail filaments. The hinder wings are very much smaller than the former pair, and sometimes are wanting altogether. These insects, owing to the lack of development in the organs of the mouth, seem incapable of taking food of any kind whatever. Their antennæ are very short and awl-shaped, and their forelegs are very often extremely long. The males are distinguished by two curious appendages affixed to the last segment but one of their body, by the great elongation of their forelegs, and by the "up-and-down" manner of their flight. The females as they fly deposit their small oval eggs in the water, which sink and adhere to stones and aquatic weeds. The larvæ, which in due time are hatched from these eggs, do not bear much resemblance to the full-grown insects. Their bodies, which are flat and elongated, have three long feather-like appendages at the extremity of the abdomen. At the sides of the abdomen there are some leaf-like branchial organs attached in pairs to all the segments of the body except (according to species) the last three or four. The antennæ are long and bristle-like. The larvæ and pupæ have strong mouths, and feed by preying upon small aquatic animal life. For a long time it was quite a matter of doubt what was their proper food. Some authorities declared that because their bodies, when dissected, were found to contain mud, that they ate mud; while others supposed that they consumed vegetable matter. These larvæ construct no cases as do those of the Caddis-fly, but live either freely in the water or in curious burrows made in the banks of the ponds and streams which they inhabit. As a rule, it is the larvæ of the larger species of the *Ephemeridæ* which make the burrows. These burrows, which are formed somewhat in the shape of

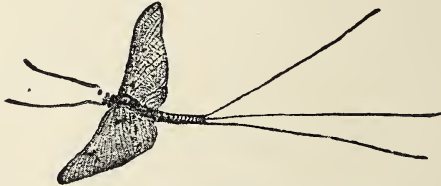
the letter **U**, are so arranged that the insect can go in at one end and out at the other, and so save itself the inconvenience of turning round within its narrow home. In making the burrows, these creatures seem, in some measure, to imitate the common earthworm by swallowing at least a portion of the mud or soil they are excavating. This habit accounts, it is thought, for the presence of mud within their bodies.

These larvæ change their skins frequently as they grow, and are said to have become pupæ when their thoraces show signs of bearing wings. After a certain time, according to species, the pupa leaves the water and develops into a fly, but, strange to say, not the perfect fly, for there is still another change before the imago appears. The sub-imago, as it is called, is the "Green Drake" of the fisherman. It is a slow and clumsy flier, and soon settles upon some spot conveniently situated for getting rid of the pellicle which covers its whole body, and hides its true colour. It then frees itself in a wonderful manner from this very thin skin, and emerges a beautiful and active fly, with the filaments at the extremity of its body of about double their former length. Numbers of these filmy skins may be seen adhering to trees or weeds upon the water's edge.

The wings of the perfect Day-fly are so delicate and fragile, that it is almost impossible to preserve the insect in anything approaching a life-like condition without placing it in spirits of some kind. These insects emerge from their pupal envelope generally about sunset. They nearly always appear, when at all, in great numbers, the males assembling together in crowds, and attracting attention by their curious and graceful up-and-down flight. The swarms of these insects, though frequently very great in this country, are often far greater in the neighbourhood of rivers and canals upon the Continent. Indeed, their number there are sometimes so enormous that the bodies of these tiny flies are gathered and used as manure.

The larvæ and pupæ of the Day-flies can be easily kept in confinement, where they may be seen to go through their

wonderful metamorphosis. They will live, apparently quite contentedly, in a small aquarium, whether its bottom is covered with mud or not. The best species for the tank is *Ephemera vulgata*, the larva of which is about 1 in. long. It will frequently change its skin, which forms a very interesting object under the microscope. It ought to be always provided with suitable food, which should consist of cyclops, water-fleas (*Daphniæ*), and the like. These little fresh-water crustaceans may be easily bred in great numbers for this and similar purposes, directions for which will be given in another chapter. When the time draws near for the pupa to become the sub-imago, a landing-stage should be prepared for it—one



DAY-FLY (*Ephemera vulgata*).

composed of a piece of bark or cork will do. And if the aquarium-keeper is fortunate, and has arranged matters properly, he will be able to witness not only the interesting sight of the pupa becoming the "Green Drake," but also the "Green Drake" developing into the beautiful and graceful Day-fly (*Ephemera vulgata*).

The Water-spider (*Argyroneta aquatica*) is an exceedingly interesting inmate of the tank ; its intelligence and ingenuity have long made it a great favourite with aquarium-keepers. It is about $\frac{1}{2}$ in. long, and is therefore rather a large spider. Its abdomen is ovate in shape, and of an olive-brown colour, and the rest of its body, including the legs, is a dark reddish-brown. Its first and last pairs of legs are of greater length than the other two pairs. The females of most spiders are larger than the males, but in regard to the *Argyroneta* the reverse is the case. Water-spiders may be found in the ponds

and ditches of many parts of England, especially in those of Cambridgeshire and Norfolk. The abdomen of the Water-spiders is covered with a kind of hair, which repels the water and prevents the creature from getting wet. Sometimes, however, when these animals are being carried in water from the pond in which they have been taken or from the shop where they have been bought, to their new home (the aquarium), they will be found at the end of their journey to be nearly if not quite drowned. The splashing of the water in the can in which they have travelled has so thoroughly



WATER-SPIDER (*ARGYRONETA AQUATICA*) AND NEST.

saturated the hairs which cover the abdomen that they (the hairs) can no longer do their duty in connection with the respiratory organs. When a spider is found in this condition it should be placed upon some blotting-paper and under a tumbler until it is perfectly dry. As a healthy spider goes beneath the surface of the water, the latter part of its body looks as if covered with silver, owing to the air which has become entangled among the abdominal hairs.

Though these spiders can live upon land, they spend the greater portion of their time under water, where they construct most ingenious and curious homes, or nests. It is quite an interesting sight to watch one of these very intelligent creatures make its nest. First of all, it begins by weaving a web between the branches of an aquatic plant, or between a stone and one side of the vessel in which it is confined, or in

some similar position. When the web is completed, the *Argyroneta* ascends to the surface of the water, and protrudes above it the extremity of its abdomen, and, with a jerky movement, obtains a bubble of air, which it holds between the latter part of its body and its crossed hindermost legs. The spider then descends with the bubble of air, and discharges it within the web which it has woven. In this way many other bubbles of air are brought beneath the surface of the water and placed inside the web, which, after a time, owing to the accumulation of air within it, assumes the shape and often the size of a lady's thimble. In making these journeys for air, the spider climbs up and down a thread which it has stretched between the nest and the surface of the water. The journeys are long or short, according to the depth at which the *Argyroneta* constructs its nest ; for they are sometimes placed quite close to the surface of the water (an example of such a position is seen in the illustration), occasionally very near to its bottom, but more frequently midway between these two positions. In one of these subaqueous homes the *Argyroneta* spends the greater part of the winter. I have had several spiders which have remained in their nests under water for three or four months, without either moving or taking food.

When the female *Argyroneta* wishes to lay her eggs, she either enlarges her old nest or builds an entirely new one. The enlargement is effected by spinning an addition of web to its lower part, which she fills or inflates with air as soon as it is completed. The male Spider often makes a new nest for himself near to the one which his lady-love has constructed or enlarged for her eggs. The eggs are enveloped in a kind of cocoon, which is fastened to the inside of the nest. The young spiders appear, according to the temperature of the water, in about a fortnight. Almost directly they leave the nest in which they have been born, they begin to construct small homes of web and air for themselves. Water-spiders feed either upon terrestrial or aquatic animals ; and for the former they often leave the water. The *Argyronetæ* while

in confinement may be provided with house-flies, mosquito larvæ, blood-worms, tiny earthworms, etc. Their appetites, however, are very uncertain; sometimes they will eagerly seize flies which have been thrown to them, and drag them within their nests, soon to turn them out again, sucked dry of all their juices; at others times they will disregard all food, however tempting it may be. I am sorry to say that these intelligent little creatures are occasionally guilty of cannibalism. More than once I have noticed that when several of them have been confined in the same carefully-covered aquarium, their numbers have gradually diminished, until only one or two of them have been left. One sex is not more guilty than the other of this unnatural practice.

Of course, there should be no other animals associated with the *Argyronetæ* except those which are intended for their food. If the small tank which is set apart for the *Argyronetæ* is properly situated in regard to light, little or no confervæ will interfere with the clearness of either the glass or the water, and the interesting habits of these animals cannot, of course, be satisfactorily watched unless both the glass and the water are perfectly transparent. This transparency is easily maintained by judicious planting and lighting.

Argyrontæ often remain above the surface of the water, especially when first placed in an aquarium. However, after a day or two, if they are healthy, they will enter the water and begin to construct their nests. The vessels in which these animals are confined should be covered, or they will escape. When flies are not taken by the spiders after they have been upon the surface of the water for a day, they should be removed, otherwise they will pollute the water.

The reddish-coloured Fresh-water Shrimp (*Gammarus fluviatilis*) is found abundantly in watercress beds. It measures about $\frac{3}{4}$ in. long, the female of the species being slightly smaller in size. Fresh-water Shrimps are good scavengers, eating vast amounts of decaying matter, animal or vegetable. They dart about the water in a very active fashion, and are interesting to watch. The bottom of their

tank should be covered with well-washed silver sand and a few large, flat stones, under which the shrimps can hide. The females carry their eggs attached to the underparts of their bodies, and there the young also remain for some time after they are hatched. As their enemies are many, and include

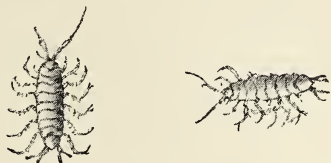


FRESH-WATER SHRIMPS (*GAMMARUS FLUVIATILIS*) (ENLARGED).

fish, water-beetles, newts and the like, Fresh-water Shrimps should have a tank to themselves, preferably planted with *Elodea canadensis* or *Callitriche verna*.

The Water-louse (*Asellus aquaticus*) closely resembles the familiar wood-louse of our rockeries and flower-beds. It has lots of legs which it uses to crawl about the mud at the bottom of ponds, streams and ditches. It does not swim. It lives, or appears to live, mainly on decaying vegetable matter.

Do not trust it, however, in a tank of spawning goldfish, for it soon makes short work of their eggs. The fish have their revenge, however, by eating the Water-louse and all its numerous offspring with the greatest of relish. Like the female fresh-water Shrimp, the female water-louse carries her eggs around with her, attached to the underpart of her body, until they hatch out, and for a short time after. *Aselli* breed prolifically in quite small aquaria with mud on the bottom, and some healthy, growing water-plants. Keep their container tightly covered, for Water-lice are adepts at climbing up the glass sides of aquaria and making their escape.



WATER-LOUSE
(*ASELLUS AQUATICUS*).

The *Daphniæ*, or Water-fleas, are diminutive creatures, a little larger than a pin's head, and called Water-fleas on account of their peculiar jumping movements in the water. They vary in colour according to what water they are in. In stagnant water they appear blood-coloured; in clear, fresh water they appear yellowish, in muddy water they look muddy-looking. All the *Daphniæ* possess five pairs of legs. The body is divided into two parts: the smallest part is the head, a portion of which is produced in front to a kind of beak, and the larger part, which consists of the thorax and abdomen, is enclosed in a shelly envelope. The female carries her eggs about with her, between her shell and the back part of her body, until they hatch out. Water-fleas are very prolific, and a single female will produce something like 300 offspring in less than six weeks!

Their food consist of tiny *Infusorians*, which may be given them in the form of old water from a not-too-clean water-butt, puddle, or small stream. *Infusoria* may be automatically produced by having a quantity of snails in their tank, and feed the snails exclusively on lettuce leaves, portions of dead worms, and scraps of raw beef or liver.

CHAPTER XI

LIVE FOODS AND ENEMIES

FISH always gain in health when they are fed occasionally on nourishing live foods. Below is a list of suitable creatures, many of which may be collected during the spring and summer by the aquarist himself, or obtained for a few pence per large portion from many of the reputable dealers in aquarium requisites.

Water-fleas (<i>Daphniæ</i>).	Mosquito-larvæ.
Frog-spawn.	Egg-rafts of mosquito.
Baby tadpoles (for large fish).	Eggs of fresh-water-snail.
Fresh-water-shrimps.	Young fresh-water-snails.
Cyclops.	Water-lice (<i>Asellus</i>).
Tiny earthworms.	Brine-shrimps (<i>Artemia</i>).
Bloodworms.	Gentles.
Whiteworms (<i>Enchytræ</i>).	Tubifex.

As well as the above, the following tiny creatures, which may be obtained in one's garden, or during a walk across grassland, are appreciated as food by most aquarium fish: baby wood-lice, tiny green caterpillars, greenfly, ants, young slugs, and tiny moths.

When feeding live foods to fish one must always bear in mind that fish do not use a knife and fork, and all food given must be small enough to be swallowed easily. Never offer as food to fish any living creature of which one is not quite sure about with regard to their habits, and character. Fish in their wild state have many enemies, and it is extremely easy to introduce some of these enemies into the aquarium,

if one is uninitiated into the secrets of successful fish-keeping. The following are a list of the more common fish enemies :

Dragon-fly larvæ.	Large tadpoles.
Fish-lice (<i>Argulids</i>).	Leeches.
Large water-beetles (<i>Dyticus</i>).	Water-scorpions.
<i>Hydra</i> (dangerous only to baby fish).	Water-boatmen.
Caddis-flies.	Large snails (destroyers of fishes' eggs).

CHAPTER XII

RECAPITULATION, ETC.

I THINK it wise in a very short chapter to recapitulate, in a rule-like form, some of the suggestions and warnings which I have given in the previous chapters to novices in aquarium matters.

1. No one should think of keeping an aquarium who does not make up his mind to bestow upon it a little daily attention. This necessary attention will involve hardly any trouble. Sometimes all that will be required will be just a glance to see that nothing is wrong. As a rule, however, there will be little to do but to supply some of the inhabitants of the tank with a small quantity of food. If the aquarium is attended to at a stated time—such as always before breakfast or before lunch—the giving of this necessary attention will become a habit, and therefore, then, is not likely to be omitted. An aquarium properly arranged and properly looked after is certain to be a source of pleasure and instruction, but if neglected, or only noticed by fits and starts, it is sure to become an eyesore and a nuisance.

2. An aquarium will run a great risk of being altogether a failure unless it be correctly proportioned; that is, the breadth of the vessel should always be greater than its depth. The strength of the tank ought to be considered before its elegance, though the latter quality should by no means be entirely disregarded.

3. An aquarium cannot do well, without a great deal of unnecessary trouble, unless it be properly situated. The sun should never be allowed to shine directly upon the water of it for more than three hours per day.

4. Unless it be very small, an aquarium should be placed, before it is filled with water, in the position in which it is intended to remain. Any attempt to remove a fairly-sized tank when full of water will be certain to do some, if not great, harm to the vessel or its contents.

5. Everything, whether gravel or sand, or water or weed, which is placed in the aquarium should be perfectly clean.

6. The aquarium ought, if possible, to be filled with water by means of one or more small siphons.

7. All aquaria, with very few exceptions (which have already been mentioned), should contain aquatic plants. These plants ought, of course, to be healthy, of the right kind, and set in the right way. *Vallisneria spiralis* is one of the best of all plants for this purpose.

8. All aquatic animals should be wisely associated. No fish ought to be allowed to molest its companions.

9. No strange fish, especially a fish purchased, should be introduced into a tank unless it has been for some time in quarantine. The introduction of an unhealthy fish is almost certain to be the cause of considerable loss.

10. Aquatic snails ought to be judiciously chosen ; that is, those univalves which feed upon *convervæ* and decaying vegetable matter should be preferred to those which eat healthy and growing plants. The Planorbes, as a rule, are the best for aquarium purposes.

11. Carnivorous beetles, newts, frogs, terrapins and toads should never be kept in the same vessel with fish.

12. No fish should be expected to live without food ; nor ought fish to be tempted to prey upon each other through lack of a sufficiency of food.

13. The different foods should be kept conveniently near the aquarium or aquaria : the animals will then run less risk of being starved.

14. No discarded food ought to be left in the tank. If allowed to remain, it will be certain to corrupt the water, and so considerably interfere with the welfare of the whole of the inmates of the aquarium.

15. All garden-worms should be killed by dashing them hard on the ground before they are given to carnivorous fish or other carnivorous animals. It is neither a pleasant nor a profitable sight to see a worm struggling with its captor, even if the creature suffers no pain. Worms should also be dipped in water before they are placed in the aquarium: they will not then be the cause of the introduction of impurities into the tank.

16. A dead animal or plant or any decaying matter should at once, upon discovery, be removed from the aquarium. A small glass tube is very useful for obtaining certain things from the bottom of the water. The tube should be about $\frac{1}{2}$ in. in diameter and a few inches longer than the water in the tank is deep. It ought to be cut perfectly square at both ends. Almost everything which is small enough to enter the tube may be removed by it from the bottom of the aquarium. The tube is used in the following way: One end of the tube is hermetically closed by means of a finger, the other end is placed over the object required, the finger is then suddenly removed from the upper end of the tube, and the object desired shoots up immediately into the tube; and if the finger be returned to its former position, and kept carefully there, so that no air can enter the tube, the object now contained within the pipe may be readily removed from the aquarium. This operation is very simple, and may be easily and quickly performed. The tube should be kept conveniently near the aquarium.

17. Every aquarium should be covered with glass in such a way that the necessary air may be able to come in contact with the water, that none of the inhabitants of the tank can escape, and that no dust can fall upon the surface of the water. This rule must be rigorously adhered to when dealing with "tropicals."

18. No aquarium is likely to do well unless the representatives of the vegetable and animal world which it contains are properly balanced; that is to say, that there is a sufficiency of oxygen-yielding weed. This balance may be known by

the growth of the plants, by the health of the animals, and the brightness of the water.

19. The water of a properly-balanced aquarium need never be changed—except, of course, under the special circumstances which have already been referred to. A little water must be added occasionally to make up for the loss by evaporation.

20. Fish should never be crowded together in an aquarium. It is always wiser to have too few fish than too many. When fish are swimming with their heads close to the surface of the water, it may be taken for granted that there are too many in the tank, or that the temperature of the water is higher than it should be. Under these circumstances, some of the fish should be at once removed, or one of the artificial means of aeration previously described should be resorted to, or some method of reducing the state of the water to its proper temperature should be employed.

21. Directly a fish is seen suffering from the dreaded fungus, it should be removed from the aquarium. If a cure is wished for, the sufferer should be placed (as already described) in running water, or in water in which chloride of sodium has been dissolved, in the proportion of a tablespoonful of the salt to half a gallon of water. A fish should be kept in this solution until it turns upon its back, when it ought to be at once placed in fresh water. This operation should be repeated once or twice every day until a cure is effected. A beetle might be kept in the solution for at least half a minute.

22. All the animals and plants which can be kept in an aquarium are interesting and instructive; some, no doubt, more so than others. Nothing, however, should be discarded as useless or uninteresting, for everything has a duty to perform in the world.

23. All who keep aquaria should be on their guard against giving the animals which they may contain any suffering, but should, instead, learn to have the same consideration for their feelings (whether they be sensitive or not) that a reason-

able and properly-disposed person is expected to have for those of his fellow-creatures.

24. *Conferva*, when tenacious, may be easily removed from the glass of a tank by means of a pad of thick brown paper dipped in salt, or by gently rubbing the glass with the finest "glass-paper." The latter may be used while the tank contains water.

25. When it is necessary to fill an aquarium with water, and no small siphon is at hand, the water may be kept clear by spreading a thick piece of paper over the gravel and planted weeds, and pouring it (the water) into the aquarium through the fine rose of a watering-can. After the filling of the tank, the paper can be easily removed without disturbing either the plants or water.

26. The pleasure of keeping an aquarium is very much enhanced if the person who owns it has some definite object in view, e.g. the thorough investigation of the life-history of some particular plants or animals. There is very, very much still to be learnt in this direction.

The series of chapters which it has given me so much pleasure to write, is now completed, and I venture to express the hope that what I have said in them will be of such use to novices in aquarium matters as to save them from some failure and disappointment, and not a few aquatic animals from unnecessary suffering.

I here repeat, that a properly arranged aquarium which is well cared for is always ornamental, interesting, instructive, and, in a sense, elevating.

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