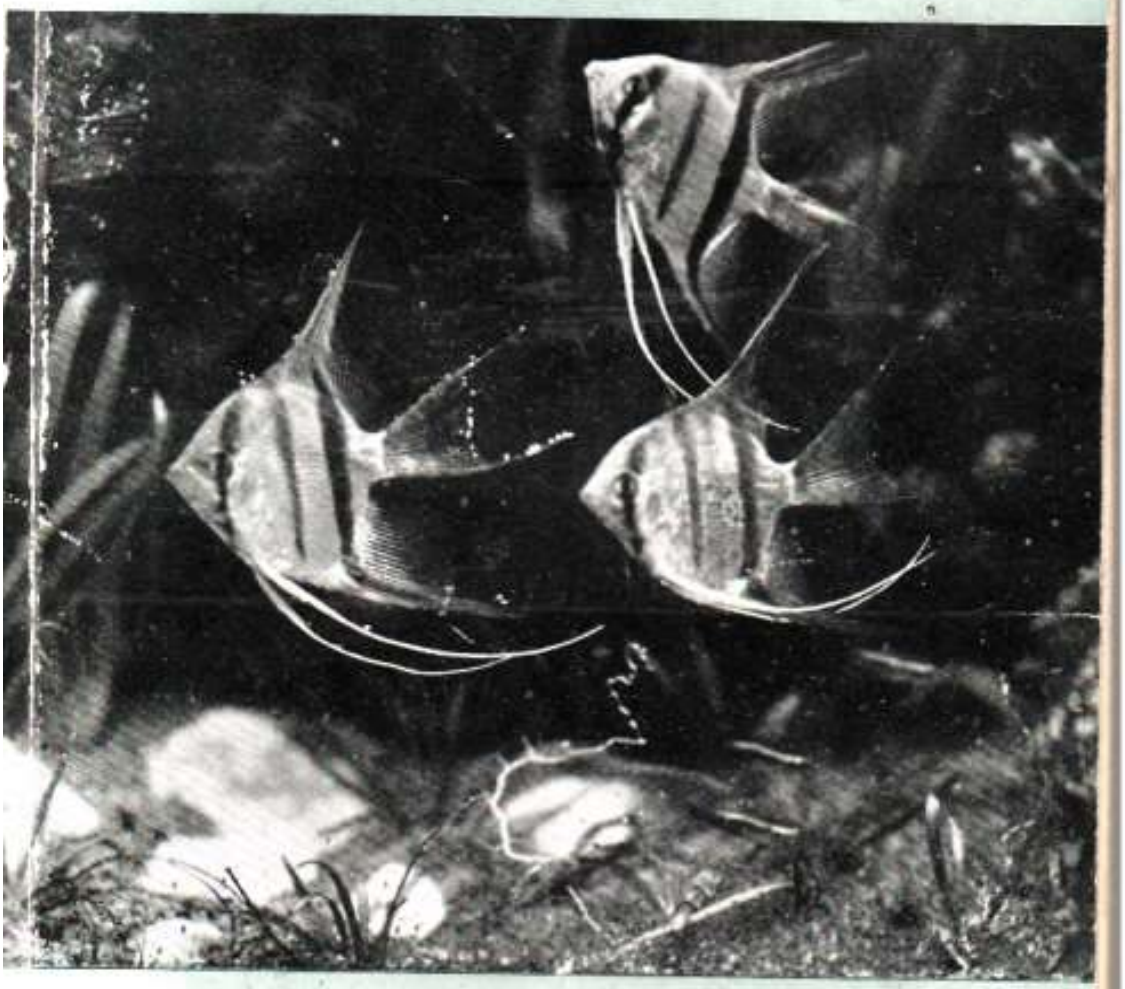
AQUARIUMS

Anthony Evans



Foyles Handbooks

AQUARIUMS

BY

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PREFACE

It is over a hundred years since aquarium-keeping as we know it to-day became popular in Britain. A lot has been learnt and a lot has been un-learnt during this time, and particularly since the second World War fish-keeping has blossomed into a home hobby the extent of which could scarcely have been foreseen by its first adherents.

To assume that everything about aquarium-keeping is now known would be wrong. Some issues remain controversial; plenty needs yet to be discovered. The hobby is one that offers amateurs a chance to make contributions to knowledge of aquatic creatures and remains a fascinating pastime for those who wish only to occupy their leisure time pleasurably.

People are often surprised at the ramifications of aquarium-keeping. If studied seriously its interests involve a knowledge of the exact as well as the biological sciences. Even beginners, for whom this book is written, soon find themselves asking questions directed to these fields. It would be presumptuous for a single author to pose as an authority on all the interests of aquaria, and it will never be possible to compress into one small book a complete account of the subject. So although many of the questions, which, from my experience as Editor of a monthly journal, I know to interest fish-keepers are covered in the following pages, I hope that all the answers will not be sought for in one book.

JULY, 1951. ANTHONY EVANS.

CHAPTER 1

INTRODUCTION

Life is believed to have first evidenced itself in an aqueous medium. It is certainly true that water has properties shared by no other liquid and that without it few forms of life can exist. For totally aquatic animals such as fishes, a group numerically greater than any other class of the vertebrates, water dominates their existence, just as it dominates three-quarters of the world's surface.

It is tempting to view an aquarium as a microcosm of this aquatic world, but the more closely water life is studied the greater is it realized that the aquarium is more akin to a comfortable cage than a miniature world on its own. With this in mind, something about the needs of its occupants obviously requires to be learnt by their keeper.

The Way Fishes Breathe

Though submerged, fishes require air, or rather oxygen. This gas, prime mover of the respiratory and metabolic processes that are the evidence of life itself, dissolves in water from the air, and the gills of a fish provide the means for passing oxygen from the water into its blood for circulation round the body. Gills are a fish's lungs, but in an aquarium the animal is acutely dependent on another 'lung'—the water surface.

Fish gills are also the exit for the waste product of respiration—carbon dioxide (another gas) from body tissues. But gills can only pass the gas into the water; if its concentration increases there, it also accumulates within the fish, to poison by its toxic nature and asphyxiate by the limiting action its presence has on the uptake of oxygen by the blood. The aquarium water surface lung is the chief means by which this poisonous gas is prevented from concentrating.

If the surface is too small for the volume of water and number of fishes below it, it cannot function as an efficient lung in obtaining oxygen and ridding carbon dioxide for the aquarium. It is obvious from this that shallow water presenting a large surface to the air will be a main feature of the satisfactory

aquarium, and that a strict limitation to the number of oxygen demanders and carbon dioxide producers within it exists.

TABLE I.

SUITABLE SIZES FOR AQUARIA

Aquarium Dimensions (ins.)	Capacity (galls.)	Surface Area (sq. ins.)
8 by 6 by 6	1	48
12 by 6 by 6	1½	72
14 by 8 by 8	3	112
18 by 10 by 10	6	180
24 by 12 by 15	15	288
30 by 12 by 15	20	360
36 by 15 by 15	30	540
48 by 15 by 15	40	720

Functions of Water Plants

Water plants are also carbon dioxide producers; they consume oxygen too, just as do the fishes. Fortunately, all the time that light is available their feeding process demands in addition that carbon dioxide be absorbed by their leaves, and results in oxygen production. This process then masks the reverse process that is still, nevertheless in progress. Plants also take from the water nitrogen-containing matter that has been excreted by the fishes and build it up into their tissues, so their presence is most desirable as water purifiers for the aquarium.

Unseen scavengers occur in aquarium water: these are the microscopic organisms including the primitive forms called bacteria. Their existence is never suspected unless the water becomes so charged with organic matter they use as food that they can increase in numbers enormously, making the water appear cloudy and, incidentally, robbing it of its oxygen. Without them, however, the excreta of fishes could not be changed to innocuous matter able to be assimilated by plants, and then a further toxic factor would be present.

As can be seen, our fish 'cage' helps to keep itself clean and if the fish-keeper does not by malpractice strain the cleaning mechanism, few troubles occur; how to avoid inviting them is the object of advice and directions given in the rest of this handbook.

Scientific Nomenclature

Popular names for animals and plants are unreliable and give no indication of relationships existing between similar groups. Zoologists accordingly use a special system of naming which employs Latin and Greek derived names to make it international. Some of the names are tongue-twisters at first, but how they are pronounced is not very important for aquarium owners.

Some familiarity with them is necessary because many fishes lack common names and because they are widely used in literature on fishes. The names are not just 'high-falutin' ' but are really helpful. What Tom may call a 'beacon,' Dick may call a 'head-and-tail-light' fish, but Tom, Dick and Henri as well, if he is a fish-keeper, will know the same fish as *Hemigrammus ocellifer*.

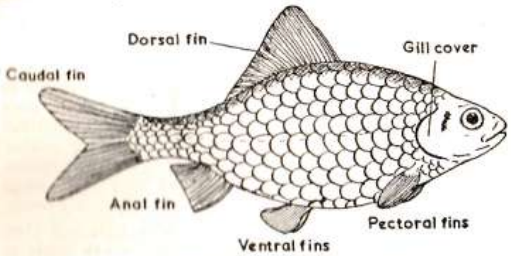

Fig. 1. Names given to the fins of a fish.

Scientific names, by convention, should always be printed as this example, in italic type. They mostly have only two parts: 1, the name of the genus (generic name, e.g. *Hemigrammus*) printed with a capital, and which is shared by a number of similar fishes; 2, the trivial name (e.g. *ocellifer*) which is printed without a capital and is bestowed on only one kind of fish within the genus. Thus, in the genus *Hemigrammus* there are numerous species—*Hemigrammus ocellifer*, *Hemigrammus caudovittatus*, *Hemigrammus pulcher*, and so on. The same trivial or second part of a scientific name may be used again for a fish of another genus to form its binominal specific or species name, but never given to another fish in the

CHAPTER II

FISH-KEEPING EQUIPMENT

In considering the various containers suitable for indoor fish-keeping the well-known glass 'goldfish bowl' will be ignored. It can be of use to the aquarist, but it is not satisfactory as a regular home for fishes.

Rectangular all-glass aquaria are cheap and useful, but their disadvantage is that any rough treatment will crack them, and they are irreparable. The metal-framed glazed aquaria or 'tanks' are more robust and are used universally; angle-iron or sheet zinc are metals commonly employed in the structure of these types.

Size of Aquarium

A bewildering array of tank sizes confronts the beginner in the dealers' shops. He should not think that the smaller ones are meant for him, and leave the larger ones for more ambitious aquarists. Each size of tank has a special use, and the smaller ones are not suited to the beginner but are of greatest application in ancillary activities to fish-keeping such as breeding small fishes, growing young plants and culturing living foods.

Recommended size is one 24in. long, 12in. wide and 15in. deep, which costs a little over two pounds to buy made in angle iron, with a range of finishes and colours to choose from. This size can form an attractive decorative addition to a living-room and may be used to house a group of small mixed tropical fishes—as a 'community tank,' or used as a coldwater aquarium for a smaller number of the bigger sized fishes that are commonly kept.

For most tropical fishes the 24in. aquarium also makes a good breeding and fry-rearing tank, and it is a convenient size for the aquarist planning to have a large collection of aquaria, or for one who is designing a fish house. Special sizes to fit room alcoves and recesses are made to order by some firms, but in making plans for these the introductory remarks on surface area and volume of water should be recalled.

Selecting a Tank

Here are some points to look for when buying a new aquarium:—

1. The frame corners should be square and the welded joints finished off smoothly, particularly at the top and bottom strips.
2. When placed on a flat surface the tank should not rock.
3. The glass used should be of adequate thickness for the tank's dimensions. (See Table II, page 15). It should also be perfect and free from optical defects.
4. Slate is the preferred material for the base, but it is rarely obtainable these days. If glass is used in this position it should be at least ¼in. plate and preferably one of the wire reinforced glasses.
5. Glazing cement should be soft to touch in the areas visible outside the tank and there should be no great amounts of it exposed inside. Cements that dry out hard are liable to crack and cause leaks; they do not treat the glass so kindly as the soft and resilient cements should the tank receive a knock.
6. Although a new tank is not expected to leak, this often happens. In moving it about the cement seal is displaced and seepage of water occurs at the edges. Very bad leaks merit return of the tank to the dealer. Where oozing occurs the aquarium should be filled with water into which garden soil has been stirred, and left for a few days, when such small leaks will seal themselves.

Aquarium-making

Although some fish-keepers may be in a position to weld their own angle-iron frames or to solder zinc frames for aquaria, these techniques cannot be described here. Ready welded iron frames are on the market, however, or may be made at low cost to order in local garages, etc.; anyone willing to undertake his own glazing and painting will find that this considerably cheapens initial outlay. Amateur carpenters can also make aquarium frames from hard woods; very attractive aquaria may be constructed from oak, for example.

Preparing Metal Frames

Preparation of the frames is a matter of some importance. Firstly, free it from rust with a hard wire brush and rub it

with emery cloth; then apply two coats of aluminium paint. An undercoat is next necessary: use a good flat paint and allow it to dry off thoroughly before applying two coats of an enamel paint of the colour chosen for the finish. With such treatment, giving particular attention to the top bars of the frames, a good life for the tank will be assured.

Aquarium Glass

Glass may be obtained and cut to size during the week that should be set aside for the paint to dry off hard. Secondhand pieces of glass can frequently be bought at low cost from builders' yards and scrap dealers; for a small charge local glaziers will cut out pieces of the sizes required. When measuring frames for the glass, check all dimensions to make certain that if the frame is slightly out of true the glass will also be cut out of square to fit. A useful way of ensuring a fit is to take sheets of cardboard that have been cut to fit the frame, along to the glass-cutter together with the glass.

For the base, which will be placed in position first, use ¼in. wired plate for 24in. by 12in. tanks, and cut it to fit into the bottom angles with about ⅛in. space all round. 42oz. sheet glass can be used for the front, back and end panels of a tank of this size (a table on this page shows suitable thicknesses of glass for different sized aquaria). The front and back panels will be the next to be positioned. Their lengths will be the same as that of the base glass, but to allow for the thickness of the base and the cement layers above and below they must be about ⅝in. less than the internal frame height. Similarly, the end panels, fitted last, will be the same height as the front and back pieces of glass, but will need to be about an inch (depending on the actual glass thickness used) shorter than the internal width of the aquarium frame. Thus, for a 24in. by 12in. by 15in. tank the following glass sizes give typical allowances:—

Base: ¼in. wired plate, 23⅛in. by 11⅛in.
Front and back: 42oz. sheet, two pieces 23⅛in. by 14⅛in.
Ends: 32oz. sheet, two pieces 11in. by 14⅛in.

If crinkly, patterned or opaque glass is readily available this can be used for the back panel without detriment to the appearance of the furnished aquarium. While measurements and cutting operations are in hand it is useful to have one or

TABLE II

SIZES OF GLASS FOR GLAZING AQUARIA

Depth Inches	Length Inches 10	12	18	24	30	36	48	60	72
10	15oz.	21oz.	26oz.	32oz.					
12	15oz.	26oz.	26oz.	32oz.					
15	—	—	32oz.	32oz.	32oz.				
18	—	—	42oz.	42oz.	42oz.	42oz.			
24	—	—	—	42oz.	42oz.	42oz.	42oz.	42oz.	42oz.
30	—	—	—	—	42oz.	42oz.	42oz.	42oz.	42oz.
36	—	—	—	—	—	42oz.	42oz.	42oz.	42oz.

TYPES OF GLASS—
Drawn clear sheet 15oz.—32oz. (⅛in.—5/32in. thick)
Heavy drawn 42oz.; ¾lb. (plate substitute, ⅜in.; ½in. thick)
Polished plate ¼in. to ½in.
Toughened plate ¼in. to ¾in. (five times stronger than plate)
Wired polished or figured plate ¼in. to ¼in. (for aquarium base)
Fractions in table indicate plate glass. ½t: Toughened plate.

two pieces of picture glass cut to fit across the inside of the finished tank; these will be found applicable later on as dividing pieces to facilitate breeding and isolation of fishes.

Aquarium Cements

Chief requirements of a good glazing material for aquarium use are: 1, It should adhere well to the glass and painted iron frame; 2, It must be soft enough to work with and should not set off hard and dry; 3, It must repel water, be inert to it and must also be non-poisonous to fish and plant life. Ideally a cement is not the first line of defence against leakage, for the area of it exposed to water in tanks with the glass cut as recommended in the previous section should be very small; its true function is to form a resilient bed for the glass when this is pushed against it by the water pressure.

There are several ready-mixed proprietary cements on the market which meet these requirements. Ordinary whiting putty is a useful preparation but is not as durable as the following old and well-tried formula:—2 parts (by weight) whiting putty, 1 part red lead, 1 part white lead, intimately mixed with gold size to a workable consistency. The mix must be kept clean, uniform in composition, and used soon after making. A 24in. by 12in. by 15in. tank takes about 2½lb. of cement to glaze it.

Glazing the Aquarium

The order in which the pieces of glass are positioned in the frame has been given. A putty knife is used to spread the cement in the frame angles in a layer about a quarter of an inch in thickness. Make the layer even and smooth, avoiding pockets of air. The glass is pressed firmly and evenly into the cement with the hands and excess cement that extrudes around the edges is trimmed off with the knife. Clean the glass as the work proceeds, using soft rag or newspaper, and see that in all cases there is good contact between glass and cement. Weights are then placed on the base glass from the inside, and cross struts of wood are arranged to keep the front, back and end panels pressed home. The aquarium is then left for three days, during which time a further coat of glossy paint can be given to the exterior. The wooden struts are removed, the tank filled with water and allowed to soak for 24 hours, when after a final cleaning of the glass it is ready for use.

Plastic Aquaria

Sheets of polished Perspex can be used to make small aquaria up to 18in. in length. No frame is used for such tanks—the pieces of Perspex may be grooved and cemented together with Perspex cement (Perspex cuttings dissolved in chloroform) or if cut square they can be cemented edge to edge and the corners reinforced with small blocks of Perspex. This cement should be left for a few days to dry out completely, and the tank is ready for use. Disadvantage of Perspex for aquaria is the ease with which it is scratched when cleaning, but it is quite unbreakable and leak-proof.

Supporting the Tank

The 24in. long aquarium stocked with water, sand and rocks can weigh as much as 1½cwt., so a firm, strong stand is needed for it to rest on. The angle iron types offered for sale are good, and they can be painted with the aquarium frame to match room furnishings and even 'grained' like adjacent furniture. Strong home-made wooden stands can be made so that the space beneath the tank is utilized—for book-shelves, for example. Aquarium stands must be quite level, or the aquarium frame may be strained, and placed where they will not receive shocks. With metal stands it is advisable to place small wooden or hard rubber or lino blocks beneath the feet to prevent damage to flooring or to floor covering. Iron brackets projecting from the wall are the steadiest means of supporting large tanks; vibration, which can be responsible for cracked glass panels, is eliminated in this way.

Aquarium Cover

The top of the aquarium should be covered with a loose sheet of glass serving to keep out dust and reduce water evaporation. With tropical aquaria, covers also prevent surface chilling. Many fishes are liable to leap from the water if suddenly frightened, and the cover ensures that they do not then leave the tank altogether.

With iron frames, rusting may occur in time along the top bars where the cover makes contact, since condensed water vapour collects in this region. To overcome this, rubber tubing may be slit along its length and slipped over the edge of the iron to form a cushioning and water-returning surface. Another method is to arrange the glass cover so that it slopes, returning the water directly into the tank. A neat way of

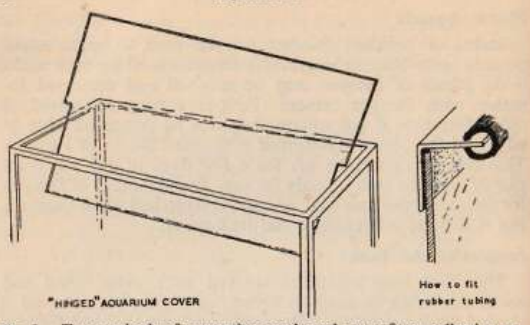

Fig. 2. Two methods of preventing condensed water from collecting on the aquarium frame.

doing this is to cut the glass to form 'lugs' of half its width which 'hinge' on the aquarium frame.

To facilitate feeding and access to the tank a cover may be made in two parts, or a corner cut from it and the loose piece placed in position separately. Cut slots in tropical aquarium cover glasses to allow entry of heater lead. With the cover, and above it, may be incorporated a hood or lamp housing to permit artificial lighting of the tank from the top.

Light is Essential

Healthy growth of water plants is a requirement of successful aquarium-keeping, and to obtain this, light must reach the tank. It must come from the top: strong side lighting is detrimental to the fishes, for in nature the light source is always above the water. In addition, side illumination causes plants to grow across the tank instead of upwards.

Daylight is undoubtedly the best lighting for aquaria. Unfortunately its variation in intensity cannot be controlled; in summer it may be too strong, encouraging the unsightly growth of primitive green plant forms (*algae*) on the aquarium glass and plants, and in winter in Britain it is certainly insufficiently strong for indoor tanks. Rarely is it possible to place these near a window (and frequently inadvisable to do so, since tropical tanks suffer great heat losses in a window position) so that some artificial lighting must be used. Ordinary electric lamps are quite satisfactory and can be mounted above the tank in one of the reflector shades sold especially for the purpose, or it is a simple matter to make a lighting hood to one's own design. The lamps are required close to the water's surface. Strip light bulbs are expensive but provide a more even illumination, and recently fluorescent light units have been introduced for aquarium use. These give the tank an attractive look; the 'warm tint' fluorescent tubes are best for plants.

For a 24in. aquarium, two 40 watt lamps burning for about eight hours each day will suffice. If the aquarium receives some daylight, this period may be reduced; on dark days it may need to be increased. Sweet's formula is one guide to the wattage (W) required for a chosen number of hours when no daylight at all is admitted. Where L: length of tank in inches, H: number of hours of lighting—

$$W = \frac{L \times 32}{H}$$

A 'dimming' device for aquarium lamps is useful. Light intensity in the aquarium can then be changed gradually when turning on or turning off, preventing shock to fishes. A variable resistance in the lighting circuit is required for this. Overhead lamps also supply heat. In tropical tanks this may be an asset, but with coldwater fishes care should be taken to see that overheating of the water from this source does not cause them discomfort.

Heating Tropical Tanks

For tropical fish tanks the water temperature needs to be about 75°F. Taking the average room temperature as 60°F. it will be seen that the amount of heat necessary to raise the water to the required level is not great, and as gentle fluctuations of 10° above and below 75°F. are tolerated by most fishes, *provided they take place slowly*, heating the tank is not a difficult matter. For home aquaria heating will have to be supplied in one of the following ways:—1, by the use of electricity; 2, by the use of gas; 3, by oil burners.

Electricity is probably the most reliable and least troublesome means of heating. Immersion heaters that can be placed in the water are on sale with a range of wattages for various

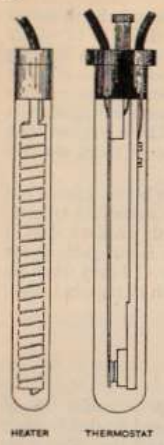

Fig. 3. Typical electric immersion heater and thermostat for aquarium use.

sizes of tanks. These heaters should be inclined in the aquarium or buried in the sand, and not placed vertically. One rated 60 watts will suffice for a 24in. tank kept in a living room that is heated in winter. For a larger tank two heaters should be used, one at each end, to distribute the heat evenly. Since 2.5 watts raise one gallon of water 10°F. an approximate guide to the number of watts required at a selected temperature is given by the following calculation:—

$$\text{Wattage required} = \frac{(\text{Reqd. tank temperature} - \text{Room temperature}) \times \text{Tank Capacity in galls.} \times 2.5}{10}$$

Economical use of electricity is assured by installing a thermostat in the aquarium. This will switch the heater on and off automatically, so that any desired temperature can be maintained; a heater of greater wattage can then be used with safety. Reliable thermostats are on sale at aquarium shops for about thirty shillings, and immersion heaters cost half this amount. A simple method of heating a tank is to

mount it on an open wooden box of the same length and width in which are fixed two lamp-holders, each carrying a 60 watt lamp (for the 24in. aquarium). A door in front of the box allows the lamps to be inspected and replaced when necessary. Those with some ingenuity in electrical matters will see that an even more satisfactory method is to mount heating elements in such a box to provide this 'base heating.'

Base heating is the only way in which gas and oil burners can be employed. Glass bottomed tanks are supported on asbestos sheets beneath which are the small flames of the burners. Gas is probably the least expensive form of heating where numbers of aquaria are kept. Although thermostats for gas can be fitted it is a simple matter to adjust the size of the gas or oil flames by experiment to give the desired water temperature. Gas jets (two in number for the 24in. tank) should be of porcelain to obviate the corrosion that occurs from water condensation when metal jets are used. Good ventilation is essential, but draughts must be excluded from the flames beneath the aquarium, and no inflammable materials should be in the vicinity. For paraffin oil burner heating, the lamps best used are those having oil reservoirs of sufficient capacity to keep them going without giving the aquarium owner too much work in re-filling.

Economy in fuel used to heat tanks in winter can be achieved by 'lagging' the back and ends of an aquarium (*and* the base and top of some). Easily removable wooden frames are clipped to the tank to retain against the glass flat bags stuffed with glass wool, cork powder or 'flock.' Power cuts or heating failures are less to be feared with the lagging in position.

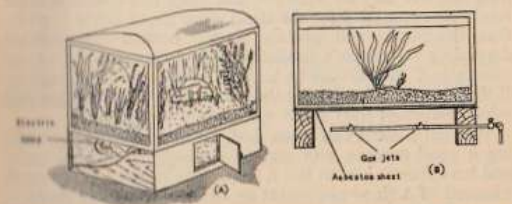

Fig. 4. (A) A simple way of base-heating by electricity. (B) Gas jets beneath the tropical aquarium.

Electrical Equipment

All electric wiring near the aquarium should be of the plastic or rubber-covered variety. Sockets, switches and wire junctions are best removed from where water may reach them. One switch to control overhead lighting and another for the tropical aquarium heating circuit are fitted: double-pole switches are safest.

Glass tube thermostats are of two types—the completely submersible and the type that is only partly immersed in water. If water enters them failure occurs. Another type fits externally to the aquarium with its metal surface in contact with the glass. Thermostats are really switches, and are connected in series and not in parallel as are heaters and lamp-holders. Properly they should be wired on the live lead of the mains supply (this is red-covered and can be identified with a neon tester).

Adjustment of new thermostats to obtain the right setting for keeping tank temperature near a chosen level is a delicate business. Give the control knob a slight turn and allow two hours for the effect to be shown by the aquarium thermometer before altering again if necessary.

A useful check on thermostat function (and power cuts) is to wire in parallel with the heaters a lamp-holder to take a 250 volt 0.5 watt neon lamp; these lamps consume very little current. If the neon lamp keeps going on and off all is well; if it stays on or off for a long time this indicates breakdown of the thermostat and action to repair or replace it should be taken.

For large tanks two heaters are advisable; heaters have a long life, but they do burn out and when two are present (of total wattage needed for the tank) a margin of safety is given. One thermostat will operate several heaters (the number depending on maker's limitations) in different tanks of the same size if they are all to be kept at the same temperature. If the tanks vary in size put the thermostat in the smallest and select heaters of the correct wattage for the others.

Tropical aquaria can be earthed, for perfect safety, by making a good contact with metal (not copper) between water and tank frame: join to this a single lead running to the earth terminal of a three-pin socket or to a safe earthing point.

A 24in. indoor aquarium kept at 75°F. takes about eight units of electricity a week to heat it, and about 14 units a week

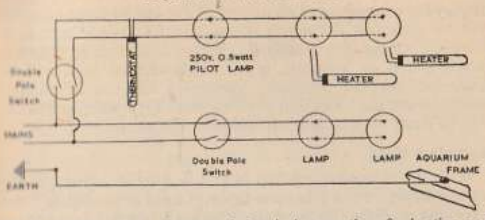

Fig. 5. Simple circuit diagram of electrical connections for heating and lighting a tropical aquarium.

total if illuminated in addition, as advised in this chapter. Consumption of electricity is less in summer.

As an emergency expedient during power failures or prolonged 'cuts' the temperature of a small aquarium can be maintained by floating in it a jar or can containing hot water.

CHAPTER III

AQUARIUM MANAGEMENT

BEFORE preparing and stocking the aquarium a firm support for it must be placed in the site chosen for its permanent position. A site away from coal or gas fires and stoves, protected from draughts, and not where the full summer glare from a window can reach the water is desirable. Coldwater aquaria should not be placed in rooms that suffer extremes of heat or cold.

Setting up Aquaria

Both coldwater and tropical aquaria need light for plant growth to occur but by using overhead electric lighting they need not be confined to the immediate vicinity of windows—seldom ideal positions for tanks. Tropical aquaria in particular can be used to brighten up a dark corner or alcove in the home when artificial lighting is supplied for them in the way recommended in Chapter II.

How the interior of the aquarium is to be set up depends on the purpose for which it is to be used. Breeding tanks are not set up in the same way as tanks used for making a decorative

display for example, and an aquarium for eels or large cichlids, will be arranged differently from one for dainty tropicals. Here the set-up of a purely decorative aquarium in which a mixed group or 'community' of fishes can be kept will be discussed, for the principles governing the use of various materials are the same and the treatment for specialized tanks will be dealt with in appropriate later chapters.

Aquarium Sand

With the cleaned aquarium in position on its stand, setting up can begin. First a bottom layer of sand is needed to form a rooting medium for the water plants. Some fish-keepers use a layer of sand above a layer of leaf-mould, garden soil or peat, the function of such a compost being to provide for the nutrition of the plants. It is indisputable that such media encourage a more luxuriant plant growth, but they also prolong settling down and sometimes are a cause of trouble when used by beginners.

When sand alone is used the water keeps clearer on first setting-up and although the plants seem to stand still for a while this is only until the organic matter from fishes' excreta has changed to provide for their growth. Bottom layers containing organic compost should not be placed in tropical tanks heated from the base and immersion heaters must not be buried in such layers.

A suitable sand for aquarium use is the coarse variety from builders' yards. Fine sands—less than double pinhead sized grains, are best avoided for they become easily disturbed at the surface, clouding the water, and too compact below for plant rooting. Small shingle is ordinarily of no use as a bottom layer; aquarium detritus falls into it and cannot be seen or removed before the water becomes polluted. All sands require thorough washing by mixing in a bucket placed under a running tap until a sample removed and shaken with water in a jar leaves the water clear and colourless.

Layer the sand in the aquarium so that it is at least two inches deep at the ends and back, sloping to about an inch at the front. Waste matter will then tend to gravitate to the front glass and may easily be removed from the sand at this point.

Rockwork

Before adding water to the aquarium, and before setting the water plants in position, rockwork may be placed. Rocks

make an additional contrast to sand and plants and are used by some fishes as spawning surfaces. Each piece of rock in a tank robs the fishes of some swimming space however, so do not overdo this furnishing.

Water-worn natural stones collected from stream or river bed give the best appearance and are free from sharp edges on which fishes can injure their scales. With practice, attractive 'rocks' can be made from coke coated with a 3 : 1 sand-cement mixture, but these must be soaked in water, to remove free lime arising from the cement, before use.

Crystalline formations such as white spar, calc spar, gypsum, marble, alabaster or limestone rocks should not be included in the aquarium for they slowly dissolve in the water, making it hard and alkaline. Pieces of metal-bearing ores are similarly best avoided; scrubbed coal or smooth slate can form unusual aquarium features, and layered pieces of 'crazy paving' will make a pleasing shelving background for larger aquaria.

Westmorland waterworn stone, all shades of grey, with dark stratum lines, is one of the finest natural stones for aquarium use. Others are the granites, obtainable in red, blue, green variegated colours; the red white-veined Mendip Mountain rock; the grey and red sandstones; Devon black rock (which bears white veins) and Somerset stones. Pumice stone and quartz have also been used in aquaria.

Positioning the rocks is a matter for trial and error to obtain a pleasing effect, for their disposition will depend on their shape and size. Keep them away from the exact centre of the tank; place them more towards the back, arranging them in broken lines with the larger ones slightly forward. Rocks which bear natural stratum lines should be arranged so that these bear some relationship to one another and so that they are disposed near-horizontally. Bury the bases of the rocks—those placed across corners can be used to retain a bank of sand; avoid forming cracks or interstices in which a dead snail or fish can decay without being seen. Small chips of the same rock may be scattered over the sand with effect, particularly if the colours of rock and sand are pleasantly contrasting.

In aquaria receiving light from the top an attractive feature can be made in the following way; assemble with rocks an open cave facing the front glass and roof it with a piece of red or dark green glass, hiding this from view at the front with rock. The interior of the cave will appear suffused with

coloured light from the glass, creating a picturesque effect.
Rockwork may also be built up and cemented inside a wooden frame the same size as the back of the aquarium, behind which it is to be placed to give the impression from the front that the small aquarium is wider than it is.

Aquarium Water

What is the best source of water for an aquarium ? Some account must be taken of the requirements of individual fish and plant species in answering such a question, since some prefer water of high salt content and others like nearly salt-free water ('salt' here being used in its chemical sense, representing several mineral compounds and not only sodium chloride or table salt). For our tank of mixed species however, the water supplied from the domestic main is usually adequate. Although tap water contains some chlorine it is not usually enough to harm fishes, and most of it escapes as the aquarium is filled.

Rain water collected away from towns is very nearly salt free. Its contaminants do not produce 'hardness'—a condition met with in varying degree in natural waters only when salts of magnesium and calcium are present after the rain has percolated through surface soil. In general, soft waters are to be preferred to hard ones for aquarium use, but do not use water that has passed through a water-softener. Some tap waters of alkaline nature lose their hardness on boiling. Others can only be 'softened' for the aquarium by diluting them with clean rain water or distilled water. Water from natural ponds may be used for aquaria, but it is best boiled first to kill any unwanted forms of life it may have.

The reaction of water, i.e. its degree of acidity or alkalinity, related to its solid and gaseous content, is a factor about which it is best not to bother when commencing fish-keeping. Absolutely pure water free from dissolved gases and solids is 'neutral'; its acid (H) and alkaline (OH) components balance one another. Disturbance of this balance such as occurs when carbon dioxide from the air dissolves in pure water causes the water to become acid (H component in excess). A scale of numbers used by the chemist to express the degree of acidity is the pH scale. Acid waters have numbers below pH 7.0, alkaline waters numbers above this figure. pH can be measured by placing a drop of the aquarium water on special test papers sold in comparator booklets. Change in colour of the paper is

matched with a colour panel relating colours to pH figures, thus giving the value required to be known.

Water is added to the aquarium before planting. It is easier to compose the picture by setting plants in an over half-filled aquarium. If the water is siphoned slowly from a bucket through a tube directed on to brown paper placed over the sand and rocks already in position disturbance will not occur; the paper is removed once they are covered with water.

Planting the Tank

In the next chapter suitable plants for tropical and cold-water aquaria are listed. Some of these are planted in the sand as cuttings; others require to be planted as rooted stems. For both types of plants the possession of a pair of planting sticks will be a useful aid to planting. Planting sticks can be made from strips of wood about eighteen inches long, each having a smooth U-shaped notch cut in one end. Aluminium rods of similar pattern can be bought. Plants or cuttings are grasped between the notches of the two sticks, pushed into the water and pressed into the sand. Then, with one stick holding down the plant the other is used to dispose the roots evenly and cover them with sand until the plant is set firmly in place.

Cuttings are best planted in bunches of four or five stems tied together round their lower ends with thread or loosely secured with lead wire in the same way to stop them floating. Their cut ends are pushed into the sand, and roots form which anchor the plants after a few weeks. Bunch together cuttings of the same kind of plant, and group all plants of one species and similar sizes together in the aquarium, without overcrowding them. Rooted plants are also set in groups in this way but are planted one at a time. Plant the tropical species in warm water—growth is retarded if they become chilled.

With regard to types of plants that can be included in any tank it is necessary to point out that just as garden plants are spaced according to their likes for light or shade, dry or wet spots and according to their growth habit, so do aquarium plants show varied requirements and need to be given similar consideration. It is not possible to grow together all varieties in one aquarium with equal success; some water plants thrive in subdued light (e.g. *Fontinalis, Cryptocoryne*), others require strong top-lighting to encourage their growth (e.g. Indian fern, *Myriophyllum*), and in natural waters the dispersal of species is very wide. Three or four species that will live in harmony

TROPICAL

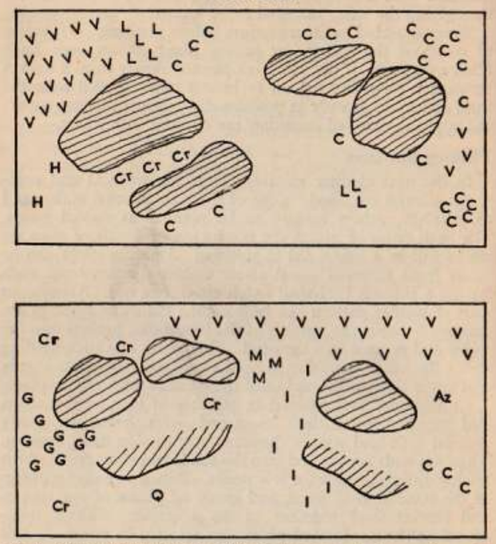

Fig. 6. Two suggested ways of furnishing a tropical aquarium with rocks and water plants (plan view)—Az : Amazon sword plant ; C : Cabomba ; Cr : Cryptocoryne ; G : Hygrophila ; H : Herpestis ; I : Indian fern ; L : Ludwigia ; M : Myriophyllum ; Q : Water clover ; V : Vallisneria.

and provide sufficient variety in the aquarium will give a more satisfying display than six or more types all competing for their favoured condition. If groups of light green plants can be arranged alternately with dark green groups (e.g. *Ambulia* and *Egeria*) the effect is particularly pleasing.

Up to three dozen plants and individual cuttings are required initially for a 24in. aquarium, the taller growing species being planted at the back and ends of the tank. Space should

COLDWATER

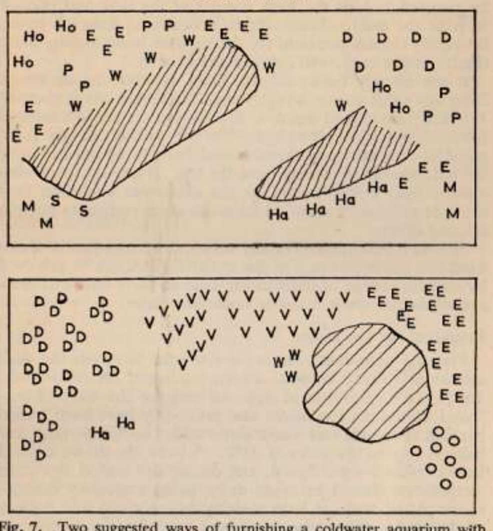

Fig. 7. Two suggested ways of furnishing a coldwater aquarium with rocks and water plants (plan view)—D : Egeria densa ; E : Elodea ; Ha : Hair-grass ; Ho : Water violet ; M : Myriophyllum ; O : Hornwort ; P : Potamogeton ; S : Sagittaria ; V : Vallisneria : W : Willow moss

be allowed in a newly set-up tank for plant growth—*Vallisneria* for example is certain to throw off a number of runners, so that it is advisable to leave room for these in this group's vicinity. Leaving a space clear of plants in the centre and foreground of the aquarium will encourage the fishes to swim where they may most easily be watched. Some fish-keepers favour centre-pieces formed by a large *Cryptocoryne* or Amazon sword plant for their tanks; for coldwater aquaria such an attraction can be supplied by a small water lily.

Plants can also be used to create an illusion of increased

distance between front and back of the aquarium. They can be grouped to hide the back corners of the tank and massed to hide the ends, while suitable selection of hues of green, favouring frontal positions for darker ones and planting paler shades at the back, will also aid the illusion.

It has already been said that light entering the aquarium from the sides causes straggly and wandering plant growth. For this reason and because it attains a state more natural for the fishes, it is best to leave clear for viewing only the front panel of an aquarium, the ends and back being covered over so that light enters mainly from the top. If a hood containing electric light bulbs is used on the coldwater aquarium they must be sufficiently removed from the water surface to prevent heating effects.

Should it be required for any reason to restrict plants of one kind to a particular part of the aquarium this can be achieved by inserting strips of glass in the sand to form barriers; these are, of course, quite invisible under the water.

Preparing for the Fishes

Planting completed, the aquarium can be given the final attentions. For a tropical aquarium, heater and thermostat are placed in position at opposite ends of the tank (if preferred, an immersion heater can previously have been buried beneath the sand) and warm water added to fill the tank and bring it to a temperature of 75°F. A week should be allowed before fishes are purchased, and during this period the water temperature should be taken daily, using a mercury thermometer placed with its bulb midway between top and bottom of the tank. Adjust the thermostat until the correct average temperature is given. The aquarium should be illuminated for this period for the benefit of the plants. Temporary water clouding is likely to occur; do not worry about it—it clears up in a short time.

It will be found that there is a gradient in temperature from the bottom of the tank, where the water is colder, to the surface, where it may be six degrees warmer. Hence it is important to see that the temperature is tested in mid-water and not in the cold or warm layers only. Slow fluctuations of temperature throughout the day will not harm tropical fishes, most of which tolerate a range 65°F.—85°F. Rapid changes cause chills however, and that is why, when the aquarium has had its fish-free settling down period, special precautions are taken

in introducing the fishes, both with tropical and coldwater specimens.

The can or jar in which they are conveyed home is floated in the aquarium to allow the two water temperatures to equalize. Then the container is tipped over gently, permitting the fishes to swim out. It is a good plan when introducing new fishes or moving old ones to effect these transfers at night. Fishes are easier to net then, when they are quiescent, and they are given the hours of darkness in which to settle down quietly in the new tank; the mad dashes which otherwise sometimes take place, and the injuries and shock that result from them, do not occur.

Regular Attentions

If the fishes are fed daily (see Chapter X) and the overhead lights are switched on for the requisite period the only other attentions needed to be given to the aquarium can be made a regular weekly job. If this is done it remains virtually no trouble. Omit the regular servicing, and in no time, like a neglected garden, its redemption means a forbidding amount of work. Here is a routine for weekly servicing:

(1). Remove hood and cover glasses, cleaning electric lamps, reflector and glass with a leather before replacing.

(2). Scrape the inside glass of the aquarium with a razor blade to remove the green growth (algae) that forms—soft growths can be removed by rubbing a pad of newspaper over the glass. It is not essential to do this for the back and end panels that are not used for viewing unless your tank becomes infested with the long filamentous types of algae.

(3). Examine plants for dead leaves and stems, cutting these out with scissors. Pull out any plants smothered with algae filaments and pick these off. Trim back plants that have made so much growth that their stems are trailing across the water surface. Cuttings can be planted in the sand.

(4). Siphon the detritus from the sand surface with a piece of rubber tubing. (Fill the tube with water by immersing it completely in the aquarium, then pinch one end and take it over the side of the tank so that it is lower than the other end. Release the pinched end and water will start to siphon over). The end of the tube in the aquarium can be used like a vacuum cleaner and moved over the sand so that all bits are sucked up, being careful not to trap small fishes and snails in it. Discard the water that siphons over with the sediment.

(5). Clean the white evaporation residue from the top edges of the glass panels and then refill with fresh water warmed to the same temperature as that in the tank. This can be done without agitating sand or plants by pouring it gently over a rock or into the cupped palm held in the water.

(6). Any scum or oil film that appears on the water surface can be removed by floating a sheet of clean newspaper on it until it is wetted, and then sliding the sheet with the adherent film from the surface, in an easy movement.

(7). Polish the outside of the glass sides with a leather.

Aquarium Accessories

A host of auxiliary appliances is offered for sale by dealers, some of them of more use than others. This brief review of common accessories will form a guide for the beginner buying his first equipment.

Thermometer: an essential item for both coldwater and tropical aquaria. The glass mercury thread types with an engraved or fixed scale, such as the ones sold for use by photographers, are most accurate. They can be attached to the glass by a rubber sucker.

Sediment remover: various types are sold but the simple length of rubber tubing used as a siphon for sediment removal is all that is really required.

Glass scraper: holders for razor blades to be used as scrapers can be obtained, and for the fish-keeper who dislikes wetting his arms these are very useful. Do not use scrapers which may scratch the aquarium glass.

Feeding ring: for the beginner's tank a feeding ring of the type that may be fixed to the glass and having a tray beneath it is of help, since if the sin of overfeeding is committed the excess food will be fairly localized for removal by siphoning, and not spread all over the aquarium. The plastic *Tubifex* holders are also handy accessories.

Tongs and forceps: refined versions of these gadgets made easily at home can be bought. They are of use for retrieving objects dropped in the aquarium, removing dead fishes, snails, etc. *Planting sticks*, essentials for setting up tanks, have already been mentioned.

Fish nets: rectangular or triangular framed nets are of most use. For general use one nine inch rectangular net of medium texture and one small two inch fine mesh net (for handling live foods, etc.) will be adequate.

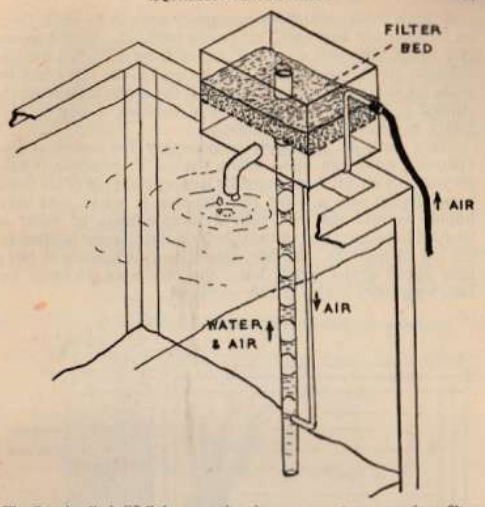

Fig. 8. An "air-lift" in operation in a corner type aquarium filter.

Pumps and aerators: small water pumps for use with aquaria are of interest to the fish-keeper who wishes to have water circulating through his tanks. Neither these nor aerators (air pumps) are essential for successful aquarium-keeping. They are helpful reserve accessories, however, particularly for the fish-breeder, for use in emergency. If an aerator is bought it is well worth paying extra to obtain the mechanical pump type. Electric vibrator types are cheaper but are also noisier and have a much shorter life. Air is released in the aquarium through porous stone blocks called diffusers, and the chief advantage of the stream of bubbles they release is the circulation of water created. Temperature gradients and 'pockets' of cold water in tropical tanks are eliminated by this circulation, and exchange of gases at the water surface is accelerated.

A home-made aerator for emergency use can be made from an air reservoir into which air can be pumped. An old motor tyre inner tube will do, or if valves from such a tube are soldered into a stout tin this may be used in the same way by pumping it up with a hand pump. If the outlet tube is partly clipped a slow and steady stream of bubbles, lasting several hours, is obtained in the aquarium.

Some form of air-supply is necessary for continuously-operating aquarium filters where the air-lift principle is employed. An air-lift is arranged by feeding a supply of air from a small tube into a wider one standing in water. As each bubble ascends the wide tube a short column of water is trapped between it and the next bubble; thus, water is lifted to the top of the tube. Air-lifts cannot work efficiently if more than about eleven inches long; the maximum diameter for such long tubes is also greatly restricted.

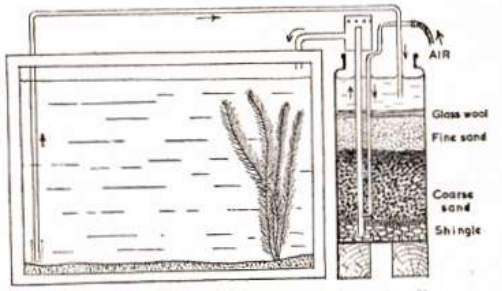

Fig. 9. Arrangement of an external type of aquarium filter.

Filters: if an aerator is possessed then the best work for it to do is to operate a filter. There are two ways in which these can be arranged. In one the water is lifted by an air-lift through a filter of glass-wool or cotton wool and then returned to the aquarium. In another type the intake end of the air-lift is connected to the filter medium (graded sand) so that only filtered water is lifted and returned. The filter medium for this type can be within the aquarium beneath the bottom sand or in a small tank or jar outside the aquarium; in this case

the aquarium water siphons continually into the outer filter of graded sands to complete the circuit.

Glass wool, fine shingle, coarse and medium sands are the best filtering media. Carbon removes organic matter that feeds the plants, although its absorptive function is soon saturated, and if it is required to free the tank of dissolved matter, it needs frequent renewal. Goldfish and carp tanks and sea-water aquaria benefit specially from filtration.

A Few "Do Nots"

DO NOT bang or tap the glass or covers of aquaria; fishes are shocked by this.

DO NOT switch on top-lighting over aquaria in a darkened room; sudden increase in light intensity may cause fishes to injure or stun themselves as they dash fearfully around.

DO NOT use paints, varnishes or solvents in the aquarium vicinity.

DO NOT move large tanks when full of water; leaks will start.

DO NOT have copper or brass pipes or objects in the aquarium: these metals are poisonous.

CHAPTER IV

WATER PLANTS FOR AQUARIA

THE feeding process of green plants is dependent on light energy and is called photosynthesis. Under the influence of sun or artificial light, green chlorophyll in the plant leaves catalyses the formation of sugars and starches from carbon dioxide gas and water. From this it will be seen that to withhold light from aquatic plants is to starve them to death. One other requirement for growth is nitrogenous material; in the aquarium, plants absorb nitrogen originating as waste from fishes.

Water Plant Growing

Other important factors influencing plant growth are temperature and lime content of the water. If tanks are to be used expressly for water plant growing these four factors—light, water organic content, lime salt concentration and temperature must be considered.

in hard cold water. Surface rosettes of leaves are formed under ideal conditions. The plant stops growing in winter. Occurs in natural ponds.

4, Water violet (*Hottonia*): rooted stems of this plant are used for propagation, and its bushy dark green foliage makes a fine underwater display. (British).

5, Curled pond weed (*Potamogeton crispus*): this species occurs wild in British streams and has wavy, reddish-green, near-transparent leaves on thick branching stems. It requires good light and is best planted as rooted stems.

6, Crowfoot (*Ranunculus*): another British pond plant that likes good top-light and grows in hard water. Its branching pale green stems appear straggly in shallow aquaria; in bunches it is a good spawning plant.

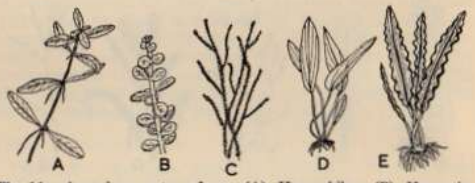

Fig. 11. Aquarium water plants—(A) Hygrophila; (B) Herpestis; (C) Willow moss; (D) Cryptocoryne; (E) Aponogeton crispum.

7, Willow moss (*Fontinalis antipyretica*): a dark green densely leaved plant which grows slowly; it attracts sediment to its stems. Shady conditions suit this low-growing species. (British).

8, *Nuphar:* a plant related to the water lilies which does well as a centrepiece in larger coldwater aquaria. The light brown rhizome is planted in the sand, and from it arise stems bearing the light green leaves. As it increases in size the rhizome may be cut to form new plants. Ordinary lighting is adequate.

Plants for tropical aquaria: 1, *Cabomba:* bright top-light is essential for this light green brittle plant with fan-like foliage (arranged alternately on the stems in opposite pairs). It also likes soft water. Cuttings, which should be set separately, not in bunches, are used for propagation. (U.S.A.).

2, *Limnophila* (*Ambulia*): superficially resembling *Cabomba* and having similar requirements, but a more successful grower.

The foliage of this plant is not so markedly fan-shaped and is whorled. (India).

3, Indian fern (*Ceratopteris*): an attractive light green rooted plant which produces young plants from its foliage. These float at the water surface and can be rooted in sand in shallow aquaria. It grows in hard water with moderate lighting.

4, *Heteranthera:* the pale green delicate single stems have long narrow leaves springing alternately from each side of them. Cuttings may be planted in groups under light of medium intensity. (U.S.A.).

5, *Hygrophila:* a hardy plant bearing light green oval leaves in opposite pairs on its branching stems. Roots spring from the nodes of the leaves and pieces of stem or even single leaves anchored in the sand will serve to propagate it. Strong light produces vigorous growth. (India).

6, Willow moss (*Fontinalis gracilis*): a finer edition of the willow moss listed in the coldwater section, this one, with tiny bright green leaves on thin dark stems, grows well in tropical aquaria at about 75°F. and will attach itself to rocks. It is best not to give it brightly lighted conditions or it will become very dense. Useful in breeding tanks for live-bearers; the young fishes hide in its mass. (British).

7, Australian underwater clover (*Marsilea quadrifoliata*): a rooted plant resembling a four-leaved clover, bearing the leaves at the end of thin stalks. Grows well in bright light, up to about six inches tall. Hard water suits it.

8, *Bacopa* (*Herpestis*): the thick, nearly circular leaves sitting tightly on strong upright stems make this a plant of distinctive appearance in the aquarium. Pieces broken from the stems soon take root. It likes moderately well-lighted conditions. (U.S.A.).

9, *Cryptocoryne:* four or five species of this plant genus having large, dark, spear-shaped leaves growing from crowns bearing thick, tough roots, are available here, but owing to their similarity, confusion of their names frequently occurs. They are all propagated by runners or by dividing the roots, and they grow well with subdued light in soft water; soil is a preferred base or pot medium. Large specimens are favoured as centre-pieces for the aquarium, but young ones look well planted in the foreground. (Asia).

10, *Aponogeton crispum:* an impressive tuberous plant with translucent green leaves having rippled edges. It grows to about eighteen inches in height in good light, and likes loam

to root in. The tubers may be divided to propagate the plants, or the pea-like seeds can be collected from the aerial spikes of white blooms and germinated in shallow dishes of wet soil. (Ceylon).

11, Amazon sword plant (*Echinodorus*): properly at home in larger aquaria, a small specimen of this plant with semi-transparent, bright green, sword-shaped leaves makes a nice centre-piece for a 24in. decorative tank. Many runners arise from its crown in medium light; do not cut them from the parent until the young plants are firmly rooted. Hard water suits it but it cannot stand temperatures below 70° F.

Floating Water Plants

Surface plants all require a strong top light, and because they are themselves opaque, they shut out light from the submerged plants. Some of them are worth encouraging in aquaria however, for fishes like to browse amongst them, and if trouble is being caused by too much light entering a tank in high summer these plants provide one method of turning off some of the rays. One way of restraining them from spreading all over the surface is to place them inside the largest sized floating feeding rings. Then all the top light is not taken and nets and other implements can be placed in the tank without becoming covered with the clinging plants.

For the coldwater aquarium, crystalwort (*Riccia*) is a tiny bright green, rootless floating plant. It will not grow well in warm water. Some aquarium-keepers have caused it to grow over the surface of the sand by anchoring some of the plants there to form a brilliant green carpet. Another tiny surface plant liking cold water is fairy moss (*Azolla*), a pale green moss-like plant bearing purplish patches. Frog-bit (*Hydrocharis*) is a larger plant with bright green leaves a little larger than pennies. It has long trailing roots and these may harbour algal growth.

Lesser bladderwort (*Utricularia minor*) grows at the surface of both tropical and coldwater tanks. In the former it increases profusely, forming dense masses of tangled light green threads, among which tiny bladders can be seen. Fish fry like to hide in it. *Salvinia* is a warm water liking floater. Each plant has a double row of several velvety-green leaves each about half an inch long, above a raft of stems and roots.

Much larger surface plants for indoor tanks are the water hyacinth (*Eichhornia*) and water lettuce (*Pistia*). The first one has green leaves supported by stems modified as bulbous floats, and the dense masses of dark-coloured feathery roots hanging beneath them are very useful fish egg traps in spawning tanks. Pale blue flowers appear in strong light. *Pistia* forms rosettes of leaves growing up to six inches across, and it too has long feathery roots.

CHAPTER V
GARDEN POND-MAKING

AUTUMN and spring are the times of year when pond-making is best undertaken. The weather is then favourable for working with concrete and more suitable for some of the strenuous operations such as digging. Before the work is begun careful planning and thought are necessary; firstly a suitable site for the pond in the garden is selected. Chief factors to be considered are:—

1. For good pond plant growth sunlight must reach it. It is undesirable that it should receive the hot rays throughout the day in full summer, however; about five hours, preferably in the morning, are sufficient. Shrubs can be planted nearby to give afternoon shade if this is not otherwise obtainable.
2. Trees are a nuisance in the immediate pond vicinity. They shut out light and may pollute the water with their leaves or undermine the concrete with their roots.
3. The pond should fit naturally into the scheme of the garden and be neither too obtrusive nor yet concealed and overlooked by nearby features.
4. In gardens with high and low ground choose the high part. Heavy rains will not wash rubbish into the pond then and emptying by siphoning is facilitated.
5. A source of water close by for filling saves much trouble as does a convenient drain for emptying.
6. Gardens bordered by public footpaths should have their ponds away from these lest the fishing proclivities of small boys and the dumping habits of untidy passers-by are excited.

Shape and Design

Next to consider is the purpose the pond is to serve. A lily-pond of purely ornamental function may be of much simpler construction than a pond in which fishes are to be

kept and bred. Most readers will want to achieve both objects, and on this assumption most of this chapter's recommendations are made.

There are two types of garden pond, the sunken and the raised. Sunken ponds may be formal or informal in design. Formal ponds—circular, square, rectangular, diamond, octagonal, etc., suit gardens laid out in geometrical patterns, whilst the informal types are best in gardens with meandering paths and asymmetrical lay-out. The informal pond's irregular outlines, although creating a more natural effect, add difficulties in construction, but by the judicious use of paving and rockery it is possible to make even a square pond, for example, look informal in outline.

Raised ponds are preferred by many gardeners and though they certainly do away with the laborious digging they possess disadvantages such as liability to extremes of temperature fluctuation that are unwanted by the fish-keeper. Whatever type you decide to build, make rough drawings and mark on them the finished dimensions you visualize. Available garden space will to some extent determine the pond size, but ponds for fish-keeping should not be less than 25 square feet in surface area. Small ponds freeze in winter, overheat in summer, and are generally more difficult to establish and maintain satisfactorily.

Varying Depths are Necessary

The depths to be marked on your sectional diagram of the pond need to be varied to suit the needs of its living inhabitants. Shallows for breeding fishes (3in. to 12in. deep), deeper regions to allow aquatic plant growth (12in. to 2 ft. deep), and a wintering depth for fishes (2 feet 6in. minimum) are required. To accommodate these the bottom of the pond is 'stepped,' with the steps or shelves for the plants distributed as uniformly as possible over the total area.

Wooden pegs can be used to mark the outline of the paper pond plan on the garden site. Digging is then commenced and earth is removed to depths about 6in. greater than the finished depths on your diagram, to allow for the thickness of concrete; the sides are set back by similar distances. Do not make the sides strictly vertical but incline them outwards slightly. Once the excavation is made (the earth removed can be used as a foundation for a background rockery to an informal pond), unless the sub-soil is gravel or chalk the soft bottom and sides

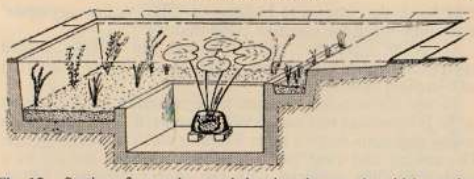

Fig. 12. Section of a garden pond showing the way in which varying depths along its length can be arranged.

can be strengthened by ramming in brick rubble, stones and similar materials before concreting is started.

At this time a means of draining the pond can be incorporated. From its lowest part drain-pipes can be laid to a main drain, to a ditch or to a sump. The sump is made by digging a pit fairly near the pond, making it at least as deep as the pond, and filling it with broken bricks. For medium sized ponds a convenient way of stoppering the outlet is to set the neck of a screw stoppered bottle in the concrete over the point where the drain-pipes begin.

Concrete and Concrete-mixing

Your paper pond plan again comes in useful, for from it can be calculated the quantities of materials to be ordered for making the concrete. A thickness of 4in to 6in. is required all round, and dividing the total square-footage of the surfaces to be concreted by 60 will give the approximate number of cubic yards of concrete necessary to obtain this. Each cubic yard of concrete will require about 6 cwt. of cement, ½ yard of sand and ¾ yard of coarse aggregate. These materials are all-important, for in addition to making a strong job, concrete for ponds must be water-tight, and the grading of its constituents influences this considerably.

1. *Cement:* it is worth paying a little extra to obtain a cement of high alumina content such as 'Ciment Fondu.' Rapid hardening of concrete made from this is ensured and more important, it contains little or no free lime to cause trouble in the pond. Coloured cements are obtainable and ordinary cements can be used to make a tinted concrete by mixing with them a good pigment from a paint supplier.

2. *Sand:* that known to builders as 'Class A fine aggregate' is recommended for concrete pond-making.

3. *Coarse aggregate:* order 'Natural ⅜in. to $\frac{3}{16}$in. graded aggregate'—a 'shingle' giving a compact concrete free from leak-causing cavities.

To mix the concrete measure these materials from a bucket in the proportions one part cement, two parts sand, three parts coarse aggregate on to a large board or clean concrete surface. The cement and sand are best mixed first with the aid of a spade and then re-mixed with the coarse aggregate added. Spray water on the well-mixed compound, using a hose spray or watering can, turning the mix over with the spade and adding more water until a concrete of even colour and consistency results. Rather more than half a bucket of water will be required for each bucket of sand used. Do not mix more concrete than you can place in position within the next hour or so.

Placing the Concrete

First cover the bottom of the pond with the freshly mixed concrete to a depth of four to six inches, spading it as it is placed to prevent air spaces forming. Smooth over the surface and then leave it to harden. This must not be hastened; in hot dry weather all fresh concrete should be covered with wet sacks to retard water loss. When it is hard a rigid yet readily dissembled wooden shuttering can be erected about six inches from the earth sides. Greasing the surfaces of the boards will aid their removal when the concrete has set. For curved pond surfaces bent plywood, lino or metal sheets can be employed as 'forms.' Fresh concrete is placed behind the shuttering and packed down well to make compact concrete walls.

The top edges of the sides need to be carefully levelled with one another with the help of a spirit level; water level in the finished pond will show up any irregularities and give a most unsightly appearance. Again, keep the concrete and shuttering moist with damp sacks in dry weather for three or four days, after which the shuttering may be removed. If it has been well placed the concrete will show even surfaces without holes and gaps, but if these are present a rendering of a one part cement to two parts sand mixture with water can be given with a trowel to smooth the surfaces.

Concrete used in making large ponds is best reinforced; large mesh galvanized wire netting is laid for this purpose

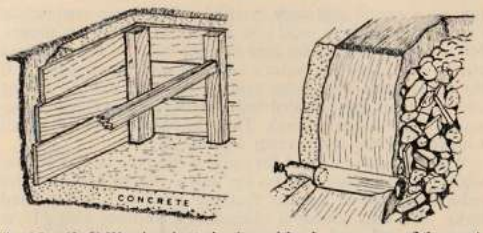

Fig. 13. (*Left*) Wooden shuttering in position in one corner of the pond. (*Right*) Sectional view of a simple outlet for the pond made by cementing in a screw-topped bottle neck arranged to drain into a sump containing brick rubble.

behind the shuttering before the concrete is placed. For good results with concrete the importance of keeping earth and other extraneous matter out of the mix, and the necessity of tamping it down well when placing, cannot be stressed too much.

'Maturing' the Pond

Lime emerges from new concrete when the pond is filled with water, its amount varying with the type of cement used. It is useless to proceed further with the pond until this alkali is removed or otherwise prevented from harming plants and fishes. This can be done in several ways:—

1. When time is no great object, as with an autumn-built pond, the repeated processes of filling, allowing to soak for a fortnight, scrubbing the surfaces with a hard broom and emptying, carried out during the winter will make the pond ready for stocking in the spring. Three or four repetitions at least are required with particularly 'limy' concrete. This method is slow and laborious but sure.

2. Sealing the surface of the concrete will prevent free lime from coming out. Water glass (sodium silicate) can be used: three coats are painted on with a brush, twenty-four hours being allowed for drying between each application. The first coat is water glass diluted 1 : 6 with water, the second a dilution of 1 : 4 and the third a dilution of 1 : 2. Bituminous paints serve the same purpose and also permit various coloured finishes to be given to the pond.

3. Filling the pond with an acid solution to neutralize the

lime is a sound and easy method. Buy some commercial ('syrupy') phosphoric acid and a book of red litmus papers. Stir about a pound of the acid into the water of the pond and after a day check the water's reaction with litmus paper. If the paper turns blue more acid is required, and the testing and additions are repeated until the water stays acid in reaction to litmus (red colour). Then the pond is emptied, rinsed with fresh water and is ready for stocking.

When the pond is filled for the first time the level will drop slightly as the concrete takes up water. Rapid and excessive reductions in level indicate that the concrete is porous and leaky. The only remedy is to render the surfaces with a layer of cement and sand mixture incorporating one of the waterproofing agents that are sold.

'Observation Ponds'

An interesting form of garden pond that can be made with a little extra trouble is one having a three or four feet plate glass window set in the concrete of one of its sides. Thick (¼in.) plate glass is used and cemented with a good layer of aquarium type putty into a brick frame; set it from within the empty pond so that water pressure will later tend to press it into the putty and against the brickwork. For viewing purposes a concreted or breize-slab lined chamber is made at the pond-side, to be reached by a few steps. Drainage within it is required. The glass in the pond becomes algae-covered and needs to be swabbed over with a mop, or scraped clean, periodically.

Bog-garden Surround

Growing sub-aquatic and water-loving plants at the pond-side is a sure way of creating a natural and beautiful effect in the garden. It is best to establish properly the foundation for such a water or bog garden at the time the pond is made. This can be done by digging an irregularly shaped two feet deep 'basin' round the pond, and concreting this cavity to make it water-retaining. Overflow pipes from the top edges of the pond sides can be arranged to run into this. The basin shape permits plants requiring near-dry, moist and relatively wet conditions each to be given an appropriate spot.

On the bottom of the concrete basin a 6in. deep layer of brick rubble or large stones is placed and over this layer is spread a rich planting medium—sieved garden loam with

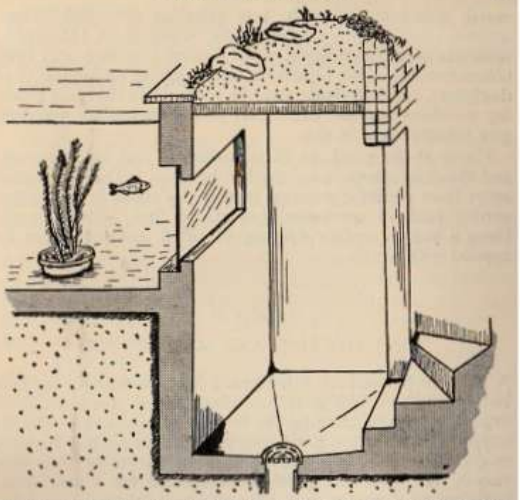

Fig. 14. Cut-away view of chamber at the side of an "observation pond."

which has been mixed peat or leaf-mould in equal parts. Weather-worn rocks are set in it and used to build small banks and valleys in the bog garden area. Place a retaining wall of rocks and stones at the edges of the pond in such a fashion as to prevent heavy rain washing the soil into the water.

A very large selection of plants suitable for growing in the pond bog surround is offered by aquatic-dealing nurserymen, and a number of pleasing wild specimens can be collected from the edges of natural ponds and streams. It is advisable to inspect a well-kept water garden in a public park or at a gardening exhibition to see the best methods of arranging the plants and to aid your choice of specimens.

With careful selections the pond can be surrounded by a show of colour throughout the major part of the year. As a preliminary stocking list the following can be recommended:

marsh marigolds (*Caltha*); bog primulas (*Primula*); irises; astilbes (*Astilbe*); purple loosestrife; water musk (*Mimulus*); umbrella plant (*Saxifrage*); globe flowers (*Trollius*); day lilies (*Hemerocallis*). Due regard for their varying requirements of dampness, sun and shade must be given when choosing planting positions and the catalogues issued by leading suppliers give valuable help in this.

Plants at the pondside make abundant and rapid growth, and the chief attention required to be given to the bog-garden apart from plentiful watering in very dry spells is the regular cutting back of specimens that exceed their allotted space. Once a year a surface dressing of sifted leaf-mould can be applied with benefit.

CHAPTER VI

POND STOCKING AND MAINTENANCE

A POND to be used for fish-keeping is better without the rich bottom medium that gives best plant growth, for the risk of organic materials entering the water and interfering with its oxygen content is too great. With the use of simpler bedding media for plants their growth may be slower in their first season, but after the pond is established for a year over-sufficient manuring matter will most probably have accumulated from various sources.

Most aquatic plants require water no deeper than two feet, and in the discussion of plans for the construction of the pond it was suggested that ledges or shelves can be built to provide quarters for them. On the bottom of these shallow parts a three or four inch layer of washed coarse sand is placed to provide root anchorage. A one inch layer of sieved garden soil beneath this sand is the only form and amount of additional bedding medium that can safely be included in the pond. The covering sand layer prevents earth being stirred into the water by the foraging habits of bottom-feeding fishes.

Water lilies demand more nutritious compost, however, provided safely by planting them in large pots or concrete boxes holding this, again with a protective layer of sand or pebbles above it. The deepest part of the pond will not be used for planting but it is advisable to place a two inch layer of sand in this region for the welfare of wintering fishes.

Before setting water plants in position the pond may be filled nearly to the top with water. Use water from the mains, running it in slowly so as to avoid disturbing the sand. Playing a hose on to a wooden board placed temporarily in the pond is a convenient method.

Planting the Pond

March, April and May are the best months in which to obtain plants and set them in the pond. It frequently turns out to be false economy to use plants from natural waters; many pests and disease organisms may be introduced with them, and once this is done their eradication from the pond is an extremely difficult matter. Purchase plants from a recognized dealer, and if possible see what you are buying. Do not expect all plants sold to you to have roots; cuttings very soon develop them when planted. Certain plants are sold entire with their root systems and cannot be propagated as cuttings—these are indicated later on.

To push plants into position in the sand with the water already in the pond a pair of metal rods or wooden sticks will be found helpful. Other accessories are strips of sheet lead, to be clipped fairly loosely around plant stems to stop them floating until they root themselves naturally, and some strong thread to tie bunches of cuttings together before leading.

Sufficient aquatic plants are needed to set clumps of three or four cuttings, or where indicated, separate plants, from 12 to 18 inches apart over the planting area. The following species are cheaply and easily obtainable, and most of them make such good growth in summer that a newly set-up pond soon takes on a well-planted appearance.

Submerged Plants

Plants for water depths of 12 to 24 inches: Use only healthy stocks, evidenced by their green, fresh and crisp appearance.

1. Canadian pond weed (*Elodea canadensis*): this very common plant is a rapid grower and may need thinning out regularly during summer. Plant cuttings in bunches as already described.

2. *Egeria* (*Elodea*) *densa:* a hardy and most decorative plant. Plant as for the foregoing, in the lightest situations.

3. Hornwort (*Ceratophyllum demersum*): the 'horns' are formed by whorls of leaves at the ends of the very brittle stems. Handle the cuttings carefully to avoid breaking them

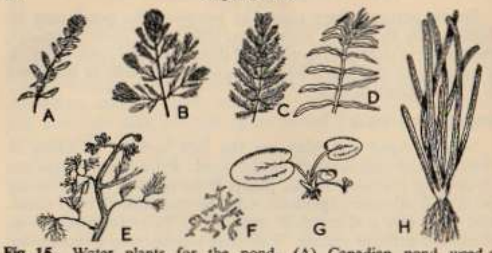

Fig. 15. Water plants for the pond. (A) Canadian pond weed; (B) Hornwort; (C) Myriophyllum; (D) Potamogeton densus; (E) Water crowfoot; (F) Riccia; (G) Frogbit; (H) Arrowhead—underwater leaves.

when bunching and leading ready for planting. Hornwort will grow in water up to three feet deep.

4. Water milfoil (*Myriophyllum spicatum*): there are several species of milfoils and some give disappointing results, stems becoming denuded of the fine leaves. Plant cuttings in small bunches in open parts of the pond where plenty of light will reach them. Loosely anchored bunches in the breeding shallows make good goldfish egg receptors.

5. Starwort (*Callitriche verna*): attractive rosettes of small leaves are formed at the water surface in late spring when this plant is at its best. Bunch and lead the stems before planting. Starwort spreads rapidly and should be thinned out as necessary.

6. Water crowfoot (*Ranunculus aquatilis*): another rapid grower which becomes rather straggly if left to itself. Small surface floating leaves are formed in addition to the fine underwater leaves, and numerous small white flowers appear at the surface in early summer. Thick bunches make useful spawning plants for goldfishes.

7. Water violet (*Hottonia palustris*): small rooted stems of this plant are best planted separately in the most shallow regions where the blue coloured flowers can emerge from the water in summer. Rootless cuttings can be induced to form roots before planting by floating them in shallow containers in a light situation for a week or so.

8. Pondweed (*Potamogeton densus*): a decorative plant with translucent green leaves on stems which arise from creeping

stems beneath the sand. Plant each leafy stem together with a piece of rooted subterranean stem, separately, and not in bunches. Requires pruning in summer to prevent it crowding other plants.

9. Arrowhead (*Sagittaria natans*): single plants with roots (propagation occurs by side 'runners') are set in sand around the edges of the planting shelves in the pond. The slightly bulbous crown above the roots, from which the ribbon-like leaves spring, should not be buried; cut back any long roots to within an inch or so of the leaves before planting.

Floating Plants

There are several very pretty plants which are entirely surface living, having roots that trail in the water, and although the presence in a pond of too many is harmful because their light-screening prevents growth of more important submerged plants, a small colony is useful to provide shade and food for adult fish and protective top shelter for tiny fry.

The duckweeds (*Lemna*) quickly cover ponds, and for this reason, despite the fact that they are eaten by goldfishes, they are better kept out. Their small size makes their total removal especially difficult if they become a nuisance. Crystalwort (*Riccia*) is subject to the same objections. Larger floating plants such as frogbit (*Hydrocharis morsus-ranae*) and water soldier (*Stratiotes aloides*) give no trouble and the particularly interesting reproductive cycles of these two species, involving periods of submerged existence, make them worthwhile additions.

Potted Pond Plants

Although the shallowest region allowed for plant-growing in our pond-planning was about 18in. this does not mean that the attractive flowering sub-aquatic plants which need only an inch or so of water and which bear the bulk of their foliage above the surface, have to be gone without. They can be planted in roomy pots or concrete boxes of rich garden soil topped with a layer of sand, and the pots placed on bricks if necessary to raise the sand surface to just below water level. The corners and sides of the pond are obvious sites for these plants, and here they create the best effects; their inclusion is, of course, purely for ornamental purposes. Suitable hardy

species, listed with their average growth-heights, are the following:—

Water forget-me-not (*Myosotis palustris*) 9 inches.
Water mint (*Mentha aquatica*) 1½ feet.
Iris (*Iris laevigata* and *kaempferi*) 2 feet.
Sweet flag (*Acorus calamus*) 2 feet.
Sweet galingale (*Cyperus longus*) 2½ feet.
Zebra rush (*Scirpus zebrinus*) 4 feet.
Reedmace (*Typha angustifolia*) 6 feet.

The size of the pond will determine how many and which types can be accommodated; taller species look out of place in very small ponds, for example. Some, such as reedmace, give best effects when planted in groups in a large concrete box situated in one pond corner. Propagation of these plants is carried out by dividing the roots in spring and replanting the separated portions.

Water Lilies

These popular aquatics are cultivated by most pond-owners for the incomparable beauty of their flowers and because their large surface leaves provide shade that is greatly appreciated by fishes during very sunny days. There are many varieties of water lilies, requiring varying depths and surface space; it is important to ascertain from the dealer the recommended depths for the types offered for sale. Successful lily culture demands attention to the following points:—

1. Water lilies require to be planted in positions receiving full sun.
2. Plant them from the end of April to June. Only have one or two plants in a small pond.
3. A rich planting medium is needed: plant the rooted tubers in suitable pots or boxes having a depth of 10 to 12 inches. Pack in *firmly*, sieved garden loam to which has been added a little rotted cow manure and some bone meal.
4. If the root-stock shows discoloration from previous planting set it in the loam so as to cover these parts. Do not bury the crown. A two-inch layer of coarse sand above the loam keeps the compost from being disturbed and a few large stones on top will stop the tuber rising when the pot is placed in the pond.
5. Build a temporary platform from bricks in the central deep part of the pond and place the potted lily on this so that it is covered by only a few inches of water. When the leaves appear and reach for the surface, lower the pot by removing a brick, repeating the process as growth progresses until the correct depth is reached (18 inches to 2 feet meets average requirements). Placing lilies in deep water at the onset may cause leaves to rot and retard flowering.
6. Do not allow lily leaves to crowd the pond surface. Cut out excess leaves and stems close to their bases. After a season or two, jumbled surface leaf formations indicate that division is needed.
7. Remove the pots from the pond in spring every second season, replenish the planting medium in them and cut up the tubers to leave one crown to each piece, trimming back straggly roots. Replant the newer pieces, one in each pot.
8. Hardy lilies can remain in the pond throughout winter, and unless a warm greenhouse is possessed, to which tropical varieties can be removed in autumn, attractive though these species are it is better to confine your lily-growing to the hardy forms.

Water hawthorn (*Aponogeton distachyon*) is an attractive summer flowering plant with floating leaves that can be treated in much the same way as water lilies. Its tubers are planted in water one to two feet in depth.

Settling Down

Allow the planted pond to remain for a month before fishes are obtained for it. During this time plant cuttings will root themselves and certain changes will have taken place in the water. Heavy growth of microscopic animals and plants will occur to such an extent as to make the water appear cloudy. Do not worry about this. Clearing happens quite spontaneously as these lowly forms of life reach their peak development and then stabilize their numbers in conformity to food supplies available to them. They become less as water plants begin to grow and compete with them for dissolved materials of organic origin. Any brown or dead plants or stems are removed during the settling down period.

Fishes for the Pond

Consideration to coldwater fishes suitable for the garden pond is given in the next chapter but here a few general remarks about choosing fishes, their numbers in the pond, introducing them and so on, are made.

Golden coloured fishes are obvious choices for they are always readily visible, but this does not restrict the pond-owner to goldfishes. There are also golden varieties of rudd, orfe, tench and carp. Active silver-scaled species such as bleak, dace and orfe, once accustomed to a pond, are very much in the picture.

Fishes caught from rivers are risky for ponds unless young specimens are trapped and first kept in an aquarium for a few weeks to see that they are free from parasites and diseases. Rather than a number of single specimens or pairs of a species stock the pond with groups of six fishes of the same kind. Try to keep fishes together that are all about the same size.

The maximum number of fishes can be obtained by allowing one inch of fish body to every twenty-four square inches of pond water surface. It is better to keep the number below this maximum so that sudden reductions in available oxygen arising from some unforeseen reason will not cause losses, so that room for growth and breeding is allowed, and for the pond to present a balanced appearance in fishes and plants and not appear overstocked.

Young fishes are ideal to start off with. They settle in more quickly and offer less likelihood of losses than larger specimens. You will be surprised at the rate of fishes' growth with adequate feeding, and it is more fun to own large fishes reared by your own care. Select healthy, active, British acclimatized fishes with clear, erect finnage, rounded body outlines and without scale injuries. Transport them to the pond in a can of water and float it in the pond for ten minutes or so before gently tipping the can to allow the fishes to swim out. Avoid scaring fishes by hurried movements; make their introduction to the pond calm and slow so that they do not dash about in the strange surroundings and possibly injure themselves.

Garden pond fishes require feeding, for small ponds do not contain sufficient natural foods to make them self-supporting. In addition to a good brand of coarse dried fish food use 'meaty' foods such as chopped raw beef, liver, heart, earthworms and live foods as recommended in the chapter on fish feeding. Never be tempted to add large amounts of dry foods to the pond. Feed daily in summer but only when the fishes appear interested, i.e. during mild spells, in winter. If you make a point of feeding always from the same corner of the pond, after a time the behaviour of the fishes when they see you standing there will be a guide to their needs of food at any time of year.

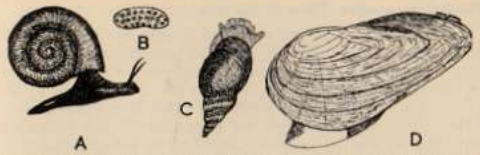

Fig. 16. (A) Ramshorn snail ; (B) Eggs of ramshorn snail ; (C) Freshwater whelk ; (D) Swan mussel.

Other Pond Inhabitants

Apart from aquatic insects such as water beetles and various fly larvae which are quite likely to introduce themselves without your bidding, there are some other invertebrate animals that are often deliberately added to the pond.

Water snails are examples of such intentionally added stock. They are usually advocated as scavengers and algae-clearers. Whilst they do some clearing up work in the pond they also eat plants and fish eggs; although when newly hatched they provide food for some fishes their numbers are still apt to become embarrassingly large. Keep them out of breeding ponds; tolerate ramshorn snails (*Planorbis*) and freshwater whelks (*Limnoea*) in ordinary ponds.

Mussels are best left out of small garden ponds. They are filter feeders and need a large sand or muddy bottom in which to wander. Small ponds cannot provide food for more than one or two of them. Deaths of mussels, perhaps unnoticed by the pond-owner, may lead to serious water pollution.

Really useful pond scavengers are the freshwater shrimp (*Gammarus*) and freshwater louse (*Asellus*)—the last not to be confused with the fish louse (*Argulus*). The small shrimps and *Aselius* can be caught from natural waters (water cress beds are rich sources of them) and will breed readily in a well-planted pond to provide a steady supply of living fish food in their youngsters and to form an active aquatic refuse disposal unit.

Pond Maintenance Through the Year

Events in the pond are governed largely by these factors: period and intensity of daylight; water temperature. Although they are approximately constant from one spring to another or one autumn to the next, variations do occur and the pond-keeper learns to treat his pond according to prevailing conditions, and not, as might be suggested by the following grouping of jobs by seasons, according to the calendar.

Winter: as temperatures approach freezing level pond fishes stop feeding and retire to the depths, where they should be allowed to rest undisturbed. They require no food. Unseasonable spells of weather resulting in raised pond temperatures may set them swimming around and small earthworms (not dry foods) should be offered to them. Water plants cease to make growth and old growth dies off.

Should the pond surface freeze over keep the ice broken. Avoid shocking quiescent fishes in doing this—do not bang the ice; melt a hole in it by standing a hot kettle or pot on its surface. Make several holes on large ponds and keep snow swept from the ice top. Snow shuts out light and excessive bacterial growth in the pond will then result. See that earth from the pond surround does not become washed in during spells of heavy rain; a low rock and concrete ledge will hold it back. Cloudy and green water in summer is often the result of earth washing into the pond.

Spring: a worrying time for the pond-keeper. Fishes awakened from their torpor by warmer water and increased daylight may be in a weak state if not properly prepared by good feeding the previous autumn. Fungus then attacks. Fishes making sluggish movements and having folded fins should be examined (if possible, without netting them at first) for this complaint—see Chapter XII. *Use dry foods very sparingly*—appetites will not be great.

Remove obviously dead plants and leaves, take out water lilies and divide and replant the tubers of these and root-stocks of sub-aquatics which became overcrowded the last summer. Place new plants in and around the pond as required. Run water in from a hose to wash away any surface scum or dirt film. Mend cracks in the concrete by lowering the water level, gouging out the crack and over-filling with a 3 : 1 sand and cement mix. Take out any frogs that appear in the pond, for males may harm fishes at this time of year.

Summer: active fishes mean healthy fishes in summer months. If fishes perpetually hug the surface with folded fins and slow movements something is wrong. Overcrowding and/or water pollution may be the cause. Feed fishes morning and evening. In really hot weather the temperature of shallow ponds should be checked; if over 70°F. hose in cold water or add ice. This is a good procedure to adopt in thundery spells too. Keep the pond filled during summer and provide shade for fishes if there are no surrounding shrubs or surface plants.

Do not allow plants to choke the surface—remove excess plants or leaves occasionally. Thread algae may become a nuisance and it should be controlled by raking out at least once a week; be careful not to trap young fishes in the mass when doing this. Shading the pond surface will help to lessen thread algae growth.

Watch out for pond pests—external ones such as herons, kingfishers, grass snakes and cats, and internal ones like water beetles and their larvae, and leeches. Net foreign and harmful water creatures from the surface when they are seen.

Autumn: fishes that are well-fed at this time are prepared for winter's worst. A little brown bread, stiff porridge or biscuit crumb are useful dietary additions to promote formation of fat stores. Remove very young goldfishes and adult specimens of fancy types to protected aquaria; all valuable fishes are best removed from ponds shallower than two feet, before onset of winter, most specially in the north of England.

Small ponds can be protected from falling leaves by light wire screens over them; skim leaves from pond surfaces or they will decompose in the water during winter. In late October, when most leaves have fallen, the pond can be cleaned out (a job necessary to do only once every two or three years). Empty through the sump, by siphoning, or by using an electric pump, and catch the fishes before the pond is quite empty, placing them in large tanks or baths of the pond water. Avoid overcrowding them in these temporary containers.

Take out water plants and wash them free of algae. Remove and wash the compost if it has an odour, scrub clean the concrete, rinse the pond and set it up again. Return the fishes without subjecting them to great temperature changes. A clean pond is not likely to come to harm during the dark days of winter, but one filled with rotting vegetation can easily become foul. In the water garden surround, a dressing of leafmould can be forked into the surface as food for next year's plant growth.

Running Water for the Pond

In the absence of a nearby stream, running water (an attractive refinement for the garden) can be economically provided by installing an electric pump or fountain. These use the same pond water over and over again but clarity of the pond is improved greatly and the fishes are kept in fine condition during the hottest weather. A continuously moving surface does not promote good water-lily growth, however.

There are available several reliable pumps and fountains suitable for garden pools, and a pump is a useful piece of equipment at pond emptying time. It can also be used for making a water-fall. Large paving stones covering a concrete pit at the pondside, in which the pump is housed, provide a disguise for it and yet give easy access to the machine. Fountains need not be placed centrally in the pond; jets from the side look equally attractive.

CHAPTER VII

COLDWATER FISH-KEEPING

JUST as the name 'tropical' applied to fish from abroad which we keep in warmed water is sometimes misleading, so is the appellation 'coldwater' for the subjects of this chapter. The range of temperatures over which most of them can be kept healthy is from 50° to 65°F., and such levels are not cold! Nevertheless, one of the problems that may have to be solved by the would-be keeper of river fishes in aquaria is how to keep down the summer temperature of their tank water.

Aquarium Size

Most of the coldwater fishes are large-bodied ones having a high rate of oxygen consumption and being specially sensitive to accumulated waste products. For this reason the larger sized aquaria (36in. and over) are recommended for them. Shallow water is also advisable, for the water-circulating movements of the fishes beneath the surface aid the exchange of gases there. Providing these conditions, is of no use, however, if the fish-keeper insists on cramming the tanks tight with fishes. Strict observance of the 'inch of fish to twenty-four square inches of water surface' rule must be made in coldwater fish-keeping.

Thus, a 36in. aquarium will not safely house more than six

specimens each having a body length of three inches, and a 24in. tank, more than four such fishes. These limitations do not allow such variety for establishment of the 'community tanks' so popular in tropical fish-keeping; one kind of fish to each tank is advisable with most coldwater fishes.

Temperature

Fishes requiring a good oxygen supply can obtain this only with difficulty as the water temperature rises, since less oxygen from the air dissolves in warm water than in cold. In rivers or lakes long spells of very hot weather must occur before an appreciable increase in water temperature takes place, but in the relatively minute volume of an aquarium a summer's day rise can be disastrous.

Sixty degrees must be regarded as an upper limit for the coldwater aquarium containing British river fishes, and a site for the aquarium (having thought also for the other factors outlined at the beginning of Chapter III) should be selected accordingly. Fishes are harmed if kept always at too low a temperature, as well, since appetite and digestion then become sluggish.

Start with Young Fishes

Generally speaking it is inadvisable to try to establish fully-grown wild fishes in the aquarium. Greater success will be obtained by netting very young fish for the purpose. These will not reach the same size that they attain in nature but will grow up and live quite happily (some will even breed) in the close confines of a tank.

Specimens caught from rivers need to be examined most carefully in a small aquarium to see that they are free from external parasites and disease before placing them in the aquarium. Some fish-keepers prefer to keep them in quarantine tanks containing water to which Tidman's Sea Salt (one ounce to the gallon) has been added, for a few days.

Covered Tanks are Needed

A good cover is an essential for the coldwater tank as many of the fishes, particularly the quickly moving active surface feeders such as minnows, bleak and orfe, are great jumpers. Plant their aquaria thickly with the plants already listed for coldwater use. One of the signs of oxygen shortage seen when the water becomes warm are wild dashes made at the surface

by the fishes, alternating with periods of listless swimming with folded fins and gasping near the top of the water.

It is not usually practicable or necessary to provide running water for tanks, but where a number of aquaria is kept, beneficial circulation of water can be provided by a series of siphons of equal size arranged from tank to tank, with a water pump returning water drawn from the last tank back to the first in the row.

Feeding

Feeding of coldwater fishes is an important factor in keeping them successfully. They have surprisingly large appetites and unless the fish-keeper is prepared to supply all the food they need, and has facilities for obtaining live foods and meat or offal, he will be wise to restrict his fish-keeping to the less demanding and more accommodating small tropical fishes.

Some general remarks on keeping fishes in ponds were made in the preceding chapter. Fishes suitable for both ponds and aquaria are included in the following list, and it gives notes on habits and chief needs.

COLDWATER FISHES

Bitterling (*Rhodeus amarus*): the alternative name of rainbow carp indicates the glorious hues that suffuse the flanks of the male at breeding time. These two or three inch long fishes are good community aquarium fishes, not minding tank temperatures slightly above normal. Eggs are deposited from the long tube (ovipositor) trailed by the female in summer, into the Painter's mussel; the presence of these molluscs is therefore necessary in the breeding tank. Newly hatched fishes are ejected from the mussel some weeks later. Chopped earthworms, insect larvae and dried foods are taken by bitterling. The beauty of this species is not seen in ponds.

Bleak (*Alburnus lucidus*): a small fish that does well in ponds and aquaria. Adults are five or six inches in length but youngsters introduced to tanks seem happy to reach a maximum of three to four inches. It occurs widely in British rivers and is an extraordinarily lively surface fish, with an obliquely set mouth, and flashing silver sides. Its fins are translucent. Although always shy in an aquarium it will rise to take food (chopped meat or offal, worms, flies and aquatic larvae as well as dried foods) when offered, with a quick dash. Bleak live

peaceably with other fishes of the same size and are tolerant of temperatures up to 65°F. in shallow, small tanks.

Bream (*Abramis brama*): rather a large fish (ten inches when adult) for aquaria, and it prefers the depths of a pond. Youngsters are silvery and when they develop into bronze coloured dark-finned adults, are not so conspicuous. For this reason, and because of its lazy nature, bream are apt to disappoint the pond-owner. Few foods are refused by bream.

Bronze carp (*Cyprinus carpio*): clear water and carp do not go together, and in an aquarium carp will see to it that the sediment is perpetually suspended in the water. They become very tame in tanks and ponds, readily taking food from the fingers. No special food preferences are shown by carp; they include vegetable matter in their diet. Their dark brown and bronze colours, with paler bellies, are not unattractive. Carp will live together with goldfishes and their breeding habits are similar. Lengths of over two feet can be attained in large ponds by this very hardy species. Warm water does not bother carp, but they cease feeding at temperatures below 48°F. Varieties are the mirror carp, which possesses a line or two of extra large and shiny scales on its sides that make small specimens handsome aquarium fishes, and the leather carp, a fish that appears to be without scales. The Japanese variety, or Hi-goi carp, is coloured red and hence is a popular pond fish.

Carp (*Carassius carassius*): of similar habits to the foregoing, Prussian or Crucian carp (the names refer to varieties differing only slightly) are also good pond subjects. Young specimens can be confused with uncoloured common goldfishes, for like them and unlike the previously mentioned carp they have no mouth barbels. All the carp enjoy a fairly long life.

Chub (*Leuciscus cephalus*): too big for the aquarium when adult, but young chub up to six inches in length can be placed in aquaria. Such large specimens are apt to be bullies and should not be included in ponds with smaller or less sturdy fishes. Large scales are possessed by chub, and these are silvery in young specimens. Temperatures over 60°F. will upset this fish.

Dace (*Leuciscus leuciscus*): young dace are very similar to chub but do not have the convex edges to their anal fins. They are very active surface fishes and like plenty of room. Live foods are essential. The pond is really the best place to keep this species, which lives at peace with other fishes.

Eel (*Anguilla vulgaris*): small eels kept in aquaria on their own make unusual and highly interesting subjects. They are of little use in ponds, for scarcely if ever, are they seen. A deep layer of very coarse sand or fine shingle should be provided in the aquarium, and plants other than sturdy ones such as pondside rushes added purely for decoration cannot be used. The aquarium must also have a tight-fitting cover and should receive only weak illumination. Young eels will bury their bodies in the sand, with the head protruding above it. Earthworms or meat and offal are well-liked foods and must be abundantly provided. Eels are hardy and tolerant of wide temperature changes.

Gudgeon (*Gobio gobio*): a bottom-living long-bodied fish of dull coloration which reaches a size of about six inches. In aquaria its sand-grubbing habits upset water plants and fine shingle is a better medium to use. Young specimens do well in tanks, but the species is not really suited for the garden pond, although it becomes quite tame there. Vegetable and animal foods are taken and earthworms can provide a staple item of diet.

Loach (*Cobitis barbatula*): small specimens of two inches in length make good aquarium subjects despite their retiring nature (they like plenty of stones beneath which they can hide). Night is the time when they are active. The spiny loach (*Cobitis taenia*) is similar, slightly smaller and has longer barbels around its mouth. The loaches live amicably with other small fishes and feed on small worms and meat.

Miller's thumb (*Cottus gobio*): a small fish, sometimes called the bullhead, of unusual shape and finnage, which makes a good aquarium inmate. It is common in British streams, and likes cool living conditions. Miller's thumbs can be kept with larger fishes but are too eager to use their capacious mouths to be company for small specimens. Large stones as shelter can be placed in the aquarium, and plenty of worms should be provided to feed the fishes.

Minnow (*Phoxinus phoxinus*): this fish is the 'red-throat' of small boy anglers; the males adopt a scarlet-coloured undersurface in early summer. Minnows are small (three inches) fishes that take to pond life but do not do well in *small* aquaria. They are very attractive specimens for larger shallow tanks. Worms and aquatic larvae are preferred as food. The temperature of their tank should be maintained below 65°F., and although they get on well with other small fishes, their liking

to swim with others of their own kind in small shoals, and the fine sight they make in this way, makes it worth while to give them plenty of space on their own.

Orfe (*Leuciscus idus*): the golden variety of this continental fish is an excellent fish for the garden pond. It is a slender bodied and active species, not shy of onlookers. Very young specimens can be kept in aquaria with other fishes, if they are not overcrowded, but the pond is the place for them to give full entertainment. A length of twelve inches is reached under good conditions, when plenty of live foods are available. In ponds fulfilling this food requirement and having thickly planted shallow regions, breeding may take place. Plenty of plants are needed or the eggs and fry will be eaten. Like many other coldwater fishes, male orfe develop white tubercles on their gill covers in spring. Hot thundery weather makes these fishes uncomfortable, and temperatures below 55°F. are preferred. The importance of providing live foods for orfe cannot be over-emphasized.

Perch (*Perca fluviatilis*): a striking fish for the aquarium but one that must be given only its own company, for it is ferocious to smaller or weaker fishes. It is a common river fish and year-old specimens about three inches in length are best for tank life, if the water temperature does not exceed 55°F. Real beauty is possessed by the perch; its fins are reddish and the vertical black bands on its olive green sides are prominent features. Perch are carnivorous, and become tame enough to take worms or pieces of meat from their owner's fingers. Their appetities are enormous. With larger fishes, they can be included in pond communities.

Pike (*Esox lucius*): small pike (up to six inches) are attractive fishes for a large aquarium, and they become very tame. They are prodigious eaters, and will attack any fish slightly smaller than themselves. Only meat, earthworms or small fishes will be taken as food. Water temperatures around 55°F. are ideal for pike; they should not be placed in ponds.

Roach (*Leuciscus rutilus*): for some reason the roach is subject to various diseases when kept in captivity and few fish-keepers have been successful with it either in tanks or ponds. Its scales are easily damaged, and this is a frequent cause of fungus developing.

Rudd (*Scardinius erythrophthalmus*): this is one of the commonly kept coldwater fishes and can be recommended for both ponds and aquaria. Young rudd will live in quite small

aquaria; in larger tanks or ponds they make good community fishes. Their chief attractions are their rich red fins and eyes, and the golden rudd, a colour variety of the naturally occurring type, is a beautiful fish. Fish foods of all kinds are taken, and a tank temperature of about 60°F. suits it. Rudd grow to about a foot in length. Specimens of three to six inches are favoured by fish-keepers.

Stickleback (*Gasterosteus aculeatus*): for sheer entertainment an aquarium containing these pugnacious, perky and intelligent seeming fishes takes some beating. In the breeding season, spring and early summer, the males develop bright red bellies, and with their greenish backs, silvery sides and surprisingly blue eyes they rival some of the tropical species. Fights are common at this time and unless large aquaria are used only one male should be present with the females. In tanks thickly planted with such species as *Fontinalis* the male will build a nest, in which eggs are laid by the females. Parental care of the young, when they hatch, is also demonstrated by the male stickleback. Ordinary room temperatures suit the stickleback aquarium. Living and meaty foods are required. The stickleback's predatory habits make it unsuited to the community pond.

Tench (*Tinca tinca*): another popular fish for the aquarium when small, or for garden ponds when large. It is a very dark olive-green in colour and is a bottom-loving species; consequently the golden variety is preferred for ponds. Tench grow over a foot in length but specimens two or three inches long are frequently available from dealers. It breeds readily in ponds in June or July; plants bearing the eggs are best removed to an aquarium to hatch, if it is desired to save the young. Wide ranges of temperature do not appear to affect tench. Earthworms are a favourite food.

Trout (*Salmo trutta*): as an experience in rearing young fishes the 'eyed ova' of trout can be purchased from trout hatcheries and hatched in a cool aquarium. After the yolk-sacs with which they hatch have disappeared, Infusoria must be given and followed by small living foods, or egg-yolk or powdered liver suspensions, as the fry increase in size. Without running or circulated water the adults are difficult to keep.

American fishes: several coldwater species from America are sometimes available from dealers, and one popular one is the catfish (*Ameirus nebulosus*). It grows to ten inches but the specimens sold are only a third of this size and can be added

to the community tank of similar sized fishes. It is a nocturnal species and is rather shy at first. Meaty foods, earthworms, etc., are swallowed greedily, and when well fed catfishes grow very quickly. They do not breed in aquaria and will not survive an English winter in ponds.

The sunfish and basses are large, attractive American fishes which like aquarium temperatures of 45° to 65°F. They are carnivorous and incurable bullies, so that they must be kept on their own; but like the other aggressive fishes mentioned here they are particularly good friends with their owner, greeting him with obvious signs of anticipation when he approaches their tank, and will readily feed from the hand. Species include the sunfish and the diamond, black and peacock-eyed basses.

CHAPTER VIII

THE GOLDFISH

A FISH that has been kept in captivity for centuries, one that is the sole object of study of the Goldfish Society of Great Britain and has had whole books devoted to it, surely deserves a chapter to itself in this handbook.

That wild fishes in rivers of southern China included some variants with red scales was recorded in the fourth century, and sometime between then and the tenth century these progenitors of the goldfish (*Carassius auratus*) were domesticated in ponds by the Chinese. From China they have since been dispersed all over the world, and to-day in this country the goldfish is still the most popular fish for garden pools.

In addition to the common goldfish, which even now will revert to the comparatively drab coloration of its ancestors if allowed to go wild in rivers, there are well over a hundred fancy breeds. These have had special characteristics developed (over-developed in some cases) by selective breeding; lengths of fins, body shape, eyes, colours and scales have all received attention.

Serious breeders who are members of the society mentioned above are now concentrating their efforts on four basic varieties: 'singletails,' 'twintails,' 'globe-eyes' and 'bramble-heads.' They are also recognizing three types of scale formation in each of the basic varieties: 'metallic,' 'nacreous' and 'mat.' Universal acceptance of these names has yet to be

obtained, and here names by which varieties are known to dealers will be used.

Common Goldfishes

Young goldfishes in their first months are dark bronze in colour, and some do not change to the golden form until nearly a year old. The final colour is extremely variable. All shades of yellow and gold are seen, from the brassy to the rich deep red that is so admired by fish-keepers. Some fishes retain black markings, others may show silver-coloured patches. These are often the kinds that find their way on to the market as 'common goldfishes.'

Well-nourished specimens mature by twelve months, when they are nearly three inches long. Males can only be distinguished from females in the breeding season—spring and early summer. The males then exhibit chasing behaviour in the presence of females and some of them develop small, pimple-like tubercles on the gill-covers and pectoral fins. These raised structures can often be felt with a finger tip when the fish is held in a net even if they are not readily visible. Females show sides distended with the ova they contain; this difference of outline is most marked when the fishes are viewed from above.

Common goldfishes are quite hardy and will live in the pond, providing this has a wintering region at least two feet in depth, or in coldwater aquaria. The temperature most favoured by goldfishes is around 65°F. They should not be overcrowded. Notes already given in Chapters III and VII apply equally to goldfish tanks and their maintenance.

Goldfishes thrive on small or chopped earthworms, and these, with the use of a suitable grade of dried food, can be used as food as often as they can be obtained. They will also take most of the live foods listed in Chapter X. A little green food is sometimes relished by these fishes. *Elodea* can be planted or floated in their tanks for this purpose, or a little duckweed added occasionally. Feed goldfishes at least once a day and beware of over-feeding: they are rather messy feeders with dried foods and spread them all over the tank. The result is the permanent slight milkiness so often seen in tanks of these fishes.

Filters are sometimes used in tanks containing large goldfishes to reduce the particle density of this suspension, but the bacteria responsible for the opalescence are not removed by

PLATE I

An attractive tropical aquarium pictured in the hall of a private house. Notice that electric wiring to top lights and heater are concealed and not allowed to detract from the aquarium's appearance. Electrical apparatus is controlled by a neat switch panel at one end of the stand. *Photograph: Dr Gert Aurell.*

The arrangement of water plants in an aquarium can make or mar the furnished tank. A well-planted aquarium is shown below. Tropical fishes seen in it are angels, hatchet fishes, rosy barbs, black mollies and a pearl gourami. Plants include *Myriophyllum, Limnophila*, Amazon sword plants, *Ludwigia, Cryptocoryne, Vallisneria*, (left to right). *Photograph: Valerie Lilley.*

PLATE II

Water plants for aquarium use. *Top left*, Indian fern (*Ceratopteris*); *Top right*, willow moss (*Fontinalis antipyretica*); *Bottom left*, curled pondweed (*Potamogeton crispus*); *Bottom Right*, water violet (*Hottonia*).

Photographs: Lionel E. Day.

PLATE III

Water plants for aquarium use. *Top left*, *Ludwigia*. *Photograph: Lionel E. Day.* *Top right*, *Vallisneria* (twisted leaf variety); *Bottom left*, *Cabomba*; *Bottom right*, water hyacinth (*Eichhornia*), a surface floating plant.

Photographs: L. E. Perkins.

Male veiltail goldfish.

PLATE IV

Young fantail goldfish. *Photographs: L. E. Perkins.*

this means. It is easier to siphon out and discard some of the water now and then and replace it with fresh. Complete changes of water are not necessary; partial changes are beneficial. It is of great help to the fishes in thundery and hot spells.

Fancy Goldfishes

The first three varieties in this list are suitable for pond life. It is risky to leave the others in ponds during winter, although they may be kept outside in summer months.

Comet goldfish: this variety has a head and body resembling a common goldfish and is of similar colour, but its caudal fin ('tail') is elongated into two streamers behind the fish.

Fantail goldfish: the caudal fin of the fantail is double, each half being forked, to form four lobes; it spreads behind the fish in a similar way to the tail of a fantail pigeon. The body is oval in shape and there is a paired anal fin. Like the common and comet goldfishes it is a ready breeder in ponds.

Shubunkin: shaped like a common goldfish, with similar finnage, but with a caudal that approaches that of the comet, this variety has variegated colouring and markings. In good specimens the main colour is blue with brown, red, yellow and black mottlings evenly dispersed over it. (It is said to be a 'calico' or 'scaleless' fish; actually the scales of such fishes are thin and transparent, and are not absent. A calico variety of the fantail exists, for example). Shubunkins will breed in outdoor ponds.

Veiltail goldfish: the veiltail's body is spherical. Its caudal fin is completely divided and flows far below the fish. Like the fantail it has a paired anal fin, and a calico variety is kept. The veiltail is bred in aquaria kept at about 70°F.

Telescope goldfish: a variety with protruding bulbous eyes which do appear as if they are telescopic. The telescope-eyed moor is a black fish with a body similar in shape to the veiltail, and showing this eye-protrusion.

The oranda and lion head fishes are extraordinary specimens with raspberry-like growths on the tops of their heads. These grotesque breeds are delicate and their breeding calls for the attention of the specialist.

Goldfish Spawning in Ponds

The best plan when breeding goldfishes is to let the spawning take place in an outdoor pond and then to remove the c

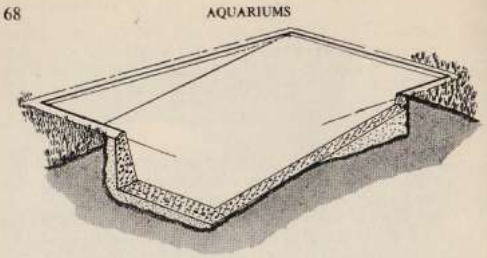

Fig. 17. Small pond with sloping bottom suitable for goldfish breeding (cut-away view).

eggs to sheltered tanks wherein the fry may be hatched and reared.

A spawning pond need not be large (four feet by six feet is a convenient size) but it must be shallow. One end should gently slope down from a depth of water of a few inches to a depth at the other end of about eighteen inches. Use fresh clean water for it and see that no water snails or other egg consumers are present. Anchor by means of string, generous bunches of clean willow moss, hornwort or milfoil, to receive the eggs. Shake the bunches regularly to keep them free from sediment. One or two pairs of mature fishes can be added in May and given liberal feeds of earthworms.

When the water temperature reaches the sixties watch for signs of the males driving the females in the pond, and then keep a close eye on the bunches of plants for the presence of eggs. Spawning is most likely to take place early one morning and the faintly amber, pin-head sized eggs will be found scattered over the plants and stuck to them. Bunches of plants with the adherent eggs are then removed to hatching tanks; the parents will continue to spawn at intervals throughout the summer, up to August, and further eggs will be available if fresh plants are provided.

It is possible to leave the eggs in the spawning pond and remove the parent fishes; the fry will hatch there quite well but the number reared will not be as great owing to the difficulty in providing sufficient food.

Hatching the Eggs

Useful containers for fry hatching and rearing can be made from old water cisterns that have been floated over inside with two coats of a mixture of equal parts of cement and sand with water. Holes can be filled in with wooden bungs beforehand. The dry cement must be soaked and washed with three or four changes of water over the course of a week before using the tank. Water from the pond can then be placed in it to a depth of a foot and the water plants with the eggs dropped in

Hatching occurs in four or five days if the water is at 75°F. and not until after a week at lower temperatures. If a cold spell occurs a low wattage immersion heater can be employed to keep the temperature up. Another tank filled with pond water should be placed in the light to go green, to provide food for the young fishes later on. For 48 hours after hatching the fry subsist on the yolk-sacs with which they are born, and no food should be given.

Top light is necessary for the rearing tank as the fry only feed during daylight hours. For the first ten days they can be given regular additions of the green water from your special tank, or a suspension of hard-boiled yolk or dried egg particles in water can be dripped in throughout the day by means of a slow siphon from a jar of the suspension. It is imperative that food is constantly available for the fry at this stage.

Rearing the Fry

If the fry have made good progress, at about two weeks they will be large enough to be given coarser suspensions of egg yolk or pulped meat or earthworm. Beware of letting excess foods accumulate, however. Some of the water can be removed and replaced by fresh from the pond each day to avoid stagnation.

After a month the young fishes should be ready to take live foods such as *Daphnia*, chopped worm and *Tubifex*, and fine dried foods. The amount they require varies with temperature, and you must be guided by their appetites. Their size will now be such that the tank will become overcrowded, so their number must be divided between several tanks. Keep the water shallow, and continue the partial changes.

Adequate living space is the main requirement from this stage onwards, and if sufficient tanks are available large numbers of healthy fishes will be reared. If you can get them

to about two inches in length before the autumn they can be placed in the pond for the winter, but smaller specimens should be kept in tanks until the following spring.

Goldfish Breeding in Aquaria

Breeding can take place in well-planted aquaria of not less than twelve gallons capacity (24in. by 12in. by 15in.). The pair of fishes must be mature, over three inches in length, and in breeding condition; the females should show bulging sides. Divide the aquarium with a cross pane of glass and place the female on one side and the male on the other. Daylight should be allowed to reach the tank.

Keep them like this for a week, feeding, as often as they will take food, with chopped worms. See that the temperature is not below 65°F., then remove the partition one evening during a sunny spell of weather and drop the water level to six inches depth. Spawning is likely to occur the following morning.

Once the eggs are laid the fishes must be removed and then hatching and rearing can take place in the same way as described above. If at the first attempt spawning does not occur, separate the fishes for another week and repeat the procedure. A change of water just before removing the glass partition sometimes encourages spawning behaviour. However, attempts made to spawn goldfishes in small tanks often do fail, particularly when young specimens are used, and disappointment need not be tinged with self-recrimination.

CHAPTER IX

TROPICAL FISHES

Most of the commonly available tropical fishes are easy to keep and do not require a great deal of attention. If the use of the word 'tropical' conveys any impression that they are tender or delicate it does so unjustifiably, for the average beginner with a small aquarium as a rule finds far greater difficulty in maintaining a pleasing-looking tank of healthy coldwater fishes than he does when beginning with tropicals.

Aquarium Size

The smallest tank that can be used for a little community of small species is the 18in. by 10in. by 10in. size, but for

general purposes the 24in. by 12in. by 15in. size is much to be preferred. Tropical aquaria are set up in the way previously discussed, and the water in them is maintained somewhere in the range 65°F.—85°F. A constant, steady level is not necessary, but *sudden* fluctuations of temperature must be avoided. Keeping fishes at unnecessarily high levels shortens their life considerably. Tank maintenance has been outlined in Chapter III and feeding is the subject of the following chapter.

Small tropical fishes can be overcrowded in tanks by ordinary standards. An allowance of ten square inches of water surface for each inch of fish body length is adequate, for their bodies are slight and they have become adapted to living in warm waters of relatively low oxygen content. The larger species, over three inches in length, should be given the full allowance of twenty-four square inches to each body inch.

Undoubtedly responsible for much of the popularity of tropicals is the attractive appearance in a living room of an illuminated aquarium housing a brilliantly coloured assortment of tiny fishes, though it frequently happens that once this is possessed its owner soon feels the urge to start breeding one or more of the species he keeps. For this additional tanks are necessary. Suggestions for suitable communities are given in this chapter after the notes on individual species.

Choosing and Transporting Tropicals

That fishes selected should be healthy specimens needs no stressing. Healthy tropicals are alert and constantly swimming round their tank; their finnage does not appear lifeless and is borne on well-coloured bodies that are nicely rounded.

For transporting them long distances quart-sized screw-topped fruit preserving jars, wrapped round with cotton wool and brown paper to retain heat, can be used. Special large Thermos flasks with wide necks are also obtainable for this purpose. Do not fill transport containers completely with water—half-filled they contain enough air to last the fishes some time. When their destination is reached float them in the prepared aquarium for a short time to equalize the water temperatures.

Live-bearing Tropicals

A number of small fishes which, instead of laying eggs, produce living young—the majority coming from Central America and the West Indies, are perhaps the most popular

of all aquarium fishes. They grow quickly, becoming mature by about two months, and most of them breed without any encouragement in small aquaria.

If plenty of water plants are present and the fishes are well fed, some of the young will escape being eaten even in tanks of mixed species. Sexing the adult live-bearers is easy, for the males have the anal fin modified to form the intromittent organ, by means of which sperms are deposited within the female to fertilize the eggs. Sperms are stored by females and several broods may be produced without subsequent consort with a male.

A temperature of 70°F. suits the live-bearers and they will take living and dried foods. Green food is also a favourite and it helps if a little green algae is permitted to grow in their tanks. All are good community fishes.

Guppy (*Lebistes reticulatus*). Male: 1in., slender and multi-coloured. Female: 2½in., olive green with a dark 'gravid spot' which increases in size when young are expected. From six to 100 young produced every four or five weeks. Life: 1½ years.

Platy (*Xiphophorus maculatus*). Male: 1½in. Female: 2in. Both olive-green with dark crescent 'moon' spot before the tail. Red, blue, black, golden, and variegated varieties occur. About 50 young produced every four weeks. Life: 2—3 years.

Variable platy (*Xiphophorus variatus*). Male: 1½in., variegated colouring. Female: 2in., olive-green back, white belly. Males carry all the colour: reds, blues and yellow. Prolific breeder.

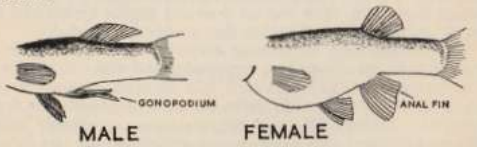

Fig. 18. Livebearer sex characteristics.

Swordtail (*Xiphophorus helleri*). 3in. Lower edge of the male's tail projects as a 2in. spike. Green with red and yellow stripes. Red, albino and variegated varieties occur. Six to 200 young produced monthly. Likes spacious living conditions; large males may be aggressive in communities and to one another. Great jumpers. Life: 2—3 years.

Mollie (*Mollienisia sphenops*). Size variable, 2½—3½in. Grey speckled with black. Velvet-black specimens are available. *Mollienisia latipinna* and *M. velifera* are larger mollies with broad dorsal fins. Mollies are fond of eating green algae. Spacious tanks are needed for mollies, they do badly if at all crowded. Females should not be netted when gravid. Young are produced monthly and are often delicate; the presence of sea salt in the water is favourable to these fishes. Young specimens can be kept in mixed tanks. Life: 5 years.

Mosquito fish (*Heterandria formosa*). Male: ¾in. Female: 1in. Olive, with dark line and vertical bars. Two or three young are born weekly, with periods of quiescence occurring irregularly. Fine dried foods or tiny living foods are required. Too small for the community tank. Life: 2 years.

Half-beak fish (*Dermogenys pusillus*). Male: 2in. Female: 3in. Coming from Siam, these fishes show an unusual feature in the marked extension of the lower jaw to form a bird-like beak. They can only feed from the water surface: dried foods, mosquito larvae, *Tubifex* and blood worms are taken. Small broods are produced regularly; the new-born young lack the beak. Community fishes.

Egg-laying Tropicals

For convenience of presentation the egg-layers are grouped under the commoner fish families encountered in the aquarium. These are the Cyprinidae (carps); the Characidae (characin fishes); the Anabantidae (bubble-nest builders); the Cichlidae (cichlids).

Sexing egg-layers is often a difficult task, and where no sex differentiation characters are listed the general remarks on sexing fishes in the chapter on breeding should be consulted (see page 92). The growth rate of fishes, their size and the age to which they live are extremely variable; factors like temperature, abundance of food, stamina of the strain and the amount of living space allowed, influence the figures considerably.

TROPICAL CARPS

Zebra fish (*Brachydanio rerio*): 2in. Wide blue-black longitudinal stripes on a silvery body. A stream-lined and very active fish. At home in community or small tanks. 75°F. is an agreeable temperature. Males are slimmer than females, which bulge noticeably when ready for spawning. Easy to breed. Live foods are preferred. Life: 2—3 years. (India).

Pearl danio (*Brachydanio albolineatus*): 3 in. Pink-suffused mother-of-pearl appearance. Same habits, etc. as zebra fish.

Giant danio (*Brachydanio malabaricus*): 4in. Metallic blue lines broken by golden vertical bars. Fins redden when fishes are in breeding condition. Active fishes with no strict dietary demands. Too large for communities of small fishes but good mixers with fishes of similar sizes. Females are fuller in outline than males; easily bred. Life: 3—5 years. (India).

Rosy barb (*Barbus conchonius*): 3in. Males develop bright red colours spreading to the finnage when in breeding trim. Normally both sexes show glistening silvery scales darkening over the back. There is a black spot near the tail; male finnage always shows more colour than the female. Breeding at 75°F. (24in. aquarium); 150—500 eggs scattered in plants; fry hatch after 36 hours. Dried and live foods. Life: 3 years. (India).

Tiger barbs (*Barbus tetrazona* and *B. partipentazona*): 2in. Both species show four vertical dark bars spaced along their heads and bodies, are silvery below and have red finnage. The former species (Sumatra tiger barb) lacks the dark saddle that forms part of a fifth bar below the dorsal fin in the Malayan tiger barb (*B. partipentazona*). Males have brighter colours, and more red in the fins; they are less rotund. Often kept as community subjects but will nip the fins of long-finned species. Large tanks are used for breeding—not readily accomplishable. 75°F. Life: 3 years. (Malaya).

Ruby barb; nigger or purple-headed barb (*Barbus nigrofasciatus*): 2½in. When in breeding colour a magnificent fish. Males then show a ruby red glow on the head and foreparts. Dark bars occur on the body on a normally dark olive ground. Females recognized by their plumpness. Good community fish and not difficult to breed in medium sized tanks with soft water. 75°F. Usual barb diet—dried foods, live food of all sorts and some green food. Life: 3 years. (Ceylon).

Chequered barb (*Barbus oligolepis*): 2in. Colour differences distinguish the sexes, females being plainer. Prominent black marked scales are possessed by both, and the orange black-edged dorsal fin is another feature. 75°F. Peaceful community fish. Not easily bred. Barb diet. Life: 3 years. (Sumatra).

Cherry barb (*Barbus titteya*): 1¾in. Variable coloration. A blue-black lateral stripe is a constant feature. Males are cherry red on head and lower body at breeding times; females are less brilliant in colour. 75°F. All foods. Breed in well-

planted shallow medium-sized tanks; eggs hatch 36 hours. Look best in a small shoal on their own. Life: 2—3 years. (Ceylon).

Ticto (*Barbus ticto*): 3in. A lively barb with two dark spots distinguishing its conspicuously scaled silvery sides. Males more colourful, with a rose-red band to the dorsal fin. 75°F. All foods. Breed readily in 24in. aquaria that are well-planted; up to 300 eggs; 30 hours hatching. A peaceful species best kept with other lively fishes. Life: 3 years. (India).

Harlequin fish (*Rasbora heteromorpha*): 1½—2in. An outstanding fish having a black triangle at the rear half of its body. Males show a beautiful golden line along the top edge of the triangle, and the red background is more intense. A fish that often defies breeders' efforts. Large leaved plants such as *Cryptocoryne* are used for spawning. 75°F. Likes plenty of live food. Good community fishes. Life: 3 years (Malaya).

Scissors-tail (*Rasbora trilineata*): 2½in. The deeply cleft tail and the closing and opening movements of its lobes earn this attractive fish its popular name. 75°F. Live foods. Females are deeper-bodied when ready for breeding, which can occur in small aquaria with plenty of plants. Well worth keeping on their own. Life: 5 years. (Malaya).

White cloud mountain minnow (*Tanichthys albonubes*): 1½in. This tropical fish will live and breed in outdoor ponds in summer and stands temperatures down to 45°F. Its body has a head to tail blue-green streak (iridescent in young fishes). Easily bred in small aquaria at 70°F. Small live or dried foods. Excellent community specimens. Life: 2½ years. (China).

CHARACINS

Flame fish (*Hyphessobrycon flammeus*): 1½in. Olive-brown above, silvery yellow below with a deep wine-red rear end of the body. Red fins and gold-rimmed eyes. Males show more red in the ventral fins, and like the anal, these fins are black-edged in males. Breed in small aquaria with soft water; 150 eggs; hatching time 48 hours. 75°F. Live foods for preference. Fin-nippers if kept with long-finned fishes. Life: 3½ years. (Rio de Janeiro).

Glow-light tetra (*Hyphessobrycon gracilis*): 1½in. The 'glow-light' is an iridescent head to tail line of red, broken by a blue spot. The glow also appears in the upper part of the eyes. Sexing is difficult. Light-screened tanks (ten gallon size) with soft water, in a quiet position, are used for breeding; eggs

are hatched in complete darkness; 24 hours hatching time. Use live foods mainly. Good community fishes. 75°F. Life: 3 years. (Guiana).

Neon fish (*Hyphessobrycon innesi*): 1½in. A slender fish with an 'electric' blue-green iridescent band running through the eye nearly to the tail, and having a bright red stripe just in front of the tail below the neon line. Varied diet of all foods. Breeding is a job for the specialist. Good community fishes. 75°F. Life: 3 years. (Western Amazon).

Belgian flag tetra (*Hyphessobrycon heterorhabdus*): 1½in. An attractive fish with red coloured eyes and a lateral stripe composed of black, red and yellow lines. Colours are variable however. 75°F. Live foods should predominate in the diet. Seldom breeds in aquaria. Males evidence 'hooks' on the anal fin when caught in fine nets. Peaceable with other fishes. Life: 3 years. (Amazon).

Serpae (*Hyphessobrycon serpae*): 1½in. A red-coloured characin with a black-marked dorsal fin. The male is the more brilliant fish; it has a taller and broader dorsal and is less deep in the body. Very active when young. Breed in soft water over a pebbly base; hatching time 20 hours. 75°F. Varied diet. Sometimes a fin-nipper in mixed tanks. Life: 3 years. (Brazil).

Rosy tetra (*Hyphessobrycon rosaceus*): 1½in. Prominent, tall black dorsal fin with white edge developed by the males is also more pointed than the same female fin, in this pink coloured fish. Self-selected pairs will spawn in 24in. tanks arranged as for glow-light tetras; 200 eggs; keep light from them; hatching time 36 hours. Peaceful with other fishes. 75°F. Life: 3 years. (Guiana and Brazil).

Black widow fish (*Gymnocorymbus ternetzi*): 2½in. The funereal livery of the widow is quite attractive, particularly in young specimens under two inches. Live foods are needed to get a good size in this fish. Breeds infrequently. 75°F. Small fishes are best for community life. Life: 3—4 years (Paraguay).

Enamel fin; X-ray fish (*Pristella riddlei*): 1½in. White enamel-like tips to dorsal and anal fins and its rather translucent body are responsible for this fish's popular names. Females have plumper bodies than males and the species is not difficult to breed. 75°F. Live foods should predominate. Lives quietly with other fishes. Life: 3 years. (South America).

Oblique fish (*Thayeria obliqua*): 2½in. Swims in an unusual head upwards position. A black line extends from the gill

cover laterally into the lower tail lobe. All foods. Breeds in medium-sized aquaria. 75°F. Well behaved with fishes of its own size. (Amazon).

Beacon fish; head-and-tail-light fish (*Hemigrammus ocellifer*): A bright red glowing spot above the eye pupil and another at the tail are immediately apparent features. The full deep body of the female and the small white flecks on the anal fin of the male serve to differentiate them. All foods are taken. 75°F. Ready spawners; two males are placed with one female in a 24in. tank, thickly planted, in soft water; 300 eggs; hatching time 48 hours. Suitable for the community. Life: 3 years. (Guiana and Brazil).

Bloodfin (*Aphyocharax rubripinnis*): 1½in. All the fins except the pectorals are blood red, though the colour comes and goes with the fishes' moods. The body is olive-green above and bright silver below the lateral silvery band. Breeding takes place in 24in. aquaria thick with plants; hatching time 30 hours. 75°F. Living and dried foods taken. Good community fishes. Life: 4 years. (Argentina).

Hatchet fish (*Gasteropelecus* sp.): about 2in. Strange, thin, flat-bodied fishes with deep bellies and upturned mouths denoting their surface feeding habits. Live foods are necessary. Have not bred in aquaria and are not really suited to community life. 75°F. (South America).

Pencil fish (*Nannobrycon eques*): 1½in. Fishes with elongated bodies which swim head upwards in the water. Golden brown with dark horizontal stripes; red splash on anal fin. Varied feeders. 75°F. Community fish. Life: 3 years. (Guiana and Amazon).

Nannostomus marginatus: 1½in. A very attractive small species with an elongated body marked with red and dark bands, and a silver belly. Fins are also marked with red. Breeds (males are the slimmer and more colourful fishes) in small aquaria. 75°F. Will live in peace with other small specimens. Life: 2 years. (South America).

BUBBLE-NESTERS

Fishes mentioned here are readily bred. Large tanks (at least 24in. in length) should be used but the water depth need be only six inches. Male bubble-nesters construct the raised nest of bubbles at the surface, in which numerous eggs are placed. Females must be removed after spawning; the male parent can be left to look after nest and young fishes for

Fig. 19. Male blue gourami with bubble-nest on water surface.

a week. A tight-fitting cover to the tank is necessary to exclude draughts and surface chilling. Large amounts of food (Infusoria or fine egg-yolk suspension) must be available for the fry.

Paradise fish (*Macropodus opercularis*): 3in. A fish that will live in tanks at 60°F. The male is brilliantly coloured and has longer fins than the female. Pugnacious to smaller fishes. All foods are taken. Life: 5 years. (China).

Siamese fighting fish (*Betta splendens*): 2½in. Males of this species cannot be kept together when over three months. They do not require a lot of space and tanks can be partitioned to accommodate them. Long flowing brightly coloured finnage distinguishes the male. 10in. aquaria will house pairs of fighters, or young pairs can be placed in community tanks. Live and meaty foods. 75°F. Life: 2 years.

Dwarf gourami (*Colisa lalia*): 2in. A shy fish but worth including in a community. Males are brightly coloured and have larger fins. All foods. 75°F. Life: 3 years. (India).

Thick-lipped gourami (*Colisa labiosa*): 3in. Sexed as the foregoing. Suitable for large fish communities. All foods. 75°F. Life: 5 years. (Burma).

Blue gourami (*Trichogaster trichopterus*): 4in. A blue variation of the silvery three-spot gourami. Males are darker

in hue and possess longer, pointed dorsal fins. All foods. 75°F. Life: 3 years. (India and Malaya).

Pearl gourami; mosaic or lace gourami (*Trichogaster leeri*): 4in. A beautiful gourami, sexed as the blue. All foods. 75°F. Like the blue, small specimens can be kept in communities. Life: 3 years. (Malaya).

CICHLID FISHES

Among the most interesting of all tropicals, these fishes are rather big and need large aquaria to themselves. They produce numerous young, for which parental care is shown, but space considerations prevent fish-keepers from raising them all. Plants are seldom tolerated in their tanks and rockwork (on which eggs are often laid) must be the chief decorative feature. Most cichlids live from five to ten years, some species even longer. They become very tame and show an interesting form of 'kissing' that appears to be a test of strength and superiority with their fellows. Living or meaty foods are the only acceptable diet; unwanted baby live-bearers are greatly appreciated as food.

Angel fish (*Pterophyllum scalare*): 5in. Pictured on the front cover. Small specimens (half-crown size) take to community life. They are unusual cichlids in being troublesome to induce to breed, and their shape is atypical of cichlid form. Sexing is difficult. Young angels occasionally lose appetite and waste away; change of diet or living conditions can be tried as cure. Intensity of the dark vertical markings varies enormously from time to time and is not necessarily a sign of something amiss. 75°F. (Amazon).

Jewel fish (*Hemichromis bimaculatus*): 4in. A beautiful but savage fish. 75°F. (Africa).

Chanchito (*Cichlasoma facetum*): 5in. Less vicious than the jewel fish but too big for ordinary tanks. 70°F. (Argentina).

Fire-mouth cichlid (*Cichlasoma meeki*): 4in. Fiery red under surface (most marked in the male at breeding time). Pugnacious. 75°F. (Yucatan).

Jack Dempsey fish (*Cichlasoma biocellatum*): 5in. Pugnacious but none the less beautiful. 75°F. (Brazil).

Blue acara (*Aequidens latifrons*): 5in. A species quite tolerant of other fishes of its own size. Youngsters have great beauty and large numbers are produced. 75°F. (Panama).

Egyptian mouth-breeder (*Haplochromis multicolor*): 2½in. Females use their capacious mouths as nurseries for up to 100

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eggs and fry. Can be kept with fishes a little larger than itself. 75°F. (Egypt).

Dwarf cichlid (*Apistogramma ramirezi*): 2in. A cichlid with a future in aquarium life, for it is small, very attractive in colour, breeds easily, and behaves itself with other fishes. 75°F. (Venezuela).

CATFISHES

These bottom-living, 'whisker'-bearing fishes are amusing community tank occupants though they are active mainly at night. Sexing and breeding them is mostly difficult. A wide variety of foods is taken. Temperatures from 65°F. to 75°F. are suitable.

Species include the dappled catfish (*Corydoras paleatus*) 2½in.; bronze catfish (*C. aeneus*) 2½in.; leopard catfish (*C. julii*) 2½in. The glass catfish (*Kryptopterus bicirrhus*), 2½in., resembles the X-ray picture of a fish rather than a real specimen (needs live foods but is an interesting community fish), and the upside-down catfish (*Synodontis nigraventris*) 2in. is unusual in swimming in the inverted position. This fish is disappointing in a lighted, planted tank, however, for it spends all its time hidden away.

MISCELLANEOUS TROPICALS

Glass fish (*Ambassis lala*): 1½in. A living model of fish anatomy, for the swim-bladder, intestines and backbone can all be seen clearly within the glass fish. Males show blue edging to the dorsal and anal fins. Live foods are essential. 75°F. Breeds in shallow tanks of ten gallons or more; hatching time 20 hours. Peaceful community specimen. Life: 2½ years. (India).

Half-banded coolie (*Acanthophthalmus semicinctus*): 2in. A prettily-marked orange pink coloured loach, snake-like in form, with a barbel-surrounded mouth. Breeding rare. 75°F. All foods. Useful small community fish. (Malaya).

Lyretail (*Aphyosemion australe*): 2½in. Lyretail males are beautiful fishes, and the long-bodied females are not unattractive. Prefers living foods. Breeds readily, soft water, shaded tanks; requires attention in tanks kept solely for this species. 75°F. Life: 2½ years. (Africa).

Flag fish (*Jordanella floridae*): 2in. Colourful fishes, inclined to be aggressive to others. Males more colourful, and have larger dorsal and anal fins than females. 75°F. All

foods; some vegetable matter necessary. Breeds in small aquaria; male looks after fry. Life: 3 years. (U.S.A.).

Panchax (*Aplocheilus panchax*): 2½in. Males show varied colours. Chiefly carnivorous. 75°F. Lives with fishes about the same size or a little larger. Reliable breeder. Life: 3 years. (India and Malaya).

Striped panchax (*Aplocheilus lineatus*): 3½in. Another colourful long-bodied species. Easy to breed. 75°F. Live foods. Kept only with larger fishes. Life: 5 years. (India).

Stocking Community Aquaria

Although it is not suggested that the *only* way to create a spectacular aquarium is to keep mixed species (anyone having seen a shoal of tiger barbs swimming against a background of green plants and red sandstone, for example, would deny this at once), it is a very satisfying way, for we all like variety. Community-making is a matter for some thought; fishes cannot be mixed indiscriminately, so here are some basic principles for community selection:—

1. Fishes having similar food and temperature requirements are needed for community tanks. Those wanting special diets are best omitted.

2. Choose species that are neither aggressive to others nor shy of strange company. It should be remembered though, that normally peaceful fishes can become aggressive at breeding time; 'rogues' sometimes develop as well. All that can be done is to move dissentients to another tank. 'Fin-nippers' like tiger barbs are best kept away from fishes with long finnage in small tanks; with space the vice is less indulged.

3. Species that attain similar adult sizes should be selected. Few large fishes will resist trying to eat tinier ones. Young specimens of larger-growing fishes can be included with small fishes until they become too big.

4. Colours and shapes giving the greatest variety, if this is desired, can be chosen within the limits of the first three considerations.

5. A more representative tank can be obtained by seeing that species using all levels of the water are present; all surface-skimmers, or bottom-dwellers only, would not give a good effect. Sedate swimmers, however, are scared by the presence of species which dash about the tank.

6. When the aquarium is stocked, use young specimens of the selected species, for them to grow up together. Introduce

them to the tank at the same time if possible, to prevent first inhabitants developing superior attitudes towards later arrivals. Any new fishes should be introduced at night just before 'lights out.'

7. Two fishes at least of each species (trios are better) should be used. Males are more colourful and when on their own breeding quarrels do not occur; alternatively, use one male and two females (two males to one female with guppies or platys).

8. Do not stock the aquarium to its maximum capacity. Space must be allowed for increase in size of the young fishes; crowded tanks do not look as well as moderately stocked ones and diseases or parasites make havoc with them.

Suitable Communities

The following suggestions are offered to beginners for communities of common tropicals of various kinds in tanks of different sizes.

Aquarium 18in. by 10in. by 10in. (6 gallons)

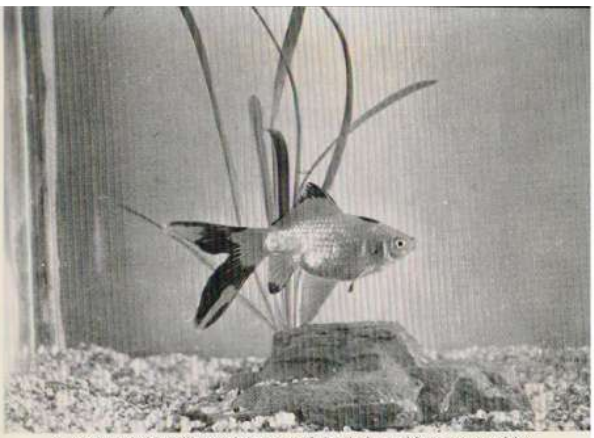
1. 2 black mollies
   2 glow-light tetras
   2 enamel fins
   2 rosy tetras
   2 *Nannostomus marginatus*
   (or 2 white cloud minnows)
2. 3 guppies (2 male, 1 female)
   2 zebra fishes
   2 ticto barbs
   2 beacon fishes
   2 half-banded coolies

Aquarium 24in. by 12in. by 15in. (15 gallons)

1. 3 platys (2 males, 1 female)
   3 tiger barbs
   3 serpae tetras
   Pair dwarf gouramies
   3 flame fishes
   2 catfishes
2. 2 red swordtails
   3 ruby barbs
   3 Belgian flag tetras
   3 black widow fishes
   3 oblique fishes
   3 small angel fishes

Aquarium 36in. by 15in. by 15in. (30 gallons)

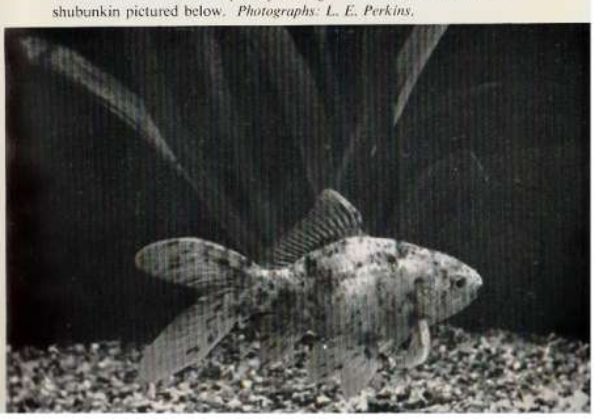
1. *Small and medium fish*
   2 black mollies
   6 guppies (4 m., 2 f.)
   3 neon fishes
   3 flame fishes
   3 ruby barbs
   Pair dwarf gouramies
   3 young angel fishes
   2 catfishes
2. *Larger fish*
   2 swordtails
   2 rosy barbs
   2 giant danios
   Pair blue gouramies
   (or 2 angel fishes)
   2 panchax
   (or pair pearl gouramies)
   1 male fighting fish



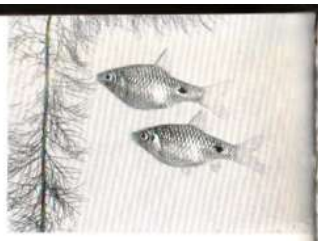
A comet goldfish still showing some of the dark markings possessed by young goldfishes.

PLATE V

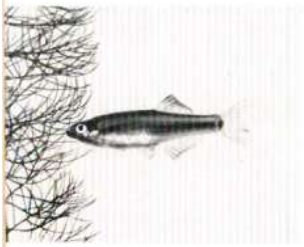
Gill cover tubercles developed by male goldfishes are to be seen on the shubunkin pictured below. *Photographs: L. E. Perkins.*



Zebra fishes (*Brachydanio rerio*); female above, male below.



Rosy barbs (*Barbus conchonius*); female above, male below.



Adult white cloud mountain minnow (*Tanichthys albonubes*).

Cherry barbs (*Barbus titteya*); male left, female right.

Male dwarf gourami (*Colisa lalia*).

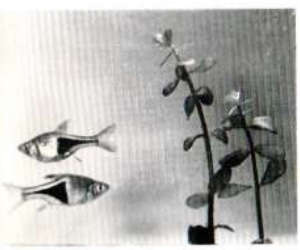
Young white cloud mountain minnows (*Tanichthys albonubes*).

PLATE VI

Photographs: G. Timmerman.

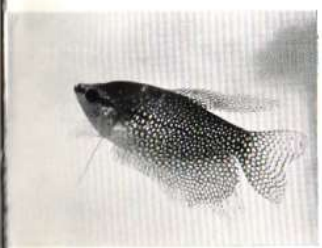
Young wagtail platys (*Xiphophorus maculatus*).

Beacon fish (*Hemigrammus ocellifer*).

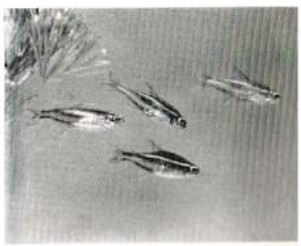


Harlequin fishes (*Rasbora heteromorpha*)

Tropical catfish (*Corydoras aeneus*).



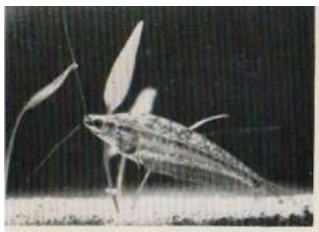
Male pearl gourami (*Trichogaster leeri*).



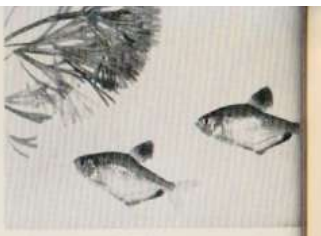
Neon fishes (*Hyphessobrycon innesi*).

PLATE VII

Photographs: G. Timmerman.



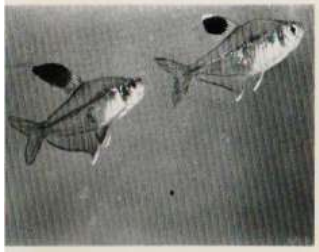
Glass catfish (*Kryptopterus bicirrhus*).



Serpae (*Hyphessobrycon serpae*); male above, female below.

Enamel fin (*Pristella riddlei*); male above, female below.

Glass fishes (*Ambassis lala*).



Rosy tetras (*Hyphessobrycon rosaceus*); male left, female right.

Guppies (*Lebistes reticulatus*); male above, female below.

PLATE VIII

Photographs: G. Timmerman.

Aquarium 48in. by 15in. by 15in. (40 gallons)

1. *Small and medium fish*
   - 6 platys (4 m., 2 f.)
   - 3 zebra fishes
   - 3 black widow fishes
   - 3 beacon fishes
   - 3 neon fishes
   - 3 serpae tetras
   - 3 chequered barbs
   - 3 angel fishes
   - 2 catfishes

2. *Mixed sizes adults*
   - 2 green swordtails
   - Pair thick-lipped or pearl gouramies
   - 1 male fighting fish
   - 3 angel fishes
   - 3 rosy barbs
   - 3 white cloud minnows
   - 2 catfishes
   - 2 black widow fishes

Water Snails

There is no necessity for the presence of water snails in aquaria; if you like them you include them. If not, leave them out. Attractive kinds to keep are the red ramshorn and the Malayan live-bearing snail; it is usually necessary to check their numbers, they breed so prolifically. Some fishes relish young snails as food. Helpful activities of snails include:—

1. Cleaning algae and sediment from plant leaves.
2. Clearing up uneaten fish food scraps.
3. In making their shells snails abstract lime salts from the water; by so doing they help to prevent harmful aquarium accumulation of lime that occurs where hard tap water is used to make up tank levels when evaporation takes place.

Disadvantages of snails in aquaria include:—

1. Choice aquarium plants are eaten by them, and so are fish eggs.
2. Their droppings increase aquarium sediment and look unsightly.
3. Empty shells litter the tank and block siphon tubes at cleaning time.

CHAPTER X

FISH FOODS AND FEEDING

FISHES in natural waters are feeding almost continuously during daylight hours in summer and they have a great variety of foods constantly before them. In the garden pond natural foods are in thin supply; in the aquarium they are absent and the fish-keeper's charges rely entirely on his provisions for them.

Dietary Requirements

Since it is not usually possible to offer anything like the variety of food enjoyed in nature, what food is given must be worth giving, and this entails knowing something of the dietary requirements of fishes. Firstly, what are the essential items of the diet and why are they necessary ?

Proteins are first on the list. Animal tissues are largely protein—muscle is almost pure protein, so that without 'meaty' foods of some kind growth is impossible, and because it cannot replace its own 'worn and torn' tissues without protein, the fish soon dies.

Carbohydrates—the energy-providing foods—come next. Cereals and other plant products provide carbohydrates, and if these are supplied in excess of the fishes' energy requirements for all essential body functions and everyday movements they become converted within the animal to a third type of food—the *fats* and *oils*, which are really substances used as animal food stores.

Other essential dietary constituents are the *vitamins* and *minerals*, about which relatively little is known in fish nutrition. Vitamins have roles to play in the animal body which in importance are quite out of proportion to the amounts needed to be included in the diet. These life-supporting compounds are supplied by the tissues of living plants and other animals that are eaten by fishes.

Dietary minerals are also best supplied by giving fishes living foods, such as the lower forms of aquatic life, to eat. Among the minerals, several of which may only be necessary in infinitesimal amounts, are calcium and phosphorus, used particularly during growth; iron, used in blood pigment formation, and iodine, required for making important body substances.

Variety is Essential

Without all these dietary constituents, growth and normal life cannot occur, increased susceptibility to diseases develops and fishes obviously appear in poor health. To ensure that his fishes' nutrition is adequate the fish-keeper must give a variety of good foods in sufficient quantity. This has been the experience of non-professional aquarists and zoo aquarium curators and is a principle that has been observed for many years by fish farmers.

However much it is sought, the perfect fish food which will meet all requirements, to be used exclusively of other foods, does not exist. Diet deficiency complaints are often slow in onset, however, so that a bad diet may sometimes be given over a long period before troubles begin to show or are noticed. Dried foods are convenient fillers and have their place in the dietary routine but they must never dominate it. Some fishes will not eat artificial foods at all.

Dried Foods

Many of the branded dried foods have been compounded from carefully-chosen ingredients. Protein is included as dried meat, egg, shrimp or insects; carbohydrate, more usually the major component, is in the form of biscuit crumb. Attempts are sometimes made to include vitamin preparations and suitable mineral elements. A dried food that is chosen for use should be:—

1. of average particle size suited to the size of the fishes' mouths—neither too large nor too small.
2. free from dust-fine ingredients that can only rot in the aquarium and cause trouble.
3. composed of ingredients other than biscuit or bread crumb.
4. fairly stable in particle size when wetted, i.e. excessive swelling is undesirable.

Keep dried foods in well-closed jars, not paper packets, in a dry place, lest they become sour and mouldy.

The correct way to use a dry food is to soften it in a little water before adding it to the aquarium. Feed fishes from two corners of an aquarium, or two sites in a pond, so that the fishes come to know the 'feeding spots.' By adding food in two places, smaller, weaker, slower or bullied fishes get their chance to feed apart from their more active and aggressive companions.

Several fishes (e.g. carp, live-bearing tropicals, barbs) like to feed on vegetable foods occasionally. Aquarium plants and soft algal growth are sometimes eaten and it is a good idea to give a little cooked cabbage, spinach or cauliflower at feeding time to see how this is received. A tiny lump of cooked porridge from the bottom of the saucepan is welcomed by fishes, and some hatcheries use a food made from two parts of oatmeal cooked with one part of dried shrimp.

Fresh Foods

The following is a descriptive list of commonly used living or freshly-dead fish foods, with details of obtaining and culturing them where practicable.

Ant pupae: although once sold dried as 'ants' eggs' for fish feeding these are of no food value unless obtained freshly from a garden ant-mound. The yellowish-white ovals can be scooped from the disturbed nest with a spoon and sieved free from earth. Most coldwater fish will take them, as will larger tropicals such as the cichlid fishes.

Blood-worms: these blood red aquatic larvae of the midge *Chironomus* are excellent live foods. They are best collected with the sediment from old rain-water butts, or from an old bowl or sink with water and dead leaves in it permanently established in a shady corner of the garden. The half inch worm-like larvae build mud burrows, and if the detritus containing them is placed in a gauze tea-strainer resting on top of a jam-jar of water so that its bottom only just touches the surface of the water, in the course of a few hours the blood worms will wriggle out clean and ready for use as food. They can be chopped with a razor blade for very small fishes.

Brine shrimps: for young fishes just past the Infusoria feeding stage freshly hatched brine shrimps are useful foods. Tubes of brine shrimp eggs can be purchased: shallow dishes containing brine (a tablespoon of Tidman's Sea Salt to a quart of water) are used to receive the eggs, which are lightly sprinkled on the surface. They hatch in two days if kept over the tropical tank at about 70°F. Strain off the tiny red shrimps in a fine-meshed net and wash them free from salt under the tap before releasing them in the aquarium.

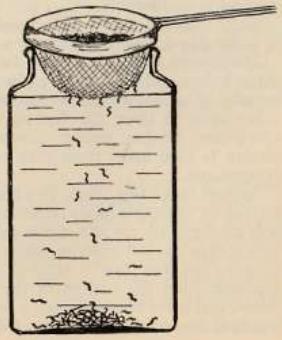


Fig. 20. Method of obtaining live foods such as blood worms free from extraneous matter.

Cyclops and Daphnia (*water fleas*)*:* ideal foods for young fishes and small tropicals. Water fleas may be collected from natural ponds, where they may be seen in summer as a reddish 'cloud' in the water, by sweeping a fairly fine-meshed large net through the water. Duck ponds are often rich sources.

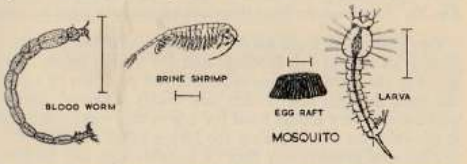


Fig. 21. Useful live foods for fishes (lines indicate natural sizes of the animals.

Cyclops is a white crustacean sometimes found with *Daphnia* and can also be used as live food. Dried water fleas are useful for winter feeding: cartons of these are offered for sale. A small culture of *Daphnia* can be maintained in the garden by introducing these crustaceans into a fairly shallow tub having a loam layer planted with *Elodea* and containing water kept rich in organic matter by the occasional immersion in it of a small weighted sack of dried horse or cow manure. In this way it is possible to breed enough water fleas for occasional but not regular feeds.

Earthworms: easily the best natural food for fishes. Used chopped or shredded for very small specimens or entire for large fishes. The pink or reddish, small types are best, and a good plan is to dig them when they are plentiful in spring and to store them in wooden boxes filled with moistened leaf-mould. Boards or wet sacks placed on the ground in a shady corner will induce worms to gather beneath them; tipping a solution of potassium permanganate on to a lawn surface usually causes quite a few worms to appear above ground. Fishes are not averse to eating chopped slugs if their owner does not mind preparing this repast.

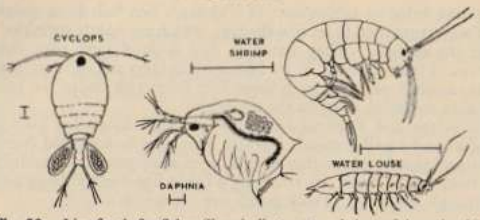


Fig. 22. Live foods for fishes (lines indicate natural sizes of the animals).

Egg yolk: yolk from hard-boiled eggs, crumbled to the right size, is of use in fish-feeding, and for young fishes it is best given in the form of a suspension of fine particles by squeezing the yolk through fine muslin into a cup of water. Dried egg powder is a very handy food for use in this way; when cooked it provides another item on the larger fishes' menu.

Flies and gentles: any flies of suitable size can be given to fishes. Freshly-killed house flies, midges, mosquitoes, green fly, etc., are soon snapped up from the water surface. Do not use insects killed by insecticides or from fly-papers. A fly trap for the garden is made by hanging a piece of meat or fish as bait through a short-stemmed funnel placed in the neck of a pickle jar. Drown the captives by adding water before removing the funnel to obtain them. Fly maggots (gentles) are rich foods that may be used for variety.

Fresh water louse (*Asellus*) *and shrimp* (*Gammarus*)*:* these live foods for larger fishes, collected from natural streams (water cress beds are rich sources) will breed in a garden sink set up with pebbles and *Fontinalis*.

Mosquito and midge larvae: these 'wrigglers' will be found in the garden container it was suggested should be used to cultivate blood worms, or they may be netted during summer in large numbers from lakes. Very small fishes have been known to choke when attempting to swallow the larvae but most adult specimens can cope with them and have great appetites for this nutritious food. Excellent for surface feeders such as orfe, hatchet fishes and half beaks. Screen and wash larvae collected from natural waters most carefully to avoid introducing undesirable water life to your aquarium.

Offal, raw meat and fish: raw heart, liver or kidney, beef or horse flesh with the fat removed and washed free of blood can be finely chopped or shredded to yield first-rate foods for the aquarium. Offal from any animal or bird can be so used. Shredded pieces of boiled white fish will also be eaten by most aquarium fishes; so will sea shrimps, cockles or mussels (fresh from the fish-monger). A piece of shrimp body suspended on cotton in the tropical aquarium makes a long-lasting meal for the fishes when they have to be left without food for a week-end.

Snails: small water snails that have increased in numbers in an aquarium can be collected, their shells crushed with forceps and then returned as an item of food for larger fishes; the tropical cichlids relish them in particular.

Tubifex (*mud worms*)*:* most aquarium suppliers sell these long thin red worms that live in mud of rivers and sluggish streams, and they are widely used by fish-keepers. Several days' supply can be bought but needs to be kept in shallow water under a dripping tap or the worms will soon die. It is best to keep them for a day or so in this way before using them as food. Harmful substances or organisms are then washed away. Thames mud is full of *Tubifex* but it is an unpleasant job collecting and freeing them from this smelly medium. Chopped *Tubifex* can be given to the smaller tropical fishes.

White worms (*Enchytrae*)*:* a culture of these earth-living worms, specially valuable as live food during winter when other such foods may be in short supply, can be started by introducing a few of the worms bought from a supplier into a shallow wooden box filled with sieved garden loam. The loam must always be kept moistened, and food for the worms —mashed potato, porridge, or milk-soaked bread, is placed on its surface. White worms can be obtained from the loam when the culture is established by placing some of the loam from near the food in a saucer resting over a pot of boiling water; the heat drives the worms to the surface and they are picked up with forceps. Keep the box covered with glass to retain moisture and with sacking to exclude light; put it where the temperature will neither exceed 65°F. nor fall below 50°F. through the year.

How often to Feed

How much and how often to feed fishes is usually a problem for beginners, one over which they often come to grief when

supplying their own answer to it. Food requirements of cold-water fishes vary throughout the year, chiefly according to water temperature. In summer they need feeding twice daily, in cold winters not at all. In spring and autumn the fish-keeper must be guided by his fishes' response to foods that he offers. Tropical fishes, of course, feed constantly the whole year, and it is usually convenient to add food to their aquarium twice daily.

Control of the amount of food given at a 'sitting' is most important, particularly when using non-living foods. If excess is given the uneaten particles soon accumulate, pollute the water and kill the fishes. With practice the fish-keeper learns the amount of food he may add with safety, and a rule for beginners is to give no more dried food than the fish in an aquarium can clear up completely within five or ten minutes of its being added.

Continuous feeding with dried foods can give rise to digestive troubles and the value of giving living or natural foods at least occasionally cannot be stressed too greatly. Fishes trailing long streamers of excreta at their rears are not receiving an adequately varied diet.

Well-nourished fishes in an aquarium can survive periods of two or three weeks without any food, and fish-keepers unable to have their stocks tended by another fish-keeper whilst away on holiday are best advised to leave the fish in this way for such periods. To entrust feeding to someone without experience of aquarium keeping is a mistake—over-feeding and tank pollution is the likely result. Food can be left in packets of the correct amounts for daily feeds during the the period of the holiday to avoid this risk; but do not leave the main stock of food within reach of the caretaker !

CHAPTER XI

FISH BREEDING

UNDER natural conditions fishes breed during certain seasons of the year and often migrate considerable distances to find a region congenial to them. Spring is the favoured season in temperate climes, and as shown by experiments, the increased light intensity and higher temperatures play a large part in inciting fishes to prepare for breeding. Even fishes in tropical climates, where these two factors may not operate to the same

extent, breed only in seasons demarcated by additional factors such as periods of rainfall.

Conditions in aquaria are fairly constant throughout the year where artificial lighting is employed and, accordingly, breeding may take place at any time. Just what starts off the breeding urge in an aquarium fish is sometimes obscure, though sudden changes of surroundings—change of water or tank, for example—are known to be followed frequently by a spawning.

Formation of Eggs and Sperms

There can be no penny-in-the-slot way of bringing about breeding. Physiological changes within the fish must occur first: ovaries must develop and produce mature eggs; sperms have to be formed in the male. Undoubtedly some of the main reasons for the tyro fish-keeper's complaint that his fishes won't breed are his failure to use mature specimens and his impatience for results at the wrong times for the fishes.

Most tropical fishes, once mature, go on forming eggs and sperms in their bodies continually, and mate and spawn often up to the time senescence sets in. The bubble-nesters, cichlids, barbs and of course the live-bearers, all show continuous if irregular cycles of breeding and sexual quiescence, and it is only necessary to provide favourable conditions, for the eggs and young to be collected and reared. Eggs are often laid, even in community tanks, without the fish-keeper ever being aware of the event.

The success of the experienced breeder, then, is usually the result of careful observation of his fishes and his skill in providing the favourable breeding conditions for them. He works with his fishes and does not attempt to drive them. Some species rarely breed in captivity, and what subtle condition is not quite right for them is unknown.

Selection of Breeders and Sexing

It is cheaper to buy young fishes usually, for bringing to maturity by regular and efficient feeding. At least six healthy specimens of uniform size should be obtained and given an aquarium (24in. size) to themselves. The average age at which breeding maturity occurs in small tropical egg-layers is eight months (in live-bearers it is much earlier), maturity being evidenced by the assumption of adult coloration and sex characters (where these latter are possessed by the species).

Sexing the fishes is the next difficulty. Fish sex organs are internal and so only secondary sex characters such as coloration (males are the most highly coloured fishes as a rule), size (females are frequently larger), behaviour (males tend to be aggressive and will also be seen to chase females), and the existence of features such as the gill tubercles of the male goldfish, ovipositor tubes or the tiny 'hooks' on the anal fins of some male characins, can be used at first sight. Live-bearers are easy to sex in this way for the males have their anal fins differentiated into the rod-like gonopodium and frequently show colour differences from their mates.

Many fishes, particularly in the characin family, do not show any readily distinguishable features however. Then incidental characters of the sexes—deeper and plumper bodies of the females, for example, and the chasing by the males, may guide the breeder. The best method of all in breeding, in fact, most useful with characins, is to allow the parents to select themselves within a group of say, six of the fishes. Careful watching of the group for a time will reveal that certain pairs are showing obvious preference for one another's society. Such a pair swim and feed together and seldom are apart. They are the ones most likely to mate when placed in the breeding tank.

The 'candling' of fishes is another good method of sexing the flat-bodied types. They are transferred to a glass tank together, and strong light (a point source or narrow beam, if possible) is placed behind the tank in a dark room. As the fishes swim in front of the light their internal organs are silhouetted. Distinct differences in the overall shape of the abdominal area can sometimes be noted in this way, which separate the sexes: e.g. black widow fish females may show the half-moon ovary outline behind the more solid area of the intestines that is the only part visible in males; flame fish males have a more pointed abdominal shadow than the females. Angel fishes have been sexed by this method as well. Again, it can only work with mature fishes !

Conditioning and Breeding Quarters

The breeding pairs selected from the original young stock are usually 'conditioned' in separate aquaria, males in one, females in another, or each on either side of a central dividing glass panel in a 24in. tank. Conditioning for breeding involves giving the fishes all the nutritious foods they will eat. Live

foods—*Daphnia*, *Tubifex*, mosquito larvae and chopped worm or fresh raw meat and offal are excellent—should be given twice daily. More food than usual will be taken since the conditioning tank should have a slightly raised temperature—78°F. to 80°F. The feeding is continued, the tanks are well-lighted throughout the day and the tank temperature is kept up, for a week or so.

When the females are obviously plump with ova and the males are displaying their intense breeding colours the fishes can be placed together at night (by removing the glass partition or by moving them to the darkened breeding tank). The breeding tank has been prepared during the conditioning; a 24in. aquarium is generally adequate, and how it is set up depends on the species of fish to be spawned; in general it should have a two inch layer of clean, coarse sand and six inches depth of soft water (clean rain water or hard tap-water diluted by three with rain-water or pure distilled water) above this. Its temperature is kept at 78°F. to 80°F.

For three-quarters of its length the aquarium is thickly planted with *bunches* of *Myriophyllum* and *Fontinalis*. A surface layer of *Riccia* is also recommended. Water snails must be excluded. The back and sides are covered over with brown paper and top-lighting over a glass cover provided.

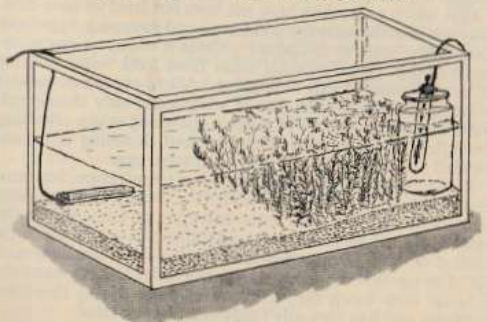


Fig. 23. Breeding aquarium for tropical fishes. The thermostat is placed in a jar of water to allow full immersion in the shallow water. The glass cover is not shown.

On the morning following the introduction of the breeders (two males can be used with one female in some species) the lights above the tank should be switched on. It is then left undisturbed; if the tank is watched this should be done quietly and from a distance. Spawning is most likely to occur within the next twenty-four hours and will last several hours, with intervals for rest; some eggs will invariably be eaten by the parents. When spawning is finished, remove and again separate the male and female fishes.

If spawning does not take place, first try the effect of replacing some of the water with slightly cooler fresh water and allowing a further twenty-four hours to pass; then if no eggs have been laid, return the fishes to their conditioning quarters and try again a week later. Fishes that have spawned should be fed well and given every care, for it is often an exhausting process, more especially for the females.

Eggs and Fry

Eggs of tropical fishes are usually separate and scattered amongst plants and on the sand as tiny globules resembling fine droplets of oil in the water. If in doubt about a spawning look carefully along the water line at the glass of the aquarium —eggs frequently become caught there by capillary attraction.

Eggs which turn white have not been fertilized or have died. They are sensitive to water conditions and some, e.g. eggs from neon fishes, seem to disappear without a trace; an egg membrane change or an osmotic effect from hard water is likely to be the cause of this happening. Micro-organisms appear to be responsible for the loss of some eggs; only clean sand, water and plants should be used in spawning tanks. Keeping the aquarium completely darkened until hatching is recommended for neon fish and glow-light tetra eggs.

Rate of egg development depends on temperature, but most eggs hatch within 48 hours at 80°F. Water depth is kept shallow for the first week after spawning to allow the newly-hatched fry, which are minute and difficult to see, to reach the surface without effort when filling their swim-bladders with air. For the first day or so they move little; absorption of the yolk-sac with which they hatch takes place during this time, but from one day onwards foods must be provided.

Fry of cichlids, live-bearers and the larger egg-layers hatch big enough to take newly-hatched brine shrimps or the tiny water fleas (*Daphnia*) sifted from larger ones through muslin.

Small barb, gourami, fighting fish and characin fry need the microscopic animalculae collectively called Infusoria. How to obtain these is described at the end of the chapter.

Fry Rearing

Infusoria is given by sieving it from the culture water on fine-meshed cloth, swilling this to release the animals in a jam jar of clean water, and then immersing the jar in the fry tank. A heavy local concentration of food is thus obtained in the water where the fry can reach it. Up to six jars a day may be needed for average spawnings from characins and barbs.

For the first week of life green water from an aquarium kept out in the sun can be added, by dripping it in to the fry through a partially closed siphon tube, throughout the day. Crushing hard-boiled egg-yolk in silk bags and squeezing these in a jar of water until it is yellow produces a fine suspension that can be dripped slowly into the aquarium instead of Infusoria, but care must be taken not to foul the tank when using such food.

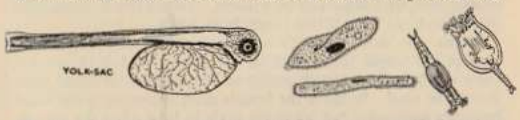


Fig. 24. On the left is a newly-hatched fish (shown magnified), and on the right is a group of organisms commonly found in Infusoria cultures and used as food by young fishes (all shown greatly enlarged).

Progress made by the fry can be watched through a magnifying glass. They should be feeding continuously so that their bellies are always seen to be distended with food. Providing sufficient of these fine foods for the first three or four weeks is no easy matter, and most deaths occur at this stage. Growth can be accelerated if food is available by keeping the aquarium illuminated night and day, when feeding never stops. Illuminate fry tanks only from above.

As the fry grow they can take larger foods. At a month newly-hatched brine shrimps (see page 86), dried egg or fine pea flour suspensions, micro worms (see page 97), and sieved *Daphnia* can be given. After six weeks they should be taking pulped worms or liver, chopped *Tubifex*, fine dried fish foods, and are progressing towards normal adult diet.

Adequate space is also important. The volume in the aquarium can be increased by adding fresh water sufficient to

make about an inch in depth difference each day after the first two weeks, but if the hatching was a large one some fry will need to be moved to a new tank. Any mis-shapen specimens can be destroyed. Handle fry by scooping them up in a cup or by drawing them up into a wide glass dip-tube; do not net small fry.

Breeding Live-bearers, Cichlids and Bubble-nesters

The above is a general account of breeding particularly applicable to barbs and characins. Zebra fishes and danios are avid egg eaters and the bottom of their breeding tank can be covered with pebbles or a thick mass of plants to trap the ova.

Long conditioning periods are not necessary for live-bearers, cichlids or bubble-nesters. All that is needed for live-bearers is to place fertilized females in small well-planted tanks and to remove them when their young are born. Do not move females nearing delivery time, however. An 18in. tank is adequate, and algae can be present. Young live-bearers take dried foods and small live foods from birth.

Plants are not of much use in cichlid spawning tanks (except for angel fishes—which use broad-bladed leaves for their eggs), but rockwork needs to be present. A 36in. tank should be used. Remove the female after spawning if the male becomes aggressive but leave the male to look after the young. Cichlid fry will eat fairly large live foods.

Bubble-nesters may be bred in a tank similar to the one described in the general account. After the eggs are laid in the bubble-nest remove the female fish; males can be left with the young for a week. Siamese fighting fish fry and dwarf gourami fry need Infusoria but young fishes of the other species can be given fine egg-yolk suspensions if Infusoria is not available. Keep the water surface warm and free from dust or oil film in aquaria devoted to bubble-nesters.

Infusoria for Fry

Infusoria can be obtained in two ways: (a) It can be collected from ponds by sweeping the water with a silk or nylon net, rinsing the inside of the net in a jar of water; (b) It can be cultured in two pound jam jars. Put a pinch of pond mud or earth from a damp corner of the garden into a jar, fill it with water from an aquarium and then add a teaspoon of milk, or a crushed lettuce leaf, an old banana skin or a slice of

soft potato. Keep the mixture in a fairly warm place. After a day start other jars in the same way, adding also a little of the water from the first jar.

In two or three days the first jar is ready: strain off the Infusorians through silk; do not add the culture solution to fry tanks. Keep a succession of jars going, for each jar soon becomes too foul for further use. Bacteria growing in the water cause the smell but they are the organisms on which the Infusoria from the pond mud feed. A drop of water from a good culture placed on glass over black paper should reveal moving specks in it to magnifying glass examination, and the culture is not ready unless it shows this.

Micro Worm Culture

Micro worms are most useful foods for fry just past the Infusoria stage. Dealers supply them, and a culture can be started by adding a few to a shallow layer of a paste of boiled oatmeal containing a little yeast, placed in small glass or china pots. Wetted match-sticks stuck in the medium become covered with the tiny worms, which can be rinsed into the fry tank. Keep the jars at 70°F. and renew any that become too 'high' by adding a little of the old medium to a jar containing fresh food.

CHAPTER XII

TROUBLES

FISHES are not unhealthy creatures, but as with human beings there are a great many ills to which they are susceptible, and just like other animals they are most likely to fall prey to disease when kept improperly, overcrowded and under-nourished.

Fish Deaths

Death of only one fish in a collection is not of much significance. In tropical tanks especially, a fish may suddenly spiral to the bottom and be dead when it gets there. No signs of disease may be found and it is to be assumed that some small fishes die this way when 'spent out.' Larger fishes usually show signs of old age (hump-backs and wasted bodies, for example). The life of small tropical fishes is reduced by keep-

ing them at too high temperatures—their body processes are so much speeded up.

Deaths of several fishes all of the same species in a community tank is a puzzling event that sometimes happens. It has been suggested that water conditioning is responsible for this—water in which one species has been dominant is supposedly inimical to the well-being of others. In polluted tanks the most sensitive fishes die first, however, and labyrinth fishes (fighting fishes and gouramies) are among the more resistant types usually. Male guppies are known to be more sensitive to water fouling from any cause than are the females.

When deaths of several species occur over a day or so a common cause must be looked for. If no obvious signs of disease or injuries are apparent, tank conditions (water fouling or poisoning, low temperature, improper diet) are likely causes. In new ponds lime from the concrete can kill fishes. Even though a recognizable disease is present in a tank of fishes conditions such as the above still need to be checked, for there can be little doubt that many ills are always in the fishes' environment but can only attack and cause an epizootic when general health has been undermined. Loss of usual appetite is one of the first signs of something going wrong.

Diseases of Fishes

Signs of the common fish diseases are listed below; first, a few general remarks on the treatment of sick fishes can be given.

1. Isolation of sick fishes in small aquaria is advisable and facilitates treatment. The hospital tank can be a large jar or goldfish bowl floated in the main aquarium where only one or two fishes are to be isolated.

2. Water levels should be dropped to two or three inches for such fish and the addition of Tidman's Sea Salt (1½ ounces to a gallon) acts as a good tonic in most cases.

3. For tropical fishes water temperature of the hospital tank is best raised to about 80°F.

4. Only live foods should be given during treatment; often the change of diet alone will bring about a cure.

5. When adding chemicals or drugs to aquaria on a weight per gallon basis deduct from the tank capacity the estimated volume of rocks and sand. Dissolve the correct weight of solid in a little water before adding; never put the solid directly into the aquarium.

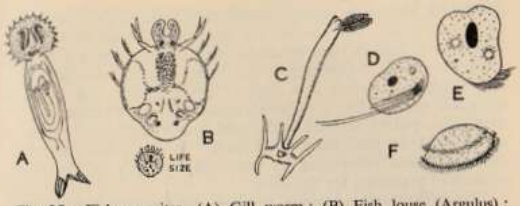


Fig. 25. Fish parasites—(A) Gill worm; (B) Fish louse (Argulus); (C) Anchor worm; (D) Costia; (E) Chilodon; (F) Cyclochaeta. All are shown greatly enlarged.

6. For direct application of antiseptics, etc., fishes may be gently held, out of water, in a wet, soft net.

7. Hopeless cases are best destroyed. Throwing a fish with great force against a hard floor or decapitating with strong sharp scissors are quick and kindest methods of despatch. Usual methods of euthanasia are difficult to apply to fishes.

Loss of balance and inability to swim: not uncommon in fancy goldfishes, this condition arises when organs in the body cavity become distended or inflamed and press on the swim-bladder. Intestinal infection, constipation (excess dried foods in diet), and chills are causes. Shallow water, with sea salt added as above, raised temperatures, and live foods, sometimes give relief.

Erratic movements: 1. Jerky swimming or shaking movements ('shimmies'), sometimes result from chilling or improper diet. Mollies often show this condition. Raised water temperature; shallow tank; give live foods. Liable to recur.

2. Fishes persistently rubbing their sides against plants, rocks and sand may be suffering from irritation by surface parasites or organisms present in polluted tanks. If no obvious parasites, try changing the water once a week for a few weeks. (a) Gill worms are common, barely visible pests and difficult to eradicate. Dipping badly infected fishes in a net (for fifteen seconds only) into a quart of water in which has been stirred a teaspoonful of Dettol kills the parasites. (b) Fish lice (*Argulus*), greyish-green flat parasites about one-eighth of an inch across, can be removed from netted fish with the aid of forceps. (c) Anchor worms (*Lernoea*) protrude from small 'pimples' on fish skin; with the fish held in a net touch the

spots with Milton or strong potassium permanganate solution, on cotton wool. (d) Leeches on fishes will fall off if the fish is placed for half an hour in salt solution (4 ounces to a gallon).

Colour changes: although in sick fishes colours usually fade, and bright coloration is a sign of good health, fish colour normally varies a lot, in tropicals especially. Low temperature may cause paling, so will fright, and colour changes alone are not always an indication of disease. A live food diet encourages good coloration by ensuring a supply of the precursors of pigments for the skin.

Skin afflictions: (a) small injuries and wounds heal spontaneously usually, but growth of fungus sometimes interferes. Lost scales are also regenerated in time. Mild antiseptics can be applied to wounds and they may then be sealed with vaseline. (b) Fungus appears as greyish or white cotton-wool like tufts and is best treated by keeping the fish in sea salt solutions: 1st day, 1 ounce/gallon; 2nd day, 1½ ounces/gallon; 3rd day, 2 ounces/gallon; 4th day, 2½ ounces/gallon. Decrease salt concentration by the reverse sequence before returning fish to fresh water. (c) White spot disease is caused by a parasite (*Ichthyophthirius*) giving rise to pin-head sized white spots over body and fins. For tropical fishes, alternately raising the tank temperature to 90°F. and lowering it to 75°F., each for 12 hours over the course of a week, gets rid of the disease. Another treatment, also of use for coldwater fishes, is to dose the aquarium with quinine sulphate (dissolving sufficient in a cup of water to give a concentration in the tank of three grains to the gallon when it is added). Add further doses at two day intervals until the spots clear up. (d) Patches of grey slime on the body surface indicate infection with microscopic parasites (*Chilodon, Costia, Cyclochaeta*). Sea salt baths as recommended for fungus have been used with success. (e) Protrusion of scales on a swollen body is the manifestation of fish dropsy, a condition arising from a variety of causes including organic changes and bacterial or worm infections. Treatments are not always successful but the salt bath sequence advocated for fungus can relieve the complaint. Swollen bodies are seen also in egg-bound female fishes. Raising the water temperature can alleviate egg-binding although experienced fish-keepers expel the egg mass by gentle pressure and 'stroking.' (f) Tumours sometimes appear as raised lumps on fishes and nothing can be done about these. Internal tumours cause body swelling and are soon fatal.

Fin and scale afflictions: (a) Split fins, tails and damaged scales regenerate in time if fungus does not develop. The damage may arise from careless handling or from the presence of a fin-nipping fish. General living conditions and diet should be checked. Where obvious fin or tail rotting is taking place the affected part can be cut away with scissors, dabbed with surgical spirit and smeared with vaseline, while the fish is held out of water. Mild conditions can be cured by a sea salt bath (1½ ounces to the gallon). (b) Protruding scales occur when skin oedema exists and the treatment is the same as that for dropsy. (c) Fins showing congestion (blood streaks) accompany general loss of condition and some infections. If other symptoms indicative of parasites are absent a change of diet to live foods and the sea salt bath (in (a) above) will clear the fins.

Mouth troubles: fishes' mouths are liable to receive injuries in concrete ponds and aquaria and fungus or tumours may later develop. Fishes appear interested in food but are unable to eat and usually waste and die. The salt water treatment for fungus can be used.

Eye troubles: two main troubles affecting fishes' eyes are opacity (the pupil becomes white and the eye surface may be raised) and 'pop-eye' (protrusion of the whole eye—exophthalmos). Opacity can arise from the presence of fungus following an eye injury, or parasites sometimes lodge within the organ. Direct application of a strong solution of salt to the eye can be tried. Cataract is another condition showing as opacity and may arise from lack of some dietary factor. Nothing can be done about protruding eyes: even when spontaneous recovery occurs blindness may ensue, and total loss of the eye is common. Loss of one eye does not bother a fish unduly but completely sightless fishes should be destroyed.

Wasting: loss of normal body contours and angular outlines accompany some infections and also occur in old age. Inadequate feeding may also be responsible; sometimes such a fish is prevented from getting its fair share of food by larger or bullying companions. Hump-back occurs in aged livebearer females, carp, goldfish, cichlids and other fishes as a sign of senility.

Water Troubles

Aquarium or pond water that does not stay clear and sparkling is an eye-sore and sometimes is a threat to the fishes' health. Cloudy waters of the following types are met with:—

1. Muddy appearance seen to be due to tiny particles suspended in the water; no odour to the aquarium. Excess bottom sediment in a tank containing fishes such as carp, which are apt to stir the deposit into the water, may be responsible. Such water is found in ponds after long periods of heavy rain. A filter can help with aquaria, but this type of water is more harmful to plants than fishes.

2. A milky appearance of water is more serious. The opalescence or milkiness, usually accompanied by bad odours, is caused by bacteria and other micro-organisms, present in very large numbers when organic materials on which they can feed have dissolved in such amounts that the water becomes a culture medium for them. The source of these materials can be: the fish—particularly in over-crowded tanks without plants; the plants—when they are dead or dying in unlighted situations; uneaten dried foods which have rotted in the water —faulty feeding may be the cause of this. Bacteria-rich water is harmful to fishes because oxidations carried out by the organisms rob them of vital oxygen; the fishes hang gasping at the surface. Although changing the water clears up the opacity for a time, if the source of the organic matter is not traced the trouble will recur, for it is quite impossible to have bacteria-free aquaria.

Advance signs of this trouble are given by the appearance in the tank of tiny pale fuzzy growths on plant leaves, and of lots of tiny white worm-like creatures about one-sixteenth of an inch long, crawling over glass and sand and swimming through the water. These forms of animal life find conditions in the tank favourable because of the growing numbers of bacteria on which they feed; typical examples of the 'fuzzy growth' are the bell animalculae (*Vorticella*), and of the 'worms,' the protozoans *Spirostomum*. When you see them ask yourself "Have I been over-feeding ? What is polluting the water ? "

Filters cannot remedy this milky water (unless very large ones containing carbon to remove the organic materials from it were used), for sand will not filter out bacteria. The aquarium must be cleaned out (indications that over-feeding was the cause will be given by sand that is found to be black below the surface or by mould-like growths and a greyish-black scum on top of the sand) and set up again. The reason for the pollution must of course, be remedied.

3. Green water is quite healthy for fishes and many breeders

keep their tank water always in this state. The green colour and cloudiness originates from the thousands of single-celled members of the algae swimming in it. Although the condition is most usually the result of admitting full sunlight to old tanks, occasionally it is accelerated by an early stage of the type of pollution discussed above (2). Absence of, or insufficient growing plants is also conducive to green water development and this applies to ponds particularly. Remedies involve shading the aquarium to cut down admitted light (shielding back and ends by painting, having floating type plants on the water surface), planting additional water plants, changing some of the water. Green pond water is a danger in late summer and autumn when owing to decreasing light the algae die. Their very large numbers are capable of turning the pond into a stinking morass, all the conditions then attaining that were mentioned in 2. Water in the pond should be changed before this happens. The greenness must similarly not be allowed to go too far in aquaria.

4. Water obtained from water-softening plants or drawn from copper or brass pipes and vessels is likely to be poisonous to both fishes and plants.

Water Plant Troubles

Green water plants which become brown or yellowish and fail to grow are receiving insufficient light—intensity or duration. More rarely the light may be adequate but the water may be at fault, or the plants are ones unsuited or unaccustomed to the temperature at which they are being kept. Growth of brown algae on the aquarium glass is additional indication of light inadequacy. Heavy deposits of sediment on plant leaves also kills them.

Algae: the kinds that can become really troublesome in ponds and aquaria are the long tough filamentous green types (blanket weed, *Vaucheria*). *Spirogyra* is a soft filamentous type that becomes a nuisance but is relished by some fishes as food. Once established in a pond these algae are difficult to remove. They must not be allowed to choke the water; periodically the masses can be pulled out with a rake. A bag containing copper sulphate crystals can be swirled round in the pond for a short time every few days for a period until the growth shows signs of dying (this treatment can be overdone—copper is poisonous to fishes and to plants). Badly affected aquaria are best cleaned out, the plants scrapped and set up again with

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fresh materials. Well-planted tanks are less prone to become badly affected with algae than scarcely planted ones and excess light is a factor increasing growth of the pest. Shading aquaria when algae are being a nuisance is a method of control but not of elimination. A blue-green form of algae that occurs in aquaria can be ridded by adding three drops of a 5 per cent. solution of methylene blue for every gallon of water. Clean and set up the tank again after the growth is dead.

Unwanted Visitors

Small water creatures of various kinds appearing in tanks apparently from nowhere often puzzle aquarium-owners. The animals are usually introduced with live foods that have not been screened as they should be, or with water plants collected from a stream. Many kinds of such unwanted visitors are found: swimming worms, caterpillar-like animals, a large assortment of larvae of flies and aquatic beetles, and various molluscs and crustaceans. Single visitors can be netted and removed from the tank. Some increase in numbers so quickly that they soon become pests, and common ones of this category are mentioned here.

Cypris is a small brown or greenish crustacean which swims jerkily over the sand. It has hard 'shells' and fishes leave *Cypris* alone; its feeding habits make it an aquaria scavenger. When it moults its skin, the old one floats to the water surface.

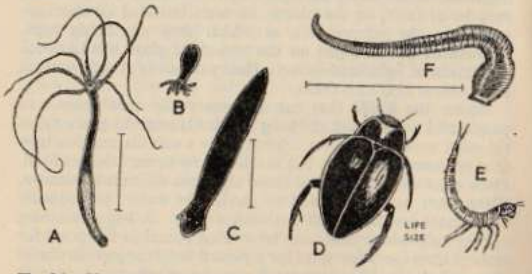

Fig. 26. Unwanted visitors—(A) Hydra, extended; (B) Hydra, contracted; (C) Planarian worm; (D) Water beetle; (E) Water beetle larva; (F) Leech. Lines indicate natural sizes of the animals.

To rid an aquarium of these creatures raising the temperature to 90°F.—100°F. for a week is the method used.

Hydra can become a nuisance in aquaria when the animals are attached all over plants and glass, and they must be excluded from breeding and rearing tanks for the half-inch long fine grey or brown trailing tentacles will catch and kill fry. The eight or more tentacles, like the slender body to which they are attached, are contractile, and when *Hydra* is disturbed it contracts from a total length of an inch to a blob less than an eighth of its previous length. Aquaria are cleared within a week by removing the fishes, raising the water temperature to 90°F. and adding ammonium sulphate dissolved in a little water (about ¼ ounce of the sulphate for a 24in. tank and ½ ounce for a 36in. tank is usually sufficient).

Planarians are black, brown or white flat-worms (unlike leeches they have no suckers) which glide over sand, plants or aquarium glass and soon multiply in numbers. They attack fish eggs and fry. The treatment described for *Hydra* can be used or in the absence of fishes, household ammonia is added to the aquarium (one tablespoonful of household ammonia to every five gallons of water). These animals survive cutting or crushing.

Leeches of many kinds exist, not all of them harmful to fishes; most attack water snails and other small creatures. The ribbon-like bodies of leeches, when extended, are seen to be broader at one end than the other and suckers are found on the undersurface. They swim through water with undulating motions or progress over surfaces with a looping movement. They can be eliminated by catching all specimens seen in tanks. Their habit of congregating beneath stones during the day can be used to trap them in ponds, by having a number of flat stones that can be pulled out on strings.

Water beetles in garden ponds can be netted as they come to the surface for air. Their larvae are a menace to young fishes, as are the larvae of dragon flies.

Grass snakes and fish-eating birds are common raiders of country ponds; in towns cats are the chief danger. Male frogs may kill fish during spring. Making a damp sloping surround to the pond will discourage fishing cats. Netting to keep out snakes and frogs can be used for small ponds, and surface netting will stop birds taking fishes.

APPENDIX

Useful Data

1 gallon of water occupies 0.16 cub. ft. and weighs 10lb.
1 U.S. gallon is equivalent to 0.83268 British gallon.
1 cubic foot is equivalent to 6.24 gallons or 28.3 litres.
1 gallon = 160 fluid ounces = 4.546 litres.
1 litre = 1.76 pints = 0.22 gallons = 35.196 fluid ounces.
1 ounce = 28.35 grams = 437.5 grains (1 grain = 0.065 gram).
1 pound = 0.453 kilogram = 7,000 grains.
4 teaspoonfuls = 2 dessertspoonfuls = 1 tablespoonful = ½ ounce.

Concentration of Solutions

Per cent. solution	Ounces per gallon (approx.)	Grains per gallon	Grams per litre	Parts per 100,000
0.1	⅛	70	1	100
0.5	½	350	5	500
1.0	1¼	700	10	1,000
1.5	2¼	1,050	15	1,500
2.0	3¼	1,400	20	2,000
2.5	4	1,750	25	2,500
3.0	4¼	2,100	30	3,000
5.0	8	3,500	50	5,000
10.0	16	7,000	100	10,000

Calculating Capacities

Rectangular ponds or aquaria: Multiply length by width by depth (all in feet) to obtain volume in cubic feet. Multiplying this by 6¼ gives the capacity in gallons.

Circular ponds: Multiply depth in feet by the square of the diameter in feet by 4.9 to give approximate gallon capacity.

Temperature Conversion

To convert Centigrade (°C.) *to Fahrenheit* (°F.) multiply by 9, divide by 5, and add 32.

To convert Fahrenheit (°F.) *to Centigrade* (°C.) deduct 32, multiply by 5, and divide by 9.

	Freezing	Aquarium Range										Boiling
°F.	32	40	50	60	65	70	75	80	85	90	100	212
°C.	0	4.4	10	15.5	18.3	21.1	23.8	26.6	29.4	32.2	37.8	100

SEA-WATER AQUARIUM-KEEPING

Small scale marine aquarium keeping is still in its infancy, but there is no reason why, with experience gained in keeping other aquaria, the amateur should not take up this hobby. Large shallow tanks are likely to make the most useful marine aquaria. Sea-water is very corrosive and the metal and putty of tanks should first be protected with bitumin paint. Stainless steel tanks are useful if the cement is covered with bitumin. The water may be collected at the coast from an unpolluted area and is transported in glass Winchester bottles, or carboys of sea-water can be purchased from the Marine Biological Association, Citadel Hill, Plymouth. Artificial sea-water can be mixed with natural water but half the tank volume should be real sea-water. Artificial water can be made by dissolving Tidman's Sea Salt—7 ounces to the gallon—in tap water. A hydrometer is an essential accessory to the marine aquarium; water density should be 1.020—1.030. Owing to evaporation and splashes water and some salt are lost and the correct way of making good the losses is to adjust the density to the correct figure by adding tap water, *not* sea-water. A reserve supply of sea-water is kept in case of accident. Keep the marine tank in a shady and cool position where the temperature will not rise above 65°F. Sea-shore sand or clean aquarium sand is used in the tank and rocks are built up to make a ledge just below water surface; a 'cave' can also be made as shelter for young crabs when changing their shells. The only plants likely to do well in sea aquaria are young green ones attached to stones collected at the sea-shore: sea lettuce (*Ulva*) is a reliable plant. Red or green algae that appear on the rocks may be encouraged. Two essentials for a marine tank are a glass cover and a filter. Using an air-lift corner filter with glass-wool over a layer of lime-stone chips (to correct acidity) and a

layer of sand, gives good results. Suitable specimens for the marine tank can be gathered from rock pools during spring tides (shortly after full and new moon), when turning over the rocks will produce plenty of specimens. The following kinds will be found hardy and interesting when starting a small collection. Anemones; small shore crabs; prawns or shrimps; small gobies or blennies. Where they have to be transported long distances carry them in masses of damp sea-weed. Raw fish is the most acceptable food for the marine tank inhabitants, but chopped earthworms, *Tubifex* and wood lice can also be used. Anemones are fed from forceps and crabs and fishes too, soon learn to accept food in this way. Tank pollution is a danger that must be carefully guarded against; dead animals and uneaten food have to be removed at the earliest possible occasion.

BOOKS FOR FURTHER READING

A History of Fishes by J. R. Norman (Benn; London, 1947).
Animal Life in Fresh Water by Helen Mellanby (Methuen; London, 1948).
Exotic Aquarium Fishes by William T. Innes (Innes Publications; Philadelphia, U.S.A., 1951).
Livebearers by Barry Funnell (Buckley Press; Brentford, 1947).
Marine Aquaria (L.C.C. Publication; Horniman Museum, London, S.E.).
The Goldfish by G. F. Hervey and J. Hems (Batchworth; London, 1948).
The Guppy by A. Fraser-Brunner (Buckley Press; Brentford, 1947).
Water Gardening by Frances Perry (Country Life; London, 1947).
Periodicals: *The Aquarist and Pondkeeper* (monthly) (Brentford, Middlesex).
Water Life (alternate months) (London, S.E.1).

AQUARIUM SOCIETIES

Societies of aquarium-keepers have been formed all over Britain and the address of the nearest one to any particular locality may be obtained by sending a self-addressed envelope to *The Aquarist*, The Butts, Half Acre, Brentford, Middlesex.

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