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KEEPING REPTILES AND FISHES

by

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COLD WATER AQUARIA AND GARDEN PONDS

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M. K.

PART ONE

CHAPTER ONE

SOME GENERAL PRINCIPLES

WHILE there are numerous books on the subject of Aquaria, singularly few have been written on the maintenance of Vivaria and the keeping of reptiles and amphibia as pets; in fact snakes, lizards, frogs, toads, newts and terrapins are very much neglected. I have never been able to understand this, as all these creatures present so many advantages for amateur naturalists, be they old or young. Reptiles and amphibia are, taking them all round, easy to maintain in health and easy to feed; while many are beautiful to look at, and all are most interesting to observe. In addition to these satisfactory points many may be kept either indoors or out in the open air. They are clean in their habits and are free from any of the objectionable smells which so often present themselves in connection with the more popular fancy mice, rats, guinea-pigs and rabbits.

The major portion of this book will be concerned with reptiles and amphibia for the very reason to which I have referred above: namely, that so little has been written about them. However, the second part of the book, which deals with cold water aquaria, should give a satisfactory general guide to anyone who wishes to add a few tanks of fish to his private collection.

I have often wondered whether the neglect of the reptiles and amphibia is not almost entirely due to popular prejudices against them, prejudices which are mostly founded on gross errors, such as the idea that toads are venomous or can spit; or that snakes sting or are slimy. I feel, therefore, that it is worth while disposing of some of these fables right away at the start. None of the species dealt with in this book can be regarded as harmful, and no sensible person is likely to be injured in the course of handling any of the specimens. On getting a closer acquaintance with snakes it will be found that they are not slimy and are not even particularly cold to the touch, while neither the frogs nor toads mentioned are capable of harming any human being by means of the venomous excretions which they exude through their skins purely as a protection against their natural animal enemies. It is true that some of the snakes described later on will attempt to bite until they are used to being handled, but none of them is able to inflict anything more than a superficial scratch, which is not likely to be half as painful as a casual encounter with a clump of stinging nettles!

Now, before we go any further it is as well to consider the type of creature with which we are going to deal. All the reptiles and amphibia, as well as the fish, are what is commonly referred to as "cold-blooded"; but this term can be rather misleading. In actual fact these creatures take their body temperatures from their surroundings. Most of them have a very wide toleration of extremes of heat and cold, but even this has been wildly exaggerated by some writers. It is quite untrue to state, for instance, that European frogs, toads and newts can survive being completely frozen, and it is equally untrue that our British viper enjoys being subjected over a long period to the blazing heat of the midday summer sun. It is, however, perfectly true that snakes and lizards enjoy a bask in the sunshine, and equally true that they can survive a considerable degree of cold; but it must be remembered that the ability to survive cold is necessary for their hibernation, and also that the increase in body temperature which takes place during spring

and summer gets them into a suitable condition for feeding and reproducing their kind. This question of temperature is a very important one and must always be borne in mind when considering the cage or enclosure in which the particular species is going to be kept. All of the species like to have hiding places to which they can retreat when the particular weather conditions which affect their daily lives demand that they should adjust themselves. For instance a toad which does most of its feeding at dusk is not likely to want to sit and sun-bathe; while a lizard which depends for its existence on insects which are about during the day, will be active during that time, but will curl itself up in some suitable hole or cranny when the warmth of the day departs.

Another important consideration which again is linked with this question of temperature is the provision of water. All reptiles and amphibia require water in some form to a greater or less degree. Snakes occasionally like to soak themselves, particularly before changing their skins; lizards delight in a drink; while frogs and toads have to maintain a certain amount of moisture either by immersing themselves completely or by seeking out a damp spot in order to prevent their sensitive skins from drying up. Newts of course, like frogs and toads, must repair to water for breeding, and therefore it will be seen that whatever type of enclosure is used for keeping one's pets, water must be provided.

Reference has been made to the shedding of skins. This shedding of skins, or sloughing as it is called, takes place regularly in all reptiles and amphibia; and the health of one's pets may to some extent be judged by the regularity and ease with which this operation is carried out. A snake when in perfect health should shed its skin almost in one piece, and the cast skins of our own snakes may frequently be found during the course of a field expedition. These make interesting exhibits and they can teach the young naturalist quite a lot about the structure of the snake. For instance, one of the characteristic differences between snakes and lizards is that the lizard possesses eyelids whereas the snake does not; and if the cast skin of a snake be examined the eyeshields, or the single scale which covers the eye of the snake, may easily be seen. Lizards, of course, cannot cast their skins in one piece owing to their legs and feet; and a lizard in the process of shedding its skin presents a peculiar "moth-eaten" appearance. Newts when in the aquatic periods of their lives shed their skins complete, and these may often be seen in the aquarium suspended on a piece of pond-weed in the water and looking like a filmy transparent envelope exactly the shape of the living creature, and perfect in every detail. Frogs and toads, which shed their skins at regular intervals according to growth, have the curious habit of pushing the shed skin into their mouths and swallowing it; and it is stated by several authorities that newts do the same, though I must confess that I have never seen this happen myself.

Now, as I have said, the skin must be sloughed cleanly and regularly in order to maintain growth; that is to say, the shedding of the skin coincides with the increase in size of the creature concerned, and as growth principally depends upon feeding, this brings up the important question of food. Later on I shall, of course, have much more to say about the individual diet of the various species dealt with, but a few general remarks on the subject will, I think, be helpful at this stage. Many people who commence to keep reptiles and amphibia fail either through providing the wrong type of food, or not enough of it; for while it is true that reptiles are capable of going for long periods without eating, it is obvious that this provision of nature should not be abused. Again, the old saying that "variety is the spice of life" is true even of cold-blooded creatures; and reptiles that have a change in their diet are likely to be in better health than

those which are subjected to a monotonous menu.

In feeding snakes it is important to remember whether the species concerned normally prefers a prey cold-blooded like itself, or whether it prefers a mammalian diet. Grass snakes, for instance, certainly prefer frogs, newts, fish and even toads; whereas pythons and boas will not look twice at even the fattest frog but will thrive on a freshly killed mouse or sparrow. Frogs and toads will eat very nearly anything in the insect line: all kinds of flies, small beetles and grasshoppers are welcomed, and the humble earthworm can always be relied upon when other insects are not so easy to come by.

Lizards are particularly fond of spiders, though they will, of course, eat most of the insects taken by frogs and toads. Caterpillars are not much liked by any of these creatures, with the possible exception of the smooth green ones. Hairy or warty caterpillars are never taken; neither do some lizards care very much for earthworms, though there are exceptions to this in the case of the green lizard and slow-worm. This last reptile, however, is really rather specialised in its diet, its favourite food being the small white or grey slugs which are such a pest to the gardener. For this reason, if for no other, the slow-worm should be carefully preserved and never killed; neither for that matter should any frog or toad, since they may all be regarded as the gardener's best friends.

One standby for the reptile keeper is the meal-worm; this is the larva of a small beetle, and in normal times meal-worms can be purchased from any pet shop or animal dealer. Now, however, they are very difficult to get, though with care and patience they can be bred.

I am frequently asked how it is possible to provide a variety of insects during the spring and summer for the purpose of feeding one's stock; and I therefore think it worth while to describe a very simple method of obtaining this type of food during any month from about March to October. All that is required is a two-pound jam jar with a metal screw top in which a few small holes have been punched, also a net about the size of the average butterfly net—preferably triangular in shape. The bag portion of this should be made of sacking or linen. This net should be fitted on to a short stout stick about two feet in length. Armed with this simple apparatus all one has to do is to go to the nearest hedgerow or field in which there is a fresh growth of herbage and sweep the verges to and fro with the net, when it will be found that an amazing variety of insects will be captured. These should be shaken down into the bottom of the net and the jar opened and inserted mouth downwards over the captured insects; the net and jar should be then turned over, when by patting the outside of the net with the hand the insects can be transferred into the jar which then has its top replaced. It is no exaggeration to say that it is not difficult to get a jar almost full of insects in the course of half an hour's sweeping. The contents of the jar may later be divided up among one's various specimens, thus providing not only a varied meal but very natural exercise for the hungry pets.

There is another very important aspect in connection with the keeping of reptiles and amphibia which can well be referred to in general, though it will be dealt with again in detail when we come to consider the individual species. This is the aspect concerning the natural environment of the various creatures. Some, of course, like moist and damp surroundings, others will only thrive in dry, sandy conditions. Some will require a certain degree of heat, while others will only do well in very moderate temperatures. It will therefore only be courting disaster if lizards are kept in very moist surroundings, or frogs in very dry ones. It is also a great mistake to keep species which demand a specialised environment in the same enclosure or case as species requiring a different environment. Furthermore, some species change their habitat according to the time of the year. During the breeding season, for instance, newts are entirely aquatic, but once the breeding season is over the adult or fully matured newt leaves the water and takes up a terrestrial existence. It is clear therefore that a suitable enclosure for newts must provide both conditions.

Reference has already been made to hibernating. This of course means that many species, certainly all our British species, retire during the winter months to some suitable spot where they remain in a comatose condition until the following spring. In nature this of course works very well; but in captivity it seems not to be so easy, and curiously enough it presents one of the most difficult problems in connection with the keeping of reptiles and amphibia. As a general rule, where one's specimens are kept in outdoor enclosures I am strongly in favour of allowing nature to take its course by leaving them to hibernate normally. Some people advocate bringing specimens indoors during the colder months, but personally I believe that this has a disturbing effect as it induces a state of partial hibernation and generally ends in the animal concerned failing to survive. It is of course perfectly possible to keep specimens indoors in a warm room and feed them throughout the entire year, but it is a curious fact that where this is done and the normal period of hibernation is not enjoyed, the breeding cycle is adversely affected, and the species will not be fertile.

In this introductory chapter an effort has been made to deal with general principles which apply to all the reptiles and amphibia. In the next chapters I shall deal with the various methods of keeping the species, together with a few hints and tips regarding the construction of both outdoor and indoor vivaria.

CHAPTER TWO

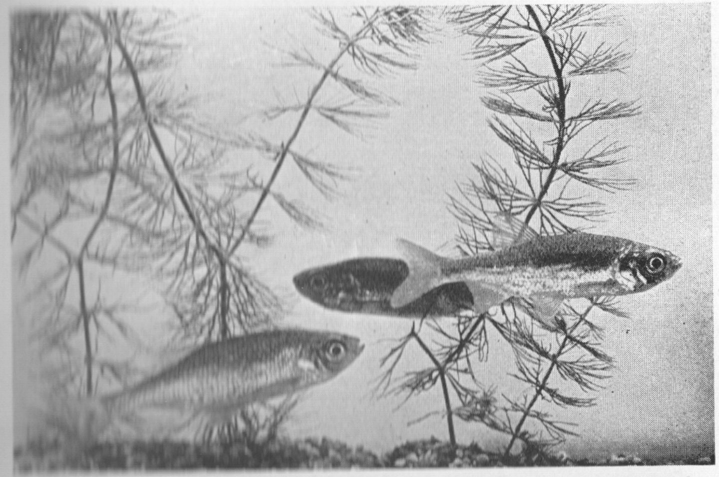
HOUSING THE COLLECTION

EACH individual person will have different ideas regarding the type and number of species which he wishes to study. Some may be limited by reasons of space, others by reason of their pockets. However, the general principles in connection with the housing and welfare of specimens remain the same, whether the collection be great or small.

Reptiles and amphibia may be kept either indoors or outdoors, except for tropical species which must have a degree of heat not likely to be encountered in our freakish climate; but I expect that the majority of the readers of this book will keep their specimens under cover, and, therefore, I propose to deal with these requirements first of all.

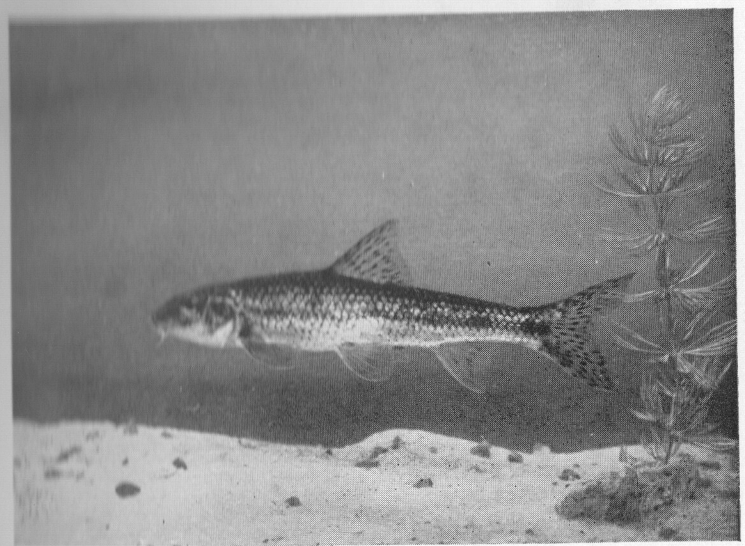
INDOOR VIVARIA

Vivaria, which is the name given to the cases or cages in which reptiles and amphibia are housed, must clearly vary in size with the number and the particular type of species which it is proposed to keep. Now, before the days of austerity, excellent vivaria made of metal with a glass front and adequately ventilated could be bought at most pet shops. Very few of these, however, are now to be found on the market, and so it may be necessary for collectors to turn their thoughts towards construction, adaptation or even makeshift; and in this connection a few consoling words of advice may not come amiss. All that the inmate of a vivarium demands is adequate space, suitable surroundings and acceptable food. It is doubtful



[Lionel E. Day, F.R.P.S.

Rudd.



W. S. Pitt.

Gudgeon.

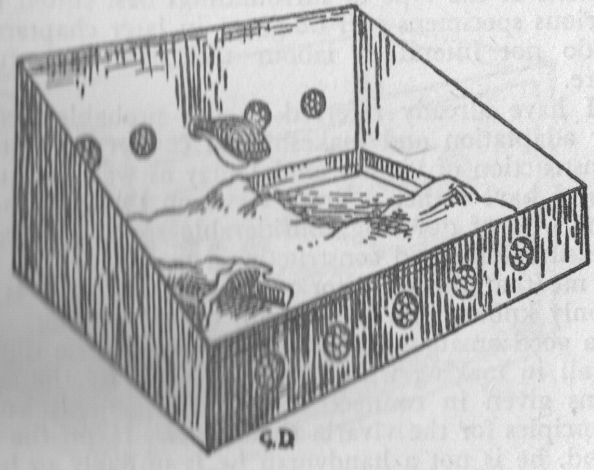
[Lionel E. Day, F.R.P.S.

Albino Axolotl.

[Lionel E. Day, F.R.P.S.

" An attractive garden pool."

if any animal has an appreciation of beauty, and the extent to which the set-up of the vivarium is pretty or artistic is solely the concern of the owner of the collection. This means that the simplest surroundings will be quite sufficient to keep the collection in good health, and it is not at all necessary to make the inside of the case into a facsimile of a hedgerow or a tropical jungle! Those who are anxious to have their



Commercial type of vivarium heated by electric light bulb. Glass over top. Perforated zinc over ventilation holes. For lizards or snakes.

vivaria as attractive looking as possible can, of course, indulge their tastes to a very considerable extent, but in doing so they should bear in mind that too much fernery, branches, stone-work, etc., may tend to hide the specimens from view rather than to show them off to their best advantage—a happy medium is obviously the most satisfactory.

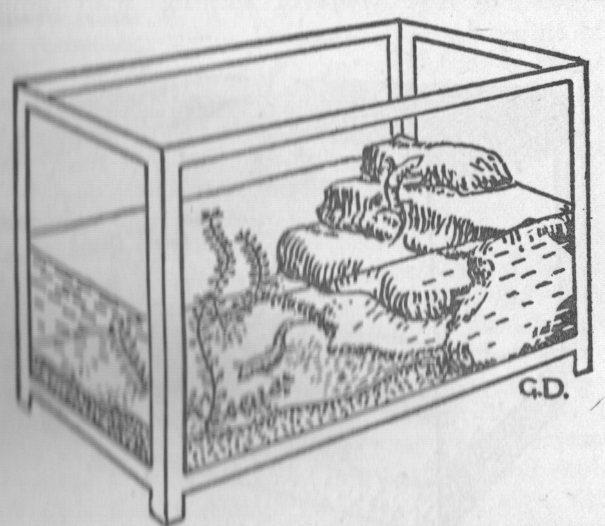
All reptiles and many of the amphibia require light, preferably varying degrees of natural sunlight;

and provided that suitable hiding places in the shape of rough stones, pieces of virgin cork, or strips of bark are included in the lay-out. The vivarium should admit as much light as possible. Similarly the vivarium should be adequately ventilated to prevent condensation, and some provision must be made in respect of drainage, though this latter point need not present a difficulty if the water vessel, which should always be provided, is separate from and not part of the general construction. Details of the type of surroundings best suited to the various specimens will be given in later chapters, and I do not intend to labour this point any further here.

I have already referred to the probable necessity for adaptation and makeshift in connection with the construction of vivaria, and I may as well say at once that I have rather definite views on the usefulness or otherwise of devoting considerable space to diagrams, measurements and constructional technique. It seems to me that the collector will either be what is commonly known as a handyman, or he will not. If he is a good amateur carpenter he will have no difficulty at all in making what he wants aided by the suggestions given in connection with the general working principles for the vivaria themselves. If, on the other hand, he is not a handyman he is unlikely to benefit very much by endeavouring to follow precise constructional details when his aims can easily be achieved without much labour.

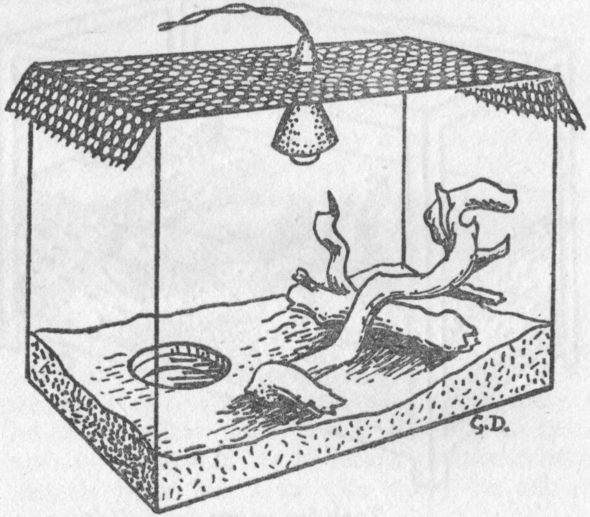
Let us assume, then, that the prospective collector is not able to obtain a properly constructed vivarium. The most practical type to aim at is a metal or wooden case of suitable size, shaped exactly like a garden frame; that is to say, higher at the back than at the front, the sloping portion being made of a sheet of glass which slides in and out. This general shape has many advantages—it is easy to set up, it lets in a great deal of light, and it protects the inmates from draughts, while rendering the inhabitants easy to observe. If,

therefore, it is possible to construct a case on these lines it will be found to be eminently satisfactory. Equally good results, however, can be obtained by using a wooden box, the front of which has a sheet of glass which slides in and out, while portions of the top of the box are removed and replaced by another strip of glass towards the front, a batten of wood across the centre of the top, and some perforated zinc tacked from this over the rear portion. Snakes, lizards, frogs,



Tank for newts.

toads and terrapins may be kept in a case of this kind without any fear of failure due to housing. Newts, however, do very much better in an ordinary aquarium tank. If this cannot be purchased, then glass accumulator jars, which can frequently be bought secondhand, will do very well. But care must be taken to see that some rockwork which rises above the surface of the water is provided, or pieces of virgin cork must be floated on top of the water in order to enable the newts to emerge when they wish. It is very important that any tanks containing newts should be securely covered, preferably with a piece of perforated zinc, for newts are wonderful climbers and can easily clamber up the side of the glass and escape if not prevented. A tank for newts need not contain water to a greater depth than a foot, though it should not be less than six inches, while the inmates will benefit a great deal if the tank is "planted" with water weeds in the manner which will be fully described in the chapters dealing with aquaria.



Vivarium suitable for lizards or snakes. Electric light fitted through perforated zinc.

These plants not only are necessary to enable the newts to breed, but they furnish natural surroundings and help to purify the water.

Accumulator jars have one great disadvantage in that they are very deep in proportion to their breadth and width, and this often means that when used as vivaria an impression of wasted space is given. This cannot be helped, but it can be slightly offset by

having several inches of sand at the bottom of the jar, thus raising the bed and lessening the height between the bed and the top of the jar.

A proper aquarium tank also makes an excellent vivarium. It can be used in its natural state with the glass transparent all round, or the back of the tank can be painted outside in order to provide additional shade and some kind of background against which the specimens can be seen. The only adaptation required when using an aquarium tank as a vivarium is to remember again the all important point of an adequate cover. Although an aquarium is naturally constructed to hold water, I still think that a separate container for water should be placed inside the tank rather than that any attempt should be made to tilt the tank so that one end can contain water while the higher end can provide the necessary land. This is because such water tends to become very foul, and it is a great nuisance to have to upset the whole of the soil, rockwork, etc., in order to clean out the "pond". It is much better to use some suitable receptacle such as a pie-dish, an enamel photographic dish (which is an excellent vessel) or indeed any dish, preferably with sloping sides, which will hold about two to three inches of water. Such a vessel can easily be removed from time to time, emptied, cleaned out and replaced. This dish should always be sunk level with the soil or sand to prevent the tenants getting underneath.

TEMPERATURE

The question of temperature is, of course, closely linked up with the housing of a collection. It is obvious that when we come to deal with outdoor enclosures we cannot have any great control over the temperatures, and therefore all the specimens to be kept in the open air will be those that will thrive in the comparatively temperate conditions of an English spring and summer. Indoors, however, one can be more ambitious, and sub-tropical and even tropical specimens can be kept. Now really tropical specimens require temperatures of anything from 75 to 85 degrees Fahrenheit, and these temperatures will be too high for those amphibia which normally come from Europe. Care must be taken, therefore, not to expect that our English frogs and toads, or the European salamander, for instance, will thrive in a temperature more suited to pythons and tropical lizards!

Correct temperatures can be arranged for each individual vivarium; but if space and species concerned permit, by far the best method of dealing with tropical or sub-tropical specimens is by setting aside a room for the various vivaria, and heating the room rather than the individual compartment. I do not suppose that very many amateur collectors will go in for the truly tropical species, for as I have said, these require very high temperatures which are expensive to maintain and which do not allow much latitude in the way of variety of inmates. Let us imagine, therefore, that we are dealing with a collection which will consist of sub-tropical and temperate varieties. Most of these will feed well and thrive at a temperature of from 65 to 70 degrees Fahrenheit; some, of course, will do perfectly well at a temperature of 60 degrees Fahrenheit, but many will not feed with any regularity at such a low heat. Now the methods of heating the room may vary—one can use an oil stove, central heating if you are lucky, or electricity. I do not recommend gas as there is always a chance of some accident taking place whereby the gas is blown out or otherwise interrupted in its flow, with fatal results to the collection. If you have your house centrally heated and you can use one of the rooms for your collection, the question of keeping the room at the temperature desired presents little or no difficulty. If, however, this is not the case, then I think an electric heater is the next best thing—if not indeed the best of all. There are excellent thermostatic controls now

on the market which are not particularly expensive, somewhere in the region of £3, and these, if linked up with a suitable electric fire, will maintain an even temperature day in, day out with surprising efficiency. If possible, it is best to use an electric heater which is enclosed in some way. The bare filament type is possibly risky when we realise that the room will frequently be left unguarded, and accidents do occur. The least satisfactory form of heating is by oil stove, for this requires much more constant attention, and is never entirely free from oil fumes which are not very pleasant either for the owner of the collection or for the specimens themselves.

Having dealt with the methods of heating an entire room, ways of heating individual vivaria must be considered; but before doing so I should like to discuss one point relative to the question of temperature which I think is insufficiently appreciated by many who go in for the keeping of those pets which require more than ordinary degrees of warmth. This is the question of natural fluctuations of temperature.

There are very few parts of the world where the temperature remains absolutely constant throughout the day and night—either on land or in the water; and it therefore seems to be unreasonable that creatures kept in captivity should necessarily require conditions markedly different from those which they enjoy in their natural haunts. Even so, many keepers of collections and many aquarists who go in for tropical fish do maintain their temperatures at the same level throughout the whole twenty-four hours. I have never believed in this; and I have recently been somewhat encouraged in my belief by hearing that, in all events in the aquarist world, some of the experts are turning their attention to the question of the advisability of lowering their temperatures at night. This not only conforms more closely with nature, but has the additional advantage of economising the heat supply. I have kept snakes such as pythons in perfectly good health and appetite in a vivarium which was 70 degrees Fahrenheit during the day and yet dropped as low as 55 degrees Fahrenheit at night. I should like to see more experiments made in this direction, and it will be interesting if those who try out this method will keep observations on the effect, if any, which this variation of temperature has upon their specimens. I am not suggesting that any improvement in condition will necessarily result, but if one can effect an economy in heating without any harmful results being observed, then at least something will have been achieved, and conditions closer to nature will have been produced.

HEATING INDIVIDUAL VIVARIA

While it is true that a heated room is eminently satisfactory for tropical and sub-tropical species, it has the disadvantage that if the collector also wishes to keep those which do not require much warmth he is faced with the problem of finding further space to house the vivaria. With individually heated cages this difficulty does not arise, but it is, of course, very difficult to heat a number of separate compartments by any other means than electricity. It is, however, very easy to do so simply by means of an ordinary electric light bulb. The method I have used myself is to have a number of leads connected with the main electric plug, these leads being run to the vivaria which it is desired to heat. A small switch such as is used on a reading lamp should be connected to the lead just where it goes into the vivarium; while inside the vivarium an electric light bulb can be fixed up by boring a hole either directly in the top of the vivarium (or at the back near the top) and screwing in an ordinary household lighting fitment. It is necessary to have something in the way of a reflector, and this can either be made out of tin, or a very satisfactory one can be constructed out of the main portion of a suitably sized round tin such as a

coffee tin or quarter pound tobacco tin; this, of course, also has a hole bored in its centre and is attached to the lighting fitment in exactly the same way as the ordinary lampshade. The whole fitting should be so arranged as to point slightly downwards in order that the heat which emanates from the bulb is not wasted.

Where snakes and lizards are concerned it is a good idea to place a flat stone about four or five inches from the bulb which can be used as a basking place.

Now, regarding the power of the electric bulbs and their heat producing qualities, it is not easy to be precise, and the collector must be prepared for a certain amount of experiment in this direction; but I have found that a case 24 inches in length, 18 inches in height and 18 inches in depth can be kept at a temperature of nearly 70 degrees Fahrenheit by means of a 60 watt bulb. The case I have in mind had an asbestos floor and back, wooden sides and glass front. Ventilation was from above by means of a three inch wide strip of perforated zinc running along the whole length of the top at the back of the case. It must, of course, be borne in mind that a metal vivarium of these dimensions will probably get hotter than a wooden case, but here again personal experiments must be carried out; the principle of the scheme is perfectly good. If the vivaria fitted up in this way are kept in a situation where, in addition to the artificial heat, they get a certain amount of sun, it will be found that it is not always necessary—at least in the summer—to have the electric current on all day. It is essential, though, to have a thermometer in each vivarium so that an eye can be kept on the fluctuation of the temperature. At night the electricity can be switched off, and as a slight precaution against sudden chills an old blanket or sack can be draped over the whole case.

This electric light bulb method of heating has, in my opinion, another advantage. I am coming more and more to the conclusion that nearly all the creatures which like to bask, also enjoy a certain amount of light, and it would seem that mere heating alone is not sufficient to maintain good condition; thus by using the method already described one can provide both light and heat from the same source.

SETTING UP THE VIVARIA

The following observations are, of course, only general. As I have said before, more detailed instructions will be given when dealing with individual genera and species; but whatever specimens are going to inhabit the vivaria, they will all require a good foundation of soil or the like; suitable hiding places; provision for water; and possibly branches, or even plants to climb upon. I will deal first with the foundation. This must obviously differ according to whether the inhabitant likes either dry or damp surroundings. Frogs, salamanders and some of the snakes must have a certain degree of moisture; and for these I do not think you can beat good clean garden soil, with perhaps a little peat-moss litter mixed in with it. It is quite a good idea to cut a sod of rough grass or turf of a suitable size and utilise that, particularly as a surround for the vessel which is to contain water. This turf has the additional advantage that it will grow and therefore improve the look of the vivarium. For snakes and lizards of the more heat-loving kinds, soft sand such as silver sand is very good, while I have found that toads do particularly well in a mixture of sand and peat moss litter.

With regard to hiding places, these can be constructed with a piece of flat stone placed in one corner of the vivarium and raised from the soil an inch or so by means of either two other pieces of stone or even pieces of wood. Some creatures, of course, like to retire at certain times and bask at certain times; and where space is a consideration, the hiding place can be arranged so that should the inmate want to bask it can

climb on to the top of its flat stone, whereas when it wishes to retire it can go underneath.

I have already made suggestions with regard to water vessels, and it is only necessary to emphasise the importance of so placing these that they are flush with the soil, and also making sure that any specimen which repeatedly resorts to the water to soak, swim or drink can easily get out again. I have known instances of lizards entering the water and being unable to get out again, thus exhausting themselves by swimming, and dying a miserable death from drowning. A small strip of bark or a well placed stone will obviate any danger of this kind.

Very many snakes, all chameleons, and, of course, tree frogs, require branches to climb or to sit upon, and there is no difficulty about providing something of this nature. In the case of tree frogs, broad leaved ferns are suitable and decorative at the same time; but where snakes are concerned care must be taken to see if the top of the vivarium is movable—as for instance where a piece of plate glass is used as a cover—that the branch does not present the snake with an easy opportunity for climbing up and forcing its way out from its point of vantage. This is best prevented by placing a brick or fairly heavy stone on the top of the plate glass.

A further necessity in the case of snakes and lizards is the provision of something which will aid in the process of sloughing the skin. A rough stone or a log of wood, or even the base of one of the climbing branches, so long as it is firmly fixed, will enable the reptile to rub its head and body against such a surface, thus helping it to change its skin comfortably.

CHAPTER THREE

OUTDOOR REPTILIARIES AND VIVARIA

ONCE the outdoor enclosure has been constructed by whichever means the collector prefers, the setting up can be based on exactly the same principles as those just laid down for indoor vivaria. The only difference is that in most cases the outdoor types will usually offer more space, and therefore greater scope; while they can obviously be made more attractive, as all kinds of ferns, heather, rock plants and even weeds can be utilised to make the general appearance more natural.

Before considering any details about constructing outdoor enclosures it is as well to remember that the principal object of the enclosure is to keep the occupants in! This important point will have a bearing on the type of material used in constructing the enclosure, the height of the walls, and the lay-out of the interior. Many reptiles and amphibia have their own methods of escaping from confinement. Snakes, once they can get an inch or two of head and neck over an obstruction, can very easily crawl out; slow-worms are expert burrowers; toads are equally expert climbers—sometimes to a quite incredible degree; while lizards, with their long scaly toes, can run up anything in the nature of brickwork or cement as easily as a man can run along a road. Of course it is quite possible to construct an enclosure which will be satisfactory for keeping in snakes, frogs, toads and lizards; but apart from the fact that it is not desirable to keep all these together, considerations of space may prevent the collector building anything on too vast a scale.

Snakes. I shall consequently start by describing a few easy ways of constructing a rectangular enclosure suitable for confining various species of snake.

Probably the easiest material with which to work is asbestos sheeting. These sheets, which can be purchased in many sizes, can be fastened to wooden posts 2 in. by 2 in. with special large-headed nails, and, as far as my own experience goes, they seem quite satisfactory and able to withstand most types of weather. Once the size of the enclosure has been decided upon, the next thing to be considered is what species is going to live in it. If the inhabitant is to be a grass snake, or any of the more usual varieties of non-tropical snake, a height of 4 ft. should be given; and in working out the height of the enclosure allowance must be made for the fact that when the wooden posts have been placed in position, the asbestos sheets must be let into the earth for about 3 in. This is to give more stability and as an additional precaution against any burrowing activities, for many snakes are also quite good burrowers. If an asbestos enclosure 4 ft. in height is constructed it will not be necessary to have anything in the nature of an overlapping ledge at the top for the purpose of preventing escapes, always provided that commonsense is used in connection with the internal lay-out, and little banks or basking places or branches are not placed near the sides of the enclosure, thus taking away something of the advantage of the height of one's walls.

Lizards. If it is an enclosure for lizards which is to be constructed, a very good one can be made from the sheets of glass supplied for garden cloches. The requisite number of sheets, according to the size intended, can be let into the earth an inch or so, after strips of wood have been hammered into the ground to act as additional support. The height from the ground to the top of the glass should be about 15 in., and as it is impossible for even a lizard to climb up glass, there is no need to have anything in the nature of a cover. This has an additional advantage, since large numbers of insects will naturally find their way into the enclosure and provide a fairly constant supply of food. Here again care must be taken that the heather or herbage growing inside the enclosure does not offer a sort of ladder by which the lizards can make their way out.

Terrapins. Where those species of terrapins which can be kept in the open air are concerned, either asbestos sheets or glass, or even well creosoted wood, can be used to pen them in; and the height of this pen need not be more than two feet. However, I am not in agreement with some collectors who use small mesh wire netting for this purpose. It is true that it will keep the terrapins in, but they are very inclined to push their snouts against the wire and injure themselves, and for this reason I do not advocate such material.

Some readers may be both exceptionally handy and also more ambitious, and the foregoing suggestions may seem to them to be too rough and ready. If that is the case they can quite easily construct a first-class reptiliary out of old bricks or breeze blocks, and so should there be any who would like to go in for anying really permanent I will give a description of an outdoor reptiliary built by a friend of mine, Colonel James Wilkins, an enthusiastic herpetologist (as those of us who keep reptiles and amphibia are called). The accompanying illustrations give an excellent idea of the general lay-out and construction; but in addition to these I am giving Colonel Wilkins' own directions for making the reptiliary:—

Constructional Details. The reptiliary was built of standard wire-cut bricks set on edge, giving a wall 2½ in. thick; the overlapping edge at the top was made with tiles; and cement mortar—one part cement to three parts sand—was used throughout. The cement was waterproofed for the two top courses together with the tiles, by means of a proprietary article called "Medusa". The walls are capped with 6-in. red tiles which should be adjusted so as to give a 3-in. overhang on the inside. The internal dimensions of the reptiliary are: length 4 ft. 6 in., breadth 8 ft., minimum height 2 ft. 6 in. The additional courses at the back of the reptiliary are provided to give this minimum height where the sun-bathing platform, which can be seen in the illustration, is raised above the ground level. The general inside ground level slopes down from the north at a gradient of about one in eleven.

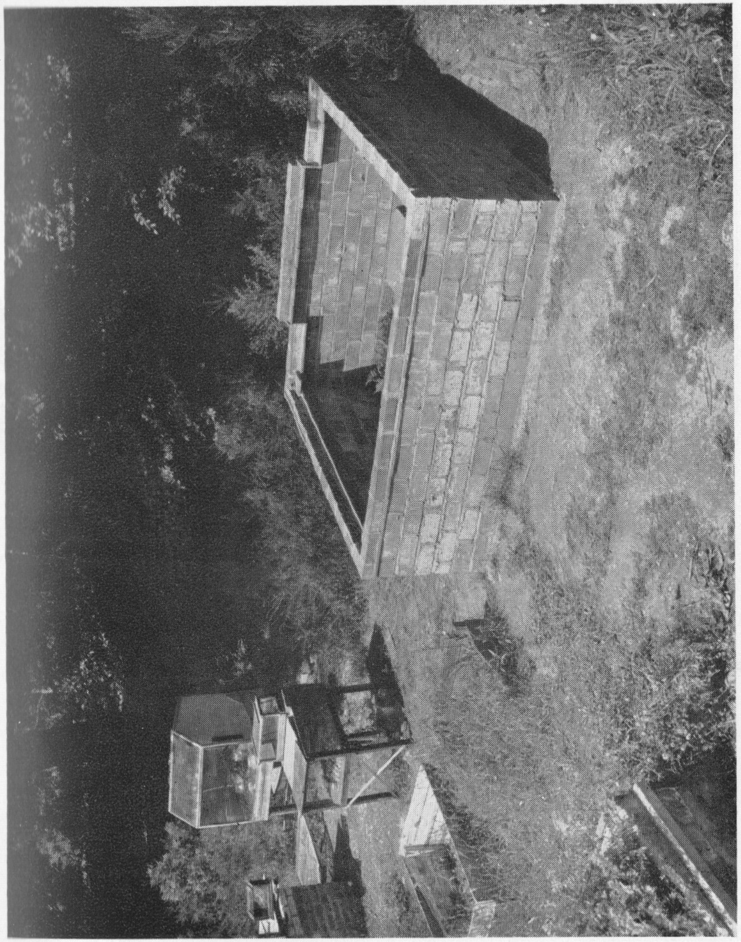
General lay-out. The bathing pool can be clearly seen in the photographs. This was made out of an old kitchen sink costing five shillings, set in concrete in a place where calculations have shown that the sun will never shine directly upon it. Underneath the big flat stone, which was to be used as a basking platform, is a hibernating chamber, to which entrance is afforded by a tunnel made from 2-in inside diameter "Mole" drainpipes. These lead from the sunk chamber to ground level, and emerge through a concrete platform with a raised rim to preclude the entrance of water. The depth of the hibernating chamber is 16 in., but this could be deeper if desired; and the overall dimensions of the hibernating chamber will obviously depend upon the number of specimens likely to be using it. The floor of the chamber is of waterproofed concrete, and the walls are of brick. In the summer, entrance to the chamber can be prevented by means of a cover on top and a plug in the drainpipe; while in the winter the chamber can be filled with dry bracken and leaves, with a layer of peat moss at the bottom.

The cost of constructing this reptiliary was exceedingly low, the actual materials having been purchased for the sum of £3, and Colonel Wilkins tells me that working single-handed, and only on a part-time basis, it took him just over fourteen days to build.

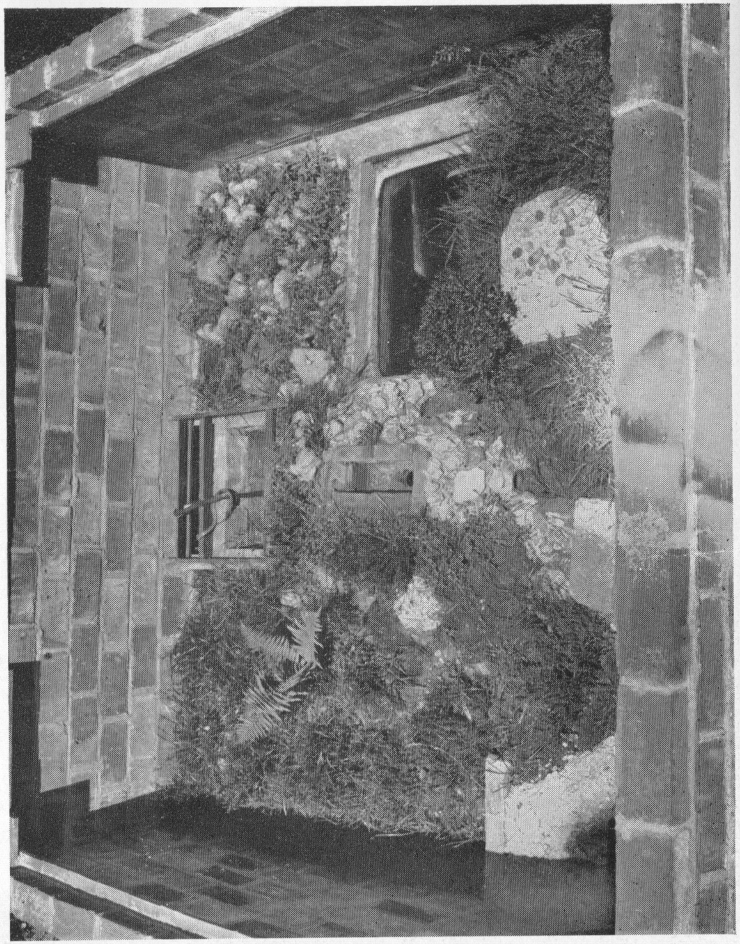
A reptiliary such as the one described above seems to me to be excellent in all respects, and provided the rules laid down for internal lay-outs are adhered to, I think that specimens kept in such an excellently constructed enclosure should have every chance of thriving. It is unlikely that the average enthusiast who goes in for outdoor enclosures will always be able to choose the most perfect part of his garden for a site, but so long as the reptiliary receives enough sun (but never too much) and the all-important question of cool water and sufficient hiding-places are borne in mind, everything in the reptilian garden should be lovely!

For those who have seen the outdoor reptiliary at the London Zoo, it is always possible to construct a smaller edition at home. The general principles are, of course, the same as those laid down by Colonel Wilkins; but the actual reptiliary itself is surrounded by a shallow moat which acts as boundary and provides a swimming bath at the same time. The outer wall of the Zoo enclosure is curved over at the top and thus nothing in the snake line can possibly get out.

It seems hardly necessary to say that frogs and toads may be kept in any of the enclosures already described except the glass enclosures for lizards which are too low; but they should not be expected to share quarters with grass snakes and still survive!



Outdoor Reptiliary and Vivaria.
[Ron Francis.



Internal layout of Reptiliary.
[Ron Francis.

CHAPTER FOUR

FEEDING

A FEW general remarks on the subject of feeding and methods of feeding are necessary, for there are several snags in connection with this important aspect of keeping reptiles and amphibia which are bound to arise in the course of maintaining a collection. One of the most tiresome of these is the ease with which certain types of food such as earthworms, mealworms, beetles, etc., can disappear into the many hiding places which exist in a vivarium if they are not eaten at once. There is no way of actually preventing this, but it is possible to reduce the annoyance by feeding at fairly regular times, which times will quite soon be recognised by the inmates, many of whom will actually appear to be presenting themselves for a meal just when it is most convenient. Another useful hint, where space permits, is to have a corner of the vivarium—which need only be a few square inches in extent—kept entirely free from soil or litter of any kind; or if this is not easy a small strip of wood or metal can be placed across one corner to prevent the litter being scratched over the clear space. This space should always be used for feeding, when the food is in the nature of earthworms, mealworms or gentles. I can assure readers that a great deal of trouble and irritation will be prevented by adopting this course.

TYPES OF FOOD

EARTHWORMS. These, of course, may be readily obtained and are suitable as food for nearly all toads and frogs, with the exception of tree frogs; for all newts; for salamanders, axolotls, and most terrapins. The young of some snakes, such as garter snakes, will also eat small earthworms.

MEALWORMS. Nearly all lizards, at least most of those likely to be kept in the vivarium, readily feed on mealworms. They are also liked by toads; rather less so by frogs; and do not appear to be attractive to either newts or salamanders.

GENTLES. This is the name commonly given to the larvæ of house flies and bluebottles. They can be obtained from many fishing tackle stores and bait suppliers, or they can be bred by exposing fish or meat to the attacks of bluebottles and flies and allowing the eggs to hatch out. This is not likely to be a popular method in the home as it is very difficult to do this without a considerable and offensive smell! However, gentles are very useful in that frogs and toads will eat the larvæ, while if the larvæ are kept until they pupate, the pupæ can be put into a small dish in the vivarium when in due course they will hatch out into flies which again are acceptable to lizards, frogs and toads, and are absolutely essential to tree frogs.

MISCELLANEOUS INSECTS AND SPIDERS. As I have stated before, these can be easily collected during spring and summer and they are equally easily fed to the collection. They also have the additional advantage that they will remain alive for quite a long time in the vivarium—at least in most cases—and are consequently there for the picking so to speak.

I have listed the above as most of them serve as food for many types of creature; but when we come to consider snakes, baby alligators, tortoises and terrapins, it is better to deal first with the predator rather than the prey.

Many of the European snakes and those from other temperate regions will eat frogs, small fish, and newts, though I have yet to find the snake that will eat the crested newt. The adder and the smooth snake are rather more specialised; and although, as I shall state again later on, I do not favour the keeping of adders, when they do feed they will generally take lizards. The smooth snake feeds almost exclusively on these.

Pythons and boas require warm blooded prey and the most suitable and most easily obtained are, of course, mice. These should be offered freshly killed and will probably have to be moved about in front of the snake to ensure arousing its interest, though once it has become used to eating dead prey, it will take them of its own accord. Neither of these snakes is averse to a bird, and it sometimes happens in the spring that fledglings are kicked out of a nest in one's garden. If this should happen the victim might just as well provide a meal for a snake as lie about to become the prey of a foraging rat or even a titbit for the household dog or cat.

Tortoises and terrapins. Land tortoises, at least all those species likely to find their way into an amateur's collection, will feed very well on grass, which they will crop quite close, also the outer leaves of cabbages and cauliflowers—in fact any of the ordinary green vegetable leaves will be readily eaten. They are also rather fond of soft fruit, and damaged gooseberries or even strawberries can be given when available. While on the subject of land tortoises it is as well finally to dispose of the belief which has been encouraged by dishonest vendors of pets that these creatures will rid the house of blackbeetles, slugs and other noxious pests. They will do nothing of the kind and should be kept to a strictly vegetarian diet.

Terrapins, often erroneously referred to as water-tortoises, are nearly but not quite confined to animal diet. They do occasionally nibble pond weed, but their principal food should consist of small fish such as minnows or bleak (not sticklebacks), small newts, or tadpoles when they are in season. Failing these much relished delicacies they will do very well on strips of ordinary fresh fish from the fishmonger, or earthworms. There is one important point to be noted in connection with the feeding of terrapins, and that is the fact that they will seize their food in the water, and the greatest care should be taken to see that no uneaten pieces of food are left in the water to contaminate it. Personally, rather than adopt the procedure of feeding the terrapins in their own " pond ", I think it is better to take them out and feed them in a separate basin of water which can be emptied after the meal is finished, and the terrapins returned to their normal home.

Before concluding these general remarks on feeding, it is as well to deal with the popular belief that reptiles can be satisfactorily kept in a state of semi-starvation. So much has been carelessly written about the ability of reptiles and amphibia to go for long periods without feeding, that unthinking persons are rather inclined to exploit this to the ultimate detriment of their pets. This error has probably arisen owing to the fact that snakes, for instance, have comparatively slow digestions, and an ample meal will last a snake for a considerable time; but this does not mean that they can be left without food and expected to thrive. I think that nearly any snake which is in suitable surroundings requires to be fed on an average of once a week or once in ten days. Individuals obviously differ, but food should always be offered at such intervals. Most of the amphibia are far more voracious and should be fed at much more frequent intervals; and I have found that nearly all frogs feed more frequently than do toads, while lizards also require reasonably constant supplies.

One last golden rule must be repeated. Except where the meal is in the nature of insects or earthworms, untouched food should be removed from the vivarium if it is clear that the inmate is not going to eat it. This is particularly necessary in the case of the mammalian food offered to the larger snakes. Few snakes will touch prey once *rigor mortis* has set in.

CHAPTER FIVE

HEALTH AND DISEASE

THE old and hackneyed adage that "Prevention is better than cure" is certainly true where the diseases of domestic pets are concerned, and with no creatures is this more true than those dealt with in this book, namely, reptiles, amphibia and fish. The diseases of all these seem to fall into two categories—those that can be prevented by proper housing and feeding, and those which are not really due to deficiencies in these departments, and which are extremely difficult for any unskilled person to treat.

If the correct type of habitat is arranged, and the proper food is supplied at the correct intervals, the collector should not be much troubled by a preventable disease.

Reptiles. Reptiles in particular are prone to both internal and external parasites. Both types of parasite are generally well established before the specimen comes into the hands of the collector, and internal infestations are very difficult for the amateur to treat and frequently prove fatal. External parasites, however, which take the form of ticks, are amenable to some treatment. The best way of dealing with these is to apply a drop of paraffin with a small brush or feather, when the tick will usually drop off of its own accord. If it does not, it can be taken off with a pair of tweezers.

Both snakes and lizards sometimes damage themselves near the snout, and set up a sore place which, if not checked, will rapidly spread. I have found that warm dilute hydrogen peroxide (one part of hydrogen peroxide to three of water) used as a bathing solution, or a solution of permanganate of potash diluted until it is the colour of pale red ink, will often prove effective. Reptiles damaged in this way should be separated from their companions.

Snakes and lizards also have occasional difficulty when changing their skins. This should not occur if the reptile is feeding well and is correctly housed ; but a new specimen may be in such a difficulty when it first comes into the collection. If this is the case the sufferer should have its bathing dish filled with clean slightly warm water, and should be allowed to soak in this for as long as it seems to enjoy it. This frequently has the desired effect, and the sloughing will be subsequently completed. This type of difficulty usually arises from the reptile being run down, due either to insufficient or incorrect food, or to overcrowding during transportation, which circumstance causes them rapidly to lose condition.

Amphibia. The most likely disease to afflict amphibia is an eruption of fungus. This can usually be recognised at once by the appearance of little patches of white—almost like threads of cotton wool. This fungus generally yields to a treatment with paraffin which should either be painted on with a small brush, or if an entire limb is affected this should be soaked in paraffin and afterwards rinsed off in clean water. This fungus disease is very contagious and therefore those under treatment should be segregated.

With regard to the prevention of disease, I am sure that variety in food makes a great deal of difference to many species of reptiles and amphibia. A few of these, of course, are specialised in their diets, but the vast majority are not confined to one type of prey and undoubtedly derive good from a varied menu. Another health point to be observed is to see that damp loving species always have their surroundings sufficiently moist, while those that inhabit dry places should not be allowed to become wet unless they are able to dry off under the sun or artificial source of heat.

Accidental injuries are rare. It is true that newts sometimes fight and even take quite big pieces out of

each other's tails. This should not give cause for alarm. Most amphibians, particularly newts, have wonderful powers of regeneration, and damaged tails and even lost toes, will be grown again if the injured newt is placed by itself to avoid continued aggression from its mates.

Do not be continually examining specimens to see whether they exhibit symptons of disease, but keep a sharp eye on their behaviour. If they are reasonably active, bathe at suitably regular times, and above all, feed well, there is not likely to be much wrong with them. Regular feeding generally indicates good health.

CHAPTER SIX

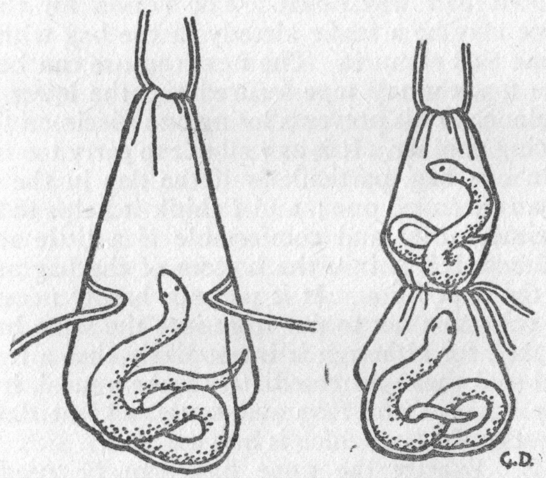
CATCHING AND TRANSPORTING SPECIMENS

As only those who are fortunate enough to be able to travel will get opportunities for collecting outside the British Isles, the following hints on methods of capture and transportation really only apply to our own range of reptiles and amphibia. Nevertheless, methods which can be used in this country are equally good for many species likely to be encountered abroad, although there are some which require specialised or expert handling. If the reader does find himself in some country where reptilian life abounds he will be wise to consult the nearest museum or zoological gardens where some helpful official will certainly be able to advise on any particular species which require particular technique.

Snakes. I shall commence by saying quite definitely that I do not advocate the capture or the keeping of adders. This is a job best left to the expert; and I refuse to be held responsible for any accident which might occur as a result of a beginner trying a prentice hand on our only poisonous reptile! No great disappointment need be felt over this, as in any case adders are extremely difficult to keep in captivity owing to their reluctance to feed except under very ideal conditions and when given considerable individual attention. This means that as far as British snakes are concerned we shall only have to concern ourselves with the grass snake and the smooth snake.

All that is required in the way of apparatus is a stiff but pliable stick, not more than three feet in length, which can be used to pin the snake down, and a supply of bags made from linen or any other similar material, to which a length of tape has been sewn about

two inches from the top. The bag should be not less than 18 in. deep and from 8 to 10 in. across. It will be noted that I do not advocate the traditional forked stick, as I consider that this very frequently leads to the snake being injured owing to the beginner's tendency to press it down too hard on the snake in an endeavour to prevent escape. A stiff pliant stick, or even an old riding whip serves very well, and in my experience will restrain the snake without undue risk of injury. It is not absolutely necessary in Britain to have a stick



Snake bags drawn as if transparent to show the snakes inside

at all, particularly when one becomes really familiar with our three snakes; but it is perhaps useful to carry one, particularly if the smooth snake should be the object of one's hunting, for there are very well marked specimens of the smooth snake which at first glance may look rather like a *not* particularly well marked adder! In such cases the use of the stick will enable the collector to have a good look at the specimen before picking it up and placing it in the bag.

Now, first of all make absolutely certain that the snake you are about to catch is not an adder. If you are in any doubt, pin it down by placing the stick firmly across the snake as near the head end as possible. When certain of identification, simply pick up the specimen gently behind its head, get out your linen bag, drop in the snake, give the bag a shake and tie up the neck with the tape. The tape should always be taken twice round the neck of the bag before tying. Some collectors have two tapes on the bag, one near the top and another about half way down. The reason for this is that there may be a snake already in the bag with the lower tape tied about it. The next capture can be put in at the top, the top tape secured and the lower tape then undone. This prevents losing one specimen when introducing another. It is as well not to carry too many snakes in one bag, particularly if the day in the field is to be an extended one; and I think it helps to keep the specimens cool and comfortable if a little rough grass or moss is put into the bottom of the bag at the start of the expedition. It is perhaps hardly necessary to warn collectors not to put frogs into the same bag as grass snakes, for although it is not likely that a freshly captured snake would immediately make a meal, it will certainly frighten the frog and cause a great deal of movement in the bag which is best avoided.

Lizards. Exactly the same bags can be used for carrying lizards; but it is essential to give the bag a good shake each time it is opened, and to be very careful in tying the tapes, particularly the lower one, as otherwise the lizards, which can easily run up the linen, may escape. Again, the collector in his hurry may tie the tape round the lizard if the above precaution is not observed.

No stick is necessary for catching either the common lizard, the sand lizard, or the slow-worm. The last named can be picked up in the hand without fear, but it should always be grasped well up the body as, like all lizards, the slow-worm has the ability to snap off its

tail, leading at the best to a damaged specimen, or at the worst to a lost slow-worm, with a wriggling tail as the only relic of the attempt. The slow-worm is the easiest of our three lizards to catch; the other two being incredibly swift in their movements and requiring a quick eye to discern and an even quicker hand to secure. However, the beginner will soon become quite expert and will get to know the exact degree of pressure required to hold the lizard without damaging it. The best way to make the initial grab is to try to keep the entire hand over the lizard, and after making sure that it is within your grasp, taking it gently between thumb and fore-finger just near the front legs in order to place it in the bag. Newly caught lizards, even the small common lizard, will sometimes try to bite, but neither this one nor the sand lizard is capable of inflicting any hurt, and the bites can be ignored.

While on the subject of catching lizards I should like to refer to the curious mis-statement which I have come across in several books: namely, that the sand lizard is less quick in its movements than the common or viviparous lizard. Personally I do not think there is anything to choose between them, and my only explanation for this mistake is that the sand lizard, being bigger than the common lizard, appears to be less agile. That this is not so anyone can find out after a few attempts at capture.

I am frequently asked how to carry the bags when one has a reasonable number of specimens inside. I have given this matter a lot of thought and have come to the conclusion that I am, myself, sometimes rather careless about this, for I have got into the habit of carrying the bags in a big side pocket of an old fishing coat that I usually wear in the field. I think this is a bad habit, for while I cannot honestly say I can remember specimens being damaged, it is obviously possible for this to happen. There are two possible methods: one is simply to carry the occupied bags in one hand, dropping them on to the ground each time a fresh capture is to be made; or alternatively fixing up a small rucksack with pieces of light ply-wood inside so placed as to turn the rucksack into a sort of box. The already occupied bags can be placed in the rucksack, while unused bags can, of course, be carried in the pocket.

Toads. The capture of toads is obviously an easy matter as they are slow in their movements and not likely to escape. They can be carried quite successfully in the linen bags.

Frogs. The common frog is, of course, very easy to catch in the breeding season when its mind is more occupied with propagating its species than with avoiding its enemies. But outside the breeding season it sometimes takes a lot of catching owing to its agility and damp skin. A small butterfly net is not at all a bad thing to have with you, as this can be placed in front of the hopping frog and will enable it to be secured without any risk of injury.

The edible frog and the marsh frog are both mainly aquatic, but are much more nervous and active than the common frog. There are two methods of catching these. The first is by means of a rod and line with a piece of red flannel at the end of the line in place of a fish hook. Frogs will frequently be found with their heads just poking out of the water, and if carefully approached may be captured by dangling the piece of flannel just in front of the head, when a frog will make a grab at it thinking it to be some attractive piece of food; it can then be swung on to land while it is still holding on. This method has the additional attraction of affording some excitement and sport, for one needs a steady hand and considerable patience. This rod and line business, however, is only likely to be effective during the day-time; and it is at night when the easiest catches will be made. For this night work it is useful for two persons to work together, one carrying the bags and a strong electric torch, and the other the net. The best type of net is one threaded

on a ring not less than 18 in. in diameter, the net itself being made of very fine mesh which should not exceed ¼in. The bag must be not less than 2 ft. in depth, and running to a point at the bottom. Armed with torch and net the habitat of the edible or marsh frogs should be approached, and the surface of the water searched carefully with the beam from the torch. The frogs sitting in the water will easily be picked out, and now the person operating the net should proceed carefully to extend the net until it is just beyond the head of the frog in question. A quick downward sweep, with the net brought in towards the operator, will generally prove successful. The light does not appear to disturb the frogs; in fact it seems to have the effect of temporarily immobilising them.

When it is certain that the frog has actually been caught in the net, the net should be given a little shake and turned over so that the ring of the net forms a slight barrier against possible escape. The operator should keep well away from the water before opening the net to take out the frog, which can be transferred to the linen bag with some water weed in the bottom of it to keep the captives moist.

Newts. Newts may be caught either with a primitive rod and line or in the net. If the former method is to be used a medium sized earthworm should simply be fixed to the end of the line with a slip knot and lowered into the water. The movement of the line will soon indicate when a newt has seized the worm; and after a pause of a few seconds to allow the newt to get a good hold, it will be found quite possible to lift it out well away from the edge and remove it. If desired, a tiny float can be constructed to act as a tell-tale, the float being about 6 in. above the worm, and the rod should not be raised until the float is pulled under the water.

If the use of a net is preferred, care must be taken to see that either the mesh is of the very finest or that some material such as bolting silk or muslin is used, for newts can wriggle their way through a very tiny aperture. A net-ring of the same diameter as that used for capturing frogs will be effective, and this should be mounted on a really strong stick as it will have to be pushed through considerable concentrations of water weed, and anything flimsy will not stand the strain. Catching individual newts as they come up to the surface of the water for air is not very profitable, as they are exceedingly quick to dive. It is really better to select a suitable spot in the pond—for instance, where there is a clump of weed surrounded by open water. Into this the net should be plunged mouth downwards and drawn towards one when it will generally be found that several newts are captured at one sweep.

Newts may also be carried in linen bags, but it is essential to give them a plentiful supply of damp weed in the bottom of the bag. I am very much against the practice of carrying newts in a bait-can containing a few inches of water, as I think that the inevitable shaking about in the course of transportation is harmful. They do perfectly well in damp weed, even for as long a period as four or five hours.

Aquatic insects for use as food. While on the subject of collecting amphibia it may be as well to devote a little attention to some of the minor captures which will be made, or can be made, while collecting a larger quarry. The young of the marsh and edible frogs, and all tadpoles and larval and adult newts all require small living food ; and good supplies of suitable creatures may be obtained from the waters where these amphibia are to be found. Included among such creatures are daphnia (commonly referred to as water fleas), the larvæ of gnats and mosquitoes ; the larvæ of may-flies, and other small aquatic flies which will all find their way into the net, either by themselves or while clinging to pieces of weed. All these make excellent food and can be kept going at home in any simple glass tank containing a good supply of aquatic vegetation. There are, however, one or two inhabitants of the

pond which one should be careful to avoid. First are leeches of all kinds, which can easily be recognised by their greater size, their wormlike structure and their undulating method of swimming. Also to be avoided are the larvæ of dragon-flies and water beetles, all of which are extremely voracious and will think nothing of seizing a small newt or tadpole, and sucking out their vital juices. The larvæ of dragon-flies and water beetles vary in size from about $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. or more, and may easily be identified as they look like elongated beetles with six legs placed towards the head end of the long body. They have rather noticeable eyes and are generally possessed of a ferocious look. Water scorpions and water boatmen should also be avoided as these are both very savage and hungry. They belong to the bugs, and have sharp beaks which will do no good to the young of any self-respecting amphibian.

CHAPTER SEVEN

BREEDING

SOME readers may remember the famous humorous advice given by *Punch* on the subject of matrimony: "To those about to get married, don't." I feel very inclined to give this advice myself with regard to the question of breeding reptiles and amphibia. This is not because it is impossible—in fact it is quite easy in some cases; but on the whole the difficulties attendant upon breeding extensively are considerable, and unless the amateur really has a great deal of time at his disposal, or is going to concentrate on only a very few species, then breeding had better be left alone. There are, of course, certain exceptions to this. Several of our own species will breed quite readily and without any particular supervision; in fact they will sometimes produce their young without their owner being aware that it is about to happen. In such cases no special problem will arise, except in respect of feeding, which in the case of reptiles is a very big problem indeed; and if any reader is inclined to disbelieve me, let him try to satisfy the growing appetites of a litter of young viviparous lizards—even if his garden *can* produce an apparently unlimited supply of greenfly!

One of my main objections to giving encouragement to breeding on an extensive scale is the fact that so many disappointments are likely to arise due to one curious phenomenon. Unless normal hibernation is allowed to take place, reptiles and amphibia may be sterile and unable to breed. Many people have wondered why they have successfully brought their pets through the winter, looking pictures of health and feeding regularly, only to find that normal breeding does not follow. The reason for this is the lack of the usual period of hibernation.

As I have already stated, feeding the young is another difficulty, particularly with reptiles. Amphibians are not difficult to manage in the tadpole state, but are extremely tricky when the stage of metamorphosis is reached; for only the tiniest insects, worms, etc., can be taken, and these are often very difficult to provide at the precise time that they are most needed.

However, I feel certain that the advice given above will probably be ignored by many enthusiasts, and therefore it may be as well to include a few general directions on breeding in respect of some of the species which do so comparatively easily in captivity.

Snakes. Snakes may very roughly be divided into those which lay eggs and those which bring forth their young alive. Quite clearly, those which lay eggs will require different treatment from those which are truly viviparous or are ovoviviparous. To take some random examples—the python, grass snake and the attractive little dice snake lay eggs, while the boas, and our own smooth snakes are ovoviviparous. It is unlikely that the average amateur collector will possess a python in breeding condition, so I really think we need say no more about this species. On the other hand a female grass snake may easily present its owner with a nice clutch of leathery-shelled, cream coloured eggs the size of large grapes. If the owner is aware of the impending event, and the snake is in an outdoor vivarium, a small heap of well-matured leaf mould, or even manure and straw, also well-matured, should be provided. Then with any luck the expectant mother will lay her eggs in this in the normal manner, and in due course they will hatch out. It is, however, very difficult to reproduce in miniature the conditions which pertain in a genuine full size manure or compost heap, for there must be just the right degree of temperature and humidity for the eggs to hatch successfully. What is more likely to happen is that either the snake will produce her eggs before provision is made, in which case I think the situation is hopeless; or the collector may come across some eggs already laid in the course of a field expedition. If this occurs, everything will depend upon whether the embryos have reached a sufficiently advanced stage of development, for if they have not then the transference of the eggs to some artificial "nest" is seldom productive of success. If the eggs are near hatching in any case (which can be ascertained by opening one up) then placing them in some slightly damp moss in a warm room, or even on the kitchen mantelpiece, will generally result in a successful hatching. These remarks about the grass snake and its eggs apply also to the dice snake and many other species of European snake likely to come into the possession of the amateur.

The various viviparous and ovoviviparous species, providing they have the correct amount of warmth, will probably produce their families without complications, and the only difficulty, as has already been stressed, will lie in providing suitable and sufficient food.

Lizards. Here again we have the same division into species which are viviparous to a greater or less degree, and those which lay eggs. Our common viviparous lizard and slow-worm both produce living young, and will do so quite happily in either an indoor or outdoor vivarium. The sand lizard lays eggs and buries them in the sand where their incubation is effected by the heat of the sun. Some authorities say that the eggs can be hatched artificially and I have no doubt that this is the case, but I must confess that I have had no success in trying to do this myself. The method usually employed is to take the eggs and place them in a tin, the bottom of which has a thick layer of damp moss. The eggs should be separated from each other and some more moss placed on top of them, while the lid of the tin should be perforated with small holes. The tin should then be placed somewhere where it can be kept at a heat of about 90 degrees Fahrenheit. The difficulty is, of course, to maintain the correct degree of moisture, for if the eggs become too damp they will get fungus

trouble, while if they are too dry they will shrivel; and the only advice I can usefully give here is that the artificial incubation of the eggs of any snake or lizard entails constant attention without undue disturbance, and this is not an easy combination to ensure.

Newts. Most newts will breed quite satisfactorily in captivity, so long as their tank is well planted with suitable pond weed. The common Canadian pond weed and Starwort are excellent for this purpose, as newts require a plant with a leaf conveniently shaped for wrapping round the eggs which are laid singly, each with a leaf to itself.

Frogs and toads. Our own frogs and toads will spawn in an outdoor vivarium as long as they have a sufficient area of water. With regard to foreign species, some of these will breed in captivity, and where the most satisfactory of these are concerned they will be dealt with separately under the heading of their species.

Salamanders. These will also breed well in captivity, but care must be taken to see that the young, which are born alive, are not deposited on dry land, as if this happens they will certainly perish. A shallow dish of water must be provided, and the adult salamanders must be removed as soon as birth has taken place.

Tortoises. These sometimes produce eggs in captivity, the female scraping a hole in the earth to a depth of four or five inches, after which the hole in which the eggs have been deposited will be covered up by the female. I do not think much success is met with in this country in leaving tortoise eggs in their natural surroundings. They can be artificially incubated in fine damp sand, subjected to a range of heat between 70 and 90 degrees Fahrenheit; but here again there is a risk of them either drying up or developing fungoid growths, and a good deal of care will have to be exercised if these dangers are to be avoided.

Terrapins. These behave in much the same way, though their eggs take much longer to hatch—upwards of fourteen weeks as compared with eight to ten for land tortoises.

This chapter is chiefly aimed at preventing disappointment rather than discouraging enterprise; but I am sure that little difficulty will be experienced with those species which I have selected as being reasonably easy to breed from. Collectors who really wish to go in for experiments with more exotic species will do well to consult one of the many textbooks on reptiles and amphibia, these can, of course, devote very much more space to the various genera and species than is possible within the compass of this book. The bibliography supplied at the end of the present volume should be of use in this respect as I have included not only works of a "popular" type, but also works by recognised authorities in the zoological world.

CHAPTER EIGHT

REPTILES

INTRODUCTION

It is not necessary for the purposes of this book to go very deeply into classification. The Class Reptilia includes the orders Crocodilia (crocodiles and alligators), Squamata (snakes and lizards), and Testudines (tortoises and turtles). Years ago people were very inclined to confuse the reptiles with the amphibians, but this is quite wrong as reptiles represent a group which has become almost perfectly adapted to terrestrial life, whereas amphibians pass the early stages of their lives in water. The reptilia all lay their eggs or produce their young on land, while practically all amphibians are aquatic during the breeding stages of their life cycle.

Among the different orders of the reptilia there are, of course, individual cases where confusion may arise. The uninitiated are apt to think that snakes are long, wormlike creatures without limbs, whereas the lizards have limbs; but, of course, some of the largest snakes, pythons and boas have vestigial limbs—degenerate traces of hind legs which once existed—while the slow-worm, which is a lizard, has no visible traces of limbs. Similarly crocodiles and lizards bear some superficial resemblance to each other, but in actual fact they are structurally quite different.

It is quite possible to keep young crocodiles and alligators in home vivaria, though not, of course, in the open air, and we will therefore begin our detailed treatment of various species of reptiles with the crocodilia.

CROCODILES AND ALLIGATORS

The treatment for both these is basically the same, and size will be the limitation which mostly concerns the amateur collector. When a young crocodile or alligator reaches a total length of between two and a half and three feet it is generally time for the amateur to present his specimen to the nearest zoological gardens! This is mainly because when this size is reached they are likely to become uncertain tempered, and a bite from a three feet specimen is no risk to be taken lightly. It is only occasionally that these reptiles are offered for sale by animal dealers, and by far the most common species to be offered is the common American alligator. It will be sufficient, therefore, if this is taken as a typical representative of the order.

Common American Alligator

Distribution. South and South-eastern States of U.S.A.

Habitat. Swamps and the muddy banks and immediate vicinity of rivers.

Description. The general description of the alligator is too well known to be gone into item by item; but in colour the young alligator is of a blackish or dark brown hue with yellow cross bands or irregular stripes on the back and tail. In the adult the colour turns to dark muddy green, sometimes shading into black. The hind toes are partly webbed; there are four "plates" on the neck and eight "plates" in the widest of the rows across the back.

Special treatment. The vivarium for the young crocodile or alligator must, of course, be reasonably roomy and stoutly constructed, for even a young one is quite strong in its movements and has a very powerful tail. The water tank should be ample, certainly sufficiently large to allow for complete submergence, and great care must be taken to prevent the water from

becoming foul. A conveniently placed brick or stone should be put into the water vessel to facilitate entry and exit, particularly the latter. It is not much use decorating the vivarium very elaborately, for anything in the nature of fernery will either be speedily debaubed with mud or uprooted. A stone or two or a large piece of virgin cork supported on stones will be quite sufficient, for the cork will provide a resting place and also a retreat under which the alligator can retire when it wishes. Temperature is a most important item, and the water in the tank should not be allowed to fall below about 75 degrees Fahrenheit, nor rise very much above 80 degrees. If the temperature is too low the alligator will refuse to feed, and once they go on hunger-strike they can be very obstinate to deal with. In spite of what has been written in many books on the subject of forcible feeding, I am very opposed to this in the case of any reptile unless it is absolutely necessary.

Food. Naturally the best kind of food is natural food, i.e., small fish and frogs, or earthworms. Fish and frogs will be snapped up viciously and killed at once, and the owner need have no qualms on the subject of cruelty. When this natural food is difficult to come by, it is quite possible to accustom the specimen to feeding on strips of raw horse-flesh or strips of fish. These will probably have to be moved about in front of the alligator's nose (with a pair of wooden forceps!), but when the specimen has been successfully fed in this way once or twice little difficulty need be anticipated. When giving this type of food the strips should be long and narrow, not lumpy, as otherwise there is a danger of the alligator not being able to swallow them.

Young alligators become remarkably tame with constant handling and even appear to be able to distinguish between their owner and a stranger. They will do well in captivity so long as correct temperature and scrupulous cleanliness are constantly borne in mind.

TESTUDINES

Land Tortoises

Two or three species of land tortoises are usually to be purchased in this country, and all of these do well in an outdoor enclosure during the warmer months of the year. They are entirely terrestrial and like as much room as possible in which to wander about. All the same I do not recommend giving tortoises a free run of the garden as they are likely to get lost, they can be tormented by dogs and cats, and in addition they will not commend themselves to the gardener of the family owing to their natural inability to distinguish between edible weeds and the more succulent vegetables. Some people have a practice which personally I strongly condemn. This is the boring of a hole at the rear of the shell and threading through this hole a cord with a knot in the end to prevent it slipping through, thus using this as a means of tethering the tortoise. Unless this is very carefully done it is likely to lead to injury, and I would much sooner see the tortoise confined in an enclosure than given what appears to be greater freedom by means of a tether.

The Greek Tortoise. This is a typical species and will serve as a guide to others.

Distribution. Greece and the surrounding islands, Syria, the Italian islands—Corsica, Sardinia and Sicily—and the mainland of Italy. It is also found in the Balearic Islands.

Habitat. The situation of the enclosure for this and other similar species of tortoises should not be too damp, and the enclosure should get a reasonable amount of sun without the whole of it being exposed to sunshine for too long a period. A big flat stone or a piece of slate can probably be arranged at a sufficient height to provide some pleasant shade. If the ground consists of rough turf so much the better, and the inclusion of some dandelion will be beneficial.

Description and coloration. This tortoise when fully grown is approximately six inches in length. The carapace or upper part of the shell is moderately vaulted, and the ground colour is bright yellow with the shields of the shell spotted and bordered with black.

Special treatment. These land tortoises require very little specialised treatment, but the fact that they hibernate must not be forgotten. The period of hibernation is roughly from the end of September to March ; and during this time the specimens must either be allowed to hibernate naturally in their enclosure, which they will do by burying themselves in soft earth, or they can be taken indoors and placed in a box with sufficient ventilation, the box being filled with dry leaves or moss or hay. They should be kept in a place where the temperature will remain even, and where they cannot be affected by sudden frost. A well built outhouse will do, though the ordinary domestic coal cellar is probably as good a place as any.

Food. The discarded portions of practically any household vegetables, coarse grass, dandelion, chickweed, and as a treat, soft fruit.

Other species of land tortoises

The *Margined Tortoise,* which reaches a length of nearly a foot, is much darker in coloration. The shell is nearly black on the upper part, with a small greenish yellow spot on each shield ; while the plastron or under-part of the shell is yellowish with a black triangular patch on each of the shields. This is much more restricted in distribution, being confined to Greece.

The *Iberian or Algerian Tortoise* is distributed throughout Southern Spain, N.W. Africa, Syria, Asia Minor and Persia.

This species reaches a length of nine inches and differs in colour from the previous tortoise in having the plastron spotted with black, the carapace being brown all over.

Terrapins

Unfortunately far fewer species of terrapins are to be obtained at the present time than used to be the case before the war, and it is difficult to prophesy when the situation will improve. This is a pity as terrapins are more active than the land tortoises, more amusing in their habits, and many are quite decorative. They make excellent pets for the vivarium, and nearly all the more commonly imported species may be kept out of doors during the summer. I must repeat the warning previously given that nearly all species of terrapins are carnivorous, and must therefore be fed differently from the land tortoise.

The European Terrapin or Pond Tortoise

Distribution. Widely distributed over Southern Europe; also North Africa, S.W. Asia.

Habitat. This and other species of terrapin like damper surroundings than the land tortoise, and although they naturally spend a great deal of their time in the water they are fond of basking—but not of being roasted! The water vessel should be large enough for a certain amount of swimming, and deep enough for the terrapin to submerge itself. Entry and exit to the water should be made easy, and a little pond weed in the water will help to make the bathing place more attractive to the inmate. Rough grass makes a very suitable surrounding, but too much thick vegetation should be avoided as if the specimen has to spend much time clambering through and over it,

it is rather inclined to fall over on its back from which position it is difficult for it to regain its feet. Some place of retirement should also be provided.

Description and coloration. The shell of nearly all terrapins is far less curved than in the land tortoises; this being, of course, a natural adaptation in order to permit swifter progress through the water. In colour the carapace varies from dark brown to darker brown or black; and the whole of the back is covered with yellow or greenish yellow streaks, which radiate in all directions. The plastron varies considerably in colour, sometimes being almost entirely dark brown or blackish, sometimes brown and yellow, and sometimes almost completely yellow. The head of nearly all terrapins is much more snake-like than those of the land tortoises, and the neck is generally longer and freer. The male can be distinguished from the female by having brownish dots on a darker background, while the female has yellow dots. The European pond tortoise grows to nearly eight inches in length, but most of the specimens seen in this country are very much smaller, some being not much larger than a half-crown.

Special treatment. Little need be said under this heading beyond the advice already given in respect of cleanliness. Except for species which are indicated as requiring high degrees of heat, terrapins will hibernate in a hole excavated in a muddy bank if such can be provided, or under heaps of rubbish, or even in the mud and debris at the bottom of the pond; or alternately they can be brought indoors, having first been well fed for some weeks, and then packed away in a box similar to that described for land tortoises. On the other hand, if desired, they can be kept indoors in a warm vivarium through the winter months.

Food. Terrapins are very varied in their diet. All kinds of water insects and their larvæ, freshwater shrimps, fish, small frogs, newts and tadpoles will be eaten. Where such food can be easily provided it is not so necessary to be continually inspecting the water vessel in order to keep it from becoming foul; but as has been said earlier on in the book, where the feeding has to be done with strips of fish or meat, or earthworms, it is much better to feed this little reptile in a separate dish of water, putting it back in its enclosure when it has finished its meal.

Similar Species

The *Iberian Terrapin.* Found in Spain, Northern Africa. It grows to about six inches in length; the carapace is dark olive green, and the head has yellow stripes on the side on an olive background.

The *Caspian Terrapin* is very common throughout the region of the Caspian Sea, and is said to be well distributed in Palestine and S.W. Asia. This is a larger species growing to a foot in length, and it possesses a very beautifully decorated carapace of a light olive colour, with wavy pale yellow stripes edged with black, the plastron being black dotted with yellow spots, these spots being much larger in the adult.

The *Painted Terrapin.* North and Central America. Seldom exceeds six inches in length. Carapace dark olive or even black with a yellow vertebral line, the shield at the margin of the carapace being scarlet; the neck has yellow bands round it. This is an exceptionally pretty little terrapin, but is not on the whole suitable for keeping out of doors. It will do excellently in a heated indoor vivarium kept at a temperature of 75 to 80 degrees Fahrenheit.

Soft Tortoises. The so-called Soft Tortoises, which are river tortoises, are sometimes imported into England. There are several species, some from the New World and some from the Old. These reptiles, as their name implies, have the peculiarity of soft shells which feel like leather to the touch, and the horny shields of the ordinary tortoises and terrapins are

absent. They have very long necks and long pointed snouts, and as a general rule the colour of the carapace is dirty brown or olive green, while some species have a few small yellowish spots on the back of the shell. All the soft tortoises are thoroughly aquatic, but are not suitable for keeping in an outdoor enclosure. They are rather vicious in temperament but do reasonably well in captivity if they are kept sufficiently warm and given plenty of live food.

CHAPTER NINE

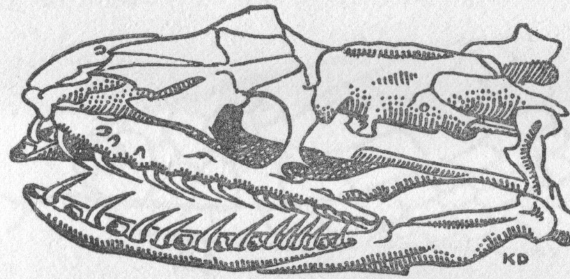
SNAKES

INTRODUCTION

THERE are about two thousand five hundred species of snakes. They range from the tiny burrowing snakes, some of which barely reach a foot in length, to monsters like pythons and boas where a length of twenty to twenty-five feet is by no means uncommon. There are sea snakes; there are snakes which live in arid deserts; swamp snakes and tree snakes. In fact there are species that inhabit practically every conceivable type of country. Snakes also vary a great deal in their methods of attacking their prey: great constricting snakes use their powerful muscles to hold and suffocate their victims; poisonous snakes inject their venom; while others simply seize their prey and swallow it without any preliminary attack or special method of seizure. There are even highly specialised snakes that eat eggs!

I do not intend to go into a mass of anatomical detail, but it is not only interesting but necessary to refer to one or two particular peculiarities of snakes which have a direct bearing on their welfare from the collector's point of view. The first is the wonderful adaptation of their jaws which enables them to swallow prey which is much greater in diameter than the diameter of the body of the snake itself. This is due to the fact that a snake virtually dislocates its jaw at will, the base of the lower jaw being suspended from the skull by means of bones which enable the jaw to be expanded; the bones of the lower jaw are capable of separation at the chin due to the presence of a very elastic ligament. When engulfing its food, therefore, the snake can move

its lower jaw both forwards and outwards and in addition the two sides of the lower jaw can be moved forward independently, so that with the help of the very ample supply of curved sharp teeth the food can be worked into the gullet by a series of muscular motions. It will, of course, be appreciated that some such adaptation as this is absolutely essential owing to the fact that snakes must consume their food whole; they are incapable of biting off pieces. It may be thought that this method of swallowing must occasion considerable inconvenience in respect of respiration. But this



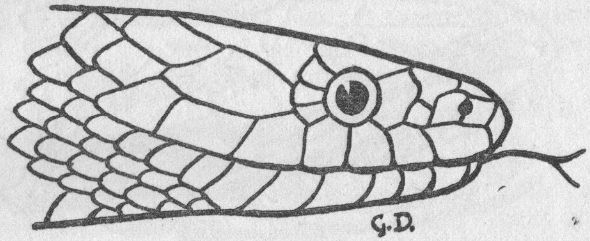
Skull of python

is not so, for another very wonderful anatomical mechanism overcomes this difficulty. If necessary, the top of the windpipe can actually be extruded so that the snake can go on swallowing while continuing to breathe uninterruptedly. This phenomenon can frequently be seen when snakes are feeding in the vivarium.

It is, I think, also worthwhile referring once again to the delicate forked tongue, that amazingly sensitive organ which is so persistently libelled and referred to as a "sting". This, of course, it is not, and it has no offensive function at all. It is used mainly for the purpose of smelling, and when a snake is seen to be darting its tongue in and out with the tips of the forks quivering, it is in fact picking up scent particles emanating from whatever object it is the snake is inspecting at the time. Another fable connected with snakes' tongues is that in order to swallow its prey a snake licks it all over, covering it with a slimy liquid. This is quite untrue and a snake does nothing of the kind.

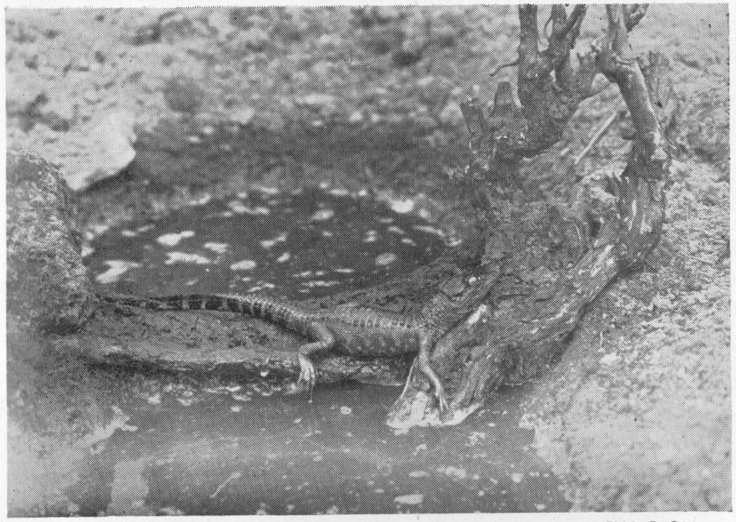
Snakes can probably hear, though they have no external ear; they can also see quite well though it is likely that many species see better at night than in the day. Cobras in particular seem to be incapable of judging distances and striking correctly in a brilliant light.

Reference has already been made to the snake's scaly skin with its regular rows of small scales on the back and much larger and wider ones underneath the body.



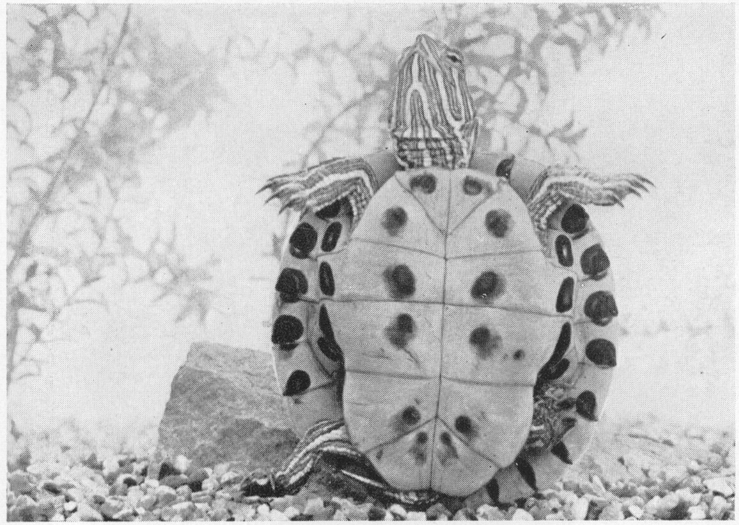
Head of a grass snake (*Natrix natrix*)

These latter are usually spoken of as the ventral shields. These shields play an important part in connection with the progression of the snake over the ground. If the "cast" outer skin, or epidermis, of the snake is examined it will be seen that in between each shield is a small portion of skin which allows the free movement of the shields. When a snake moves along, the action of the ribs and muscles operate the edges of the shields in order to allow the snake to get an actual grip on the surface of the ground over which it wishes to travel. A simple way of appreciating the necessity for this is to place the snake on a sheet of glass or a very highly polished surface, when it will be seen that the snake can hardly move forward at all, owing to the fact that there is nothing on which the ventral shields can obtain a grip.



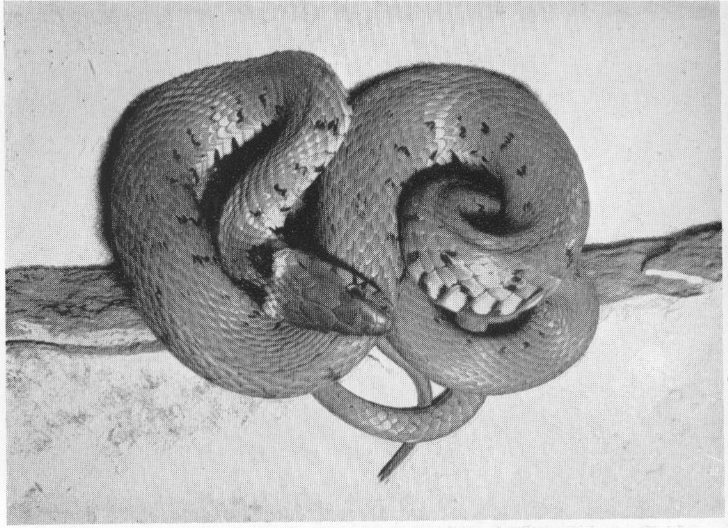
[*W. S. Pitt.*

Young Alligator.

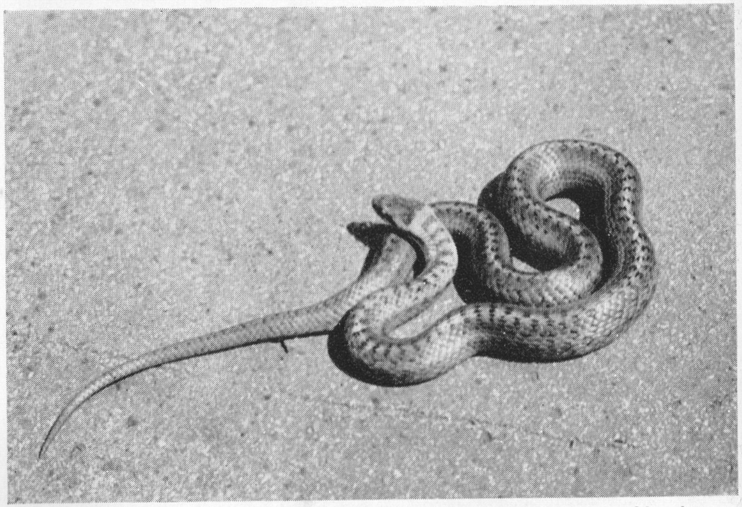


[*Lionel E. Day, F.R.P.S.*

Painted Terrapin.



[Zoological Society of London.
Grass Snake.



[Zoological Society of London.
Smooth Snake.

Although venomous snakes are expressly excluded from this book, it may be worthwhile to make a brief mention of the apparatus used by poisonous snakes to inject their venom. The poison fangs of most venomous snakes are large curved teeth situated in the very front of the upper jaw. These fangs are grooved on the anterior side thus forming a canal which opens out near the end of the tooth. The base of the tooth is connected with the poison glands by means of ducts which pass along the sides of the upper jaw. The poison is expelled by muscular contraction, and is thus injected into the wound. In the vipers and rattlesnakes, these poison fangs when not in use are folded back and can be erected at will when the snake wishes to strike. There is a mistaken idea that by the removal of the poison fangs a snake is rendered harmless; but a glance at a good specimen of the skull of a venomous snake will soon dispel this idea, for the reserve fangs will be seen neatly placed in position and ready to come forward into use if the main fangs should be extracted or suffer injury.

Many snakes, particularly the harmless varieties, have as their only means of defence glands situated at the rear of the body which contain an offensive fluid which can be ejected through the vent if the reptile is alarmed or carelessly handled. This liquid not only has a foul odour but a very persistent one; and if it gets on to the clothing it takes some time for the smell to wear off. Very little is known about the actual chemical composition of this liquid—in fact this is a point to which scientists might well devote some attention.

Snakes vary a great deal in disposition, some species being quite markedly tractable and quiet, while others seem to be equally markedly bad-tempered. Dr. Malcolm Smith, the eminent herpetologist, has frequently told me that he thinks that any snake will get used to being handled, even venomous ones, and I would not like to doubt the word of such an authority; but there are one or two species of " harmless " snakes with which I have seldom been able to get friendly: these are the æsculapian snake and the dark green snake. I have always found these to be vicious and ready to bite as soon as approached, and no amount of patience and handling on my part has been able to quieten them. For this reason, although they are very pretty snakes to have in the vivarium, I do not think that they make particularly attractive pets. Snakes have other ways of expressing individuality, one of the most annoying of which is a persistent refusal to feed. The beautiful little European leopard snake, probably one of the loveliest snakes in existence, is an example. I have never succeeded in getting one to feed, and I have not yet encountered any other herpetologist who has been any more successful. This is a great pity as the leopard snake makes a most handsome addition to any collection.

The snake most likely to be kept, by the amateur, is our own grass snake, and for that reason we will commence our notes on the various species with this most common variety.

The Grass Snake

Distribution. The grass snake is fairly well distributed all over England and Wales, with the exception of Durham, South Lancashire, Radnor and Cardigan. It is very scarce in Scotland and, of course, is unknown in Ireland where no snake exists in the wild. It is also well distributed throughout most of Europe though the Continental varieties differ considerably in size and coloration from those in this country.

Habitat. The grass snake is a definite lover of damp surroundings and is never found very far from water. It is an excellent swimmer, and in my opinion, not only resorts to the water in search of food, but also because it definitely likes swimming. The grass snake should therefore have an ample water vessel. It is also quite a

good climber, and likes to glide about a small branch if one can be provided. As with all other snakes, some place to which it can retreat should be set up, though it likes to do its share of basking in the sunshine.

Description and coloration. The general ground colour most frequently met with in this country is a darkish greeny-grey, usually with some vertical dark brown or black stripes on the side. The distinctive feature of the grass snake is a pair of yellowish patches, almost forming a collar, situated at the back of the head. These are sometimes so pale as to be nearly white; are generally yellow, and occasionally quite deep orange. These two patches are usually divided in the centre of the back of the neck, though sometimes the division is absent. There is, however, always a broad dark border behind these patches which serves to show them up very well.

The grass snake is a gracefully tapered creature and grows to quite a considerable size; specimens of between two and two and a half feet in length being quite common. Much larger specimens have been recorded, particularly from Monmouthshire, where they have been said to reach a length of over forty inches; and one giant is recorded from the New Forest which was alleged to measure five feet eight inches! However, the longest British grass snake which I myself have seen was one captured by Colonel James Wilkins in the summer of 1948 at Frensham in Surrey. This measured thirty-eight and a quarter inches. Any exceptionally large, well-built grass snake may be taken to be a female, the males seldom exceeding two feet in length.

Special treatment. Grass snakes require no special treatment. They will live quite happily in either an indoor or outdoor vivarium as long as the general principles already laid down are adhered to.

Food. The staple food of the grass snake is the common frog, though they will take small fish such as minnows, small toads, or newts. Only smooth and palmate newts, however, seem to be eaten, and I have never known a case of a grass snake eating a crested newt, though I have many times tried to induce one to take this species. This, I think, is due to the fact that the crested newt excretes a more potent venom than its smaller relatives. Again, although the natterjack toad is a much too restricted and pleasant creature to be used as food for snakes, I have noticed that the grass snake will avoid attacking one. This again may be due to the fact that when the natterjack is frightened it exudes its small droplets of venom through the skin and this venom has a very pungent smell which may be as offensive to the grass snake as the grass snake's odour is to us! Baby grass snakes may be fed on tadpoles; and I have been told by many observers that they will also eat the small grey and white slugs so beloved by the slow-worm, but I have never actually seen them doing this myself. They will, however, eagerly devour larval newts. Numerous writers have referred to the grass snake taking mice and young birds, and only last year I heard of a well authenticated case of a grass snake robbing a nest of fledglings. In captivity, however, they seem to be strangely reluctant to take warm-blooded prey. Why this should be I do not know, but I should welcome any further information on the subject.

The Continental Grass Snake

As far as habitat, treatment and food is concerned the Continental grass snake can be dealt with in exactly the same way as our own species. It may, however, be of interest to give a few details regarding variations in size and coloration. According to the late G. A. Boulenger, grass snakes from Jersey, the Spanish Peninsular and Cyprus lose the distinctive collar behind the head; while in Italy and S.E. Europe

and Asia Minor the collar is well marked though interrupted in the middle. This variety also has an orange streak extending along each side of the back in addition to the usual black vertical stripes. Some other specimens are completely black, while albinos also occasionally crop up. With regard to size, some specimens over six feet have been recorded, particularly from Sardinia and Sicily, but any specimen over four feet may be regarded as exceptionally large.

The Smooth Snake

Distribution. This is by far the rarest of our three British snakes, though it enjoys much wider distribution on the Continent. In the British Isles it is entirely confined to the South of England and as far as present observations go it is only actually found in the following counties: Surrey, West Sussex, Hampshire, Wiltshire and Dorset. There are some very doubtful reports of its presence in Berkshire, East Suffolk, East Sussex and South Devon, but most of these were made some considerable time ago. It is possible that the smooth snake exists in more localities than those referred to, and that it is sometimes seen by inexpert observers who mistake it for the adder to which it bears more than a slight resemblance. It would be very useful if more field naturalists could devote some time to searching for this snake in districts other than those in which it is definitely known to occur.

In Europe the smooth snake extends over nearly the whole continent. It has been reported as far north as Norway; it is common in parts of Belgium, Germany, Austria and France, also in South-Eastern Europe and over into South-Western Asia.

Habitat. The smooth snake insists on a dry locality; it is found principally on heathland or sandy stony ground. It is very much addicted to burrowing, and in my opinion this is one of the reasons why even in the districts where it is known to reside it is less frequently seen than, for instance, the adder.

Description and coloration. The smooth snake is not large, and it is unlikely to exceed a length of twenty-four inches; most of the English specimens which I have seen have been considerably less. Continental specimens have been reported as exceeding two feet but even this may be regarded as exceptional. The head of the smooth snake is oval in shape and is not so broad in the posterior part as that of the viper. In coloration specimens vary considerably, the background colour being grey, brown, or even a copperish hue; but whatever the ground colour may be it is patterned with a series of irregular dark spots on the back, these spots are of some shade of brown. It frequently has two dark brown or reddish brown stripes on the nape, which sometimes join up with a large dark blotch in the occipital region. It is this marking which sometimes leads to the snake being mistaken for an adder, particularly when taken in conjunction with the row of dots down the back. These, however, are really quite different from the diamond shaped zigzag markings of the typical adder. The underside of the smooth snake varies considerably in colour, some specimens having an orange or red tinge, others being brown or dark grey, while sometimes the ground colour is broken up with spots of black and white.

The smooth snake is ovoviviparous, the young being enveloped in a very thin membrane out of which they break almost immediately, as is the case with the slow-worm. Ten or twelve is a good average number of young and they are usually born late in August or early in September.

Special treatment. The enclosure or vivarium should obviously conform with the type of natural habitat. A smooth snake likes basking, and has a habit of lying very close to its place of retreat, a point which incidentally makes it very difficult to capture in the field. As regards disposition, authorities differ considerably in their views on this; some say that it takes readily to captivity, becomes extremely tame and displays some degree of intelligence; while others regard it as inclined to bite, and rather reluctant to feed. Personally I think these differences of opinion are due to the more successful methods employed by some collectors than others. Specimens I have kept have always fed well and have speedily become used to being handled; and though they will certainly try to bite when first captured, their tiny teeth can do no harm. Their method of biting is curious; they like to turn their head and nuzzle the flesh of the hand, after which they bite very deliberately. I consider them handsome and satisfactory snakes to keep, while the fact that there is still a lot to learn about their habits makes them of additional interest to collectors.

Food. The basic food of the smooth snake is lizards—sometimes the sand lizard. It is what may be rather loosely described as a semi-constricting snake as it likes very much to throw a coil or two round the body of its prey, but from my own observations I am inclined to think that this is more for the purpose of holding than it is for the purpose of true constriction. If it cannot get lizards to eat it will eat slow-worms, and several authorities report them as eating voles or mice though I do not think that these are anything like as acceptable as lizards.

The Dice Snake

This snake, sometimes referred to as the tessellated water snake, is a lively and very attractive European species.

Distribution. The dice snake has a wide range in Europe and Asia. It is particularly common in Italy; also in Austria and South Germany. It is present in

South Russia, and even extends into Siberia, but it does not go farther west than Italy and Germany.

Habitat. The dice snake is very aquatic and is never found very far from the water. It swims and dives very readily. It spends almost as much time in the water during the warmer seasons of the year as it does on land.

Description and coloration. Most of the specimens which I have seen offered for sale in this country are on the small side; in fact I have never owned one which exceeded two feet, though it has been recorded as reaching a length of four feet. Boulenger records a large specimen in the British Museum of Natural History which measures three feet ten inches.

In colour the dice snake is a beautiful olive or olive grey above with a series of dark spots down the back. It nearly always has a V-shaped dark band on the nape, not unlike that of the adder, while there is a yellowish shaded streak along the edge of the upper lip. The lower parts vary considerably, sometimes being nearly white but more usually yellowish or orange, broken by marblings of dark brown or black.

The dice snake is oviparous and it deposits its eggs in July or August in such places as holes under stones, in crannies of rocks, or under refuse.

Special treatment. An enclosure or vivarium suitable for grass snakes will be equally suitable for the dice snake, though it naturally prefers a warmish situation. It is extremely amiable in temperament—in fact I have never known one to bite. It gets very tame and can be made to feed from the hand. Altogether it is a most satisfactory snake to keep in captivity.

Food. The dice snake feeds principally on fish, though it will take tadpoles or small newts readily, and frogs and toads if it cannot get anything else. Its feeding habits are rather interesting in that when the prey is of a reasonable size it will be taken and eaten under the water, and the snake will only come out on land if it has to cope with something on the large side.

The Garter Snakes

These are snakes of North America, over which continent they are very widely distributed. There are a great many types and the variations in colour are considerable.

Distribution. See above.

Habitat. Very similar to the type of country inhabited by our own grass snake. They are very aquatic and seem to delight in swimming for swimming's sake.

Description and coloration. As I have said above there are a great many varieties of garter snake, and space does not permit of a description of each one. The typical form is anything up to about three feet in length; graceful in general appearance, very similar to the grass snake. Generally dark olive or greenish above, sometimes with black spots or even stripes. One variety which is particularly beautiful, is perhaps worth mentioning. This is the variety known as *sirtalis.* It has three stripes down the side and back which are frequently red. Other varieties have the stripes yellowish and green.

Special treatment. May be treated in all respects in the same way as the grass snake. They are very tolerant of moderate temperatures and are therefore very satisfactory to keep in this country. They have the additional advantage that they will readily accept earthworms and on occasions when frogs, etc., are in short supply they will feed on strips of fresh fish. They are quite harmless and seldom bite intentionally, though they are generally so eager to eat that they may strike at the hand which actually offers the food. They are hardy and generally easy to maintain in health.

Food. Fish, frogs, toads, newts and even earthworms.

The Four-lined Snake

This very handsome and imposing snake has the distinction of being the largest European snake. In spite of its size it makes a most suitable and interesting addition to any collection.

Distribution. It is found in Southern Italy and Sicily, Yugoslavia, Greece, Southern Russia, Asia Minor.

Habitat. The four-lined snake is not at all finicky about its surroundings. It is found in swampy localities, in dry districts and even in mountainous places. Boulenger records that it has even been found at an altitude of nearly three thousand feet.

Description and coloration. In coloration it is usually yellowish grey or pale brown, with four very dark brown or black stripes running along the sides. These stripes are interrupted, just behind the head, and there is a single black triangular stripe running from the eye to the posterior limit of the jaw. The under parts are pale yellow with brownish markings. It sometimes has other markings on the back when young, but these markings disappear as the snake matures. In length it frequently attains four to four and a half feet, and it has a considerable girth in proportion, though it is a very graceful snake.

It is oviparous ; the eggs are laid towards the end of July. It is unlikely to breed in captivity.

Special treatment. The collector has a fairly wide choice as regards the lay-out of the enclosure or vivarium, though a very ample bath should be provided. This snake can be kept out of doors during the warmer months, but owing to the fact that it will probably be bigger than any other snake in the collection care must be taken to see that it cannot climb out of its enclosure. If kept indoors the vivarium must be spacious. In disposition the four-lined snake is rather inclined to be spiteful at first, though constant handling

will soon cure this. It has an extremely loud hiss which is perhaps apt to deter the owner at first. This should not prevent the collector from keeping the species if an opportunity for obtaining one should come his way.

Food. This snake feeds very well, but exclusively on warm-blooded prey. Rats, mice or a dead bird will be accepted. It has frequently been reported as having a weakness for eggs, and this I can confirm as I once had a specimen that preferred a pullet's egg to almost any other food.

The King Snake

This heading should really be " King Snakes " as there are more than one species, but the most normally is the common king snake which is widely encountered is the common king snake which is widely distributed all over North America. King snakes are noted for antagonism towards venomous snakes, and some species will attack and eat even a rattlesnake.

Distribution. Throughout North America.

Habitat. It has a liking for shady positions, and although not very fond of water it likes a slightly damp environment.

Description and coloration. All the king snakes are very handsome, the most typical form being black, with narrow yellow or yellowish white transverse bands. In length they reach the size of six feet.

Special treatment. This snake is not suitable for keeping out of doors, and the temperature of the vivarium should not be less than sixty degrees. It is not very fond of climbing, being a ground-loving snake. Growing turf or moss provides a suitable foundation.

King snakes are always spoken of as being exceptionally tame, hardy and intelligent. The latter two points I can confirm, but I do not think they are necessarily any more tame than other species which have been dealt with. Gentle handling will, however, prove as effective with these as with other snakes.

Food. In nature, the king snake prefers other reptiles, particularly snakes, as it is a decided cannibal ; but small mammals or birds will be accepted.

Pythons and Boas

It is unlikely that a great variety of the larger constrictors will come the way of the amateur, but when young they make interesting and beautiful inhabitants for an indoor vivarium. As, however, they hail from the tropics they cannot be kept out of doors, and they require a minimum temperature of seventy degrees to keep them feeding well and in good health. Of all the boas the most likely species to be obtained will be either young specimens of the Western Boa or the anaconda, both from the New World. These are particularly fond of water and must have a bath capable of allowing the snake to submerge completely. The pythons most commonly owned are the reticulated python from Burma, Indo-China and Malaya ; the Indian python ; the African python ; the Royal python, also from West Africa, though this is more rare ; and the diamond python from Australia, which is less likely to be encountered. All these large constricting snakes take warm-blooded prey—rats, mice, small birds.

The size of the vivarium must obviously be related to the size of the specimen, and the fondness of all these snakes for climbing must be borne in mind. Pythons and boas will bite until they are used to being handled, and as their teeth are very much larger than any species yet dealt with, it is a good idea to handle a newcomer with a pair of gloves. Should a bite occur, the wound should be bathed with peroxide of hydrogen, or some similar antiseptic, to prevent infection. As with other species, however, the disposition to attack will gradually become less when the snake becomes more accustomed to its owner's touch.

Other Species

There are, of course, many other species of snake which can be kept in captivity, dozens of them in fact. But within the compass of one portion of one book it is not possible to deal with these individually. The species with which I have already dealt are those which in my opinion have the best dispositions, feed most readily, and are generally the easiest to keep of all the snakes likely to come into the possession of the average amateur. It may well be, however, that collectors will see other snakes for sale ; they may travel in other countries and collect some themselves ; or they may have some given to them by a fortunate and generous traveller. Should this be the case, the best thing to do is first of all to get the snake positively identified. There are several ways of doing this, the easiest being to take the snake along to the nearest reputable museum or zoo where the curator in charge will always be willing to help. If this is not possible, then reference should be made to the appropriate book in the list given at the end of this volume. Of course all this is assuming that the person who gives you the snake, or the shop from which you buy one, is not certain of the identification.

In an effort to give some general guidance on the subject of other species likely to be encountered, I give a list roughly divided into suitable and unsuitable species. Under the heading " Unsuitable " I include those which are generally inclined to be spiteful, those which require highly specialised treatment, and those which are reluctant feeders. If any of the more satisfactory species attract the attention of any reader, reference to the book list will provide them with sufficient knowledge as to treatment if taken in conjunction with the principles already laid down here.

Suitable Species

The Viperine Snake.	European. So called from its resemblance to the common adder or viper. Docile and quite hardy.
The Chicken Snake.	North America.
The Corn Snake.	North America.
The Horseshoe Snake.	Europe, North Africa, Egypt.
The Black Snake.	North America.
The Aesculapian Snake.	The warmer countries of Europe.

Unsuitable Species

The Leopard Snake.	Southern Italy, Yugoslavia, Asia Minor. A bad feeder.
The Dark Green or Angry Snake.	Southern Europe. Bad-tempered.

CHAPTER TEN

LIZARDS

LIZARDS, which belong to the sub-order Sauria, are fewer in number of species than snakes, there being about eighteen hundred known. With the exception of the so-called legless lizards and the skinks (some of which have extremely tiny limbs) lizards may easily be distinguished from snakes at a glance by reason of their four legs and long claw-like toes. This, however, is a very rough and ready distinction, and there are other more interesting features of differentiation. One of the principal of these is the fact that lizards, unlike the snakes, have the right and left halves of the lower jaw connected by a bony suture. They are thus unable to operate their lower jaws in the same manner as that already described in the notes on snakes. Another distinctive feature is the possession of eyelids, which, of course, enable lizards to close their eyes, which they will frequently do while sun-bathing—a thing which snakes cannot do. Again, the tongues of lizards present more variation than do the tongues of snakes; for while a great many species have forked tongues, some have this organ highly specialised, the most extreme example of this being the amazing long extensible tongues of the chameleons. Lizards also have what may be described as ears: that is an auditory aperture just behind the angle of the jaw; and, whatever may be the rights and wrongs regarding the hearing of snakes, there is, I think, little doubt that lizards can hear extremely well.

Most lizards have no very effective means of defence, with the exception of their ability to part with their tails if grasped in that region. The tail will break off and remain wriggling, and the lizard will generally escape quite unharmed. The loss of the tail does not seem to occasion any great inconvenience and in due course a sort of substitute tail will grow again. Contrary to what has been written by some authorities, however, the regenerated tail is seldom complete and shapely, and is at best a stumpy and blunter version of the original graceful appendage. When a tail is broken off close to the body the remaining stump sometimes looks curiously like a lizard's head; and quite recently I was told by a child that she and her father had seen what they thought to be a lizard with a head at each end sitting on the board in front of their beehive, busily engaged in picking off the bees. I gave what was probably the true explanation, though I am afraid that this was rather disappointing to the young girl in question!

As in the case of snakes, various species of lizards are specially adapted for life in a particular environment. There are desert lizards; forest lizards; lizards that are semi-aquatic; and there are also those quaint little lizards, the geckos, which have such highly specialised feet, bearing little sucker-like discs on the toes, that they are able to run up a wall or on a ceiling with the greatest of ease. In size, also, lizards vary enormously; the great Komodo Dragon from Sumatra attains a length of twelve feet, while some species are only a few inches in length.

Nearly all lizards are carnivorous, with just a few species that prefer a vegetarian diet, and one species (with which the amateur is not likely to be concerned) that is so highly specialised that it lives on seaweed. Those members of this order which are likely to find their way into the amateur's collection all feed very well on insects, and unless a specimen of one of the monitors is acquired no great difficulty should be encountered over feeding.

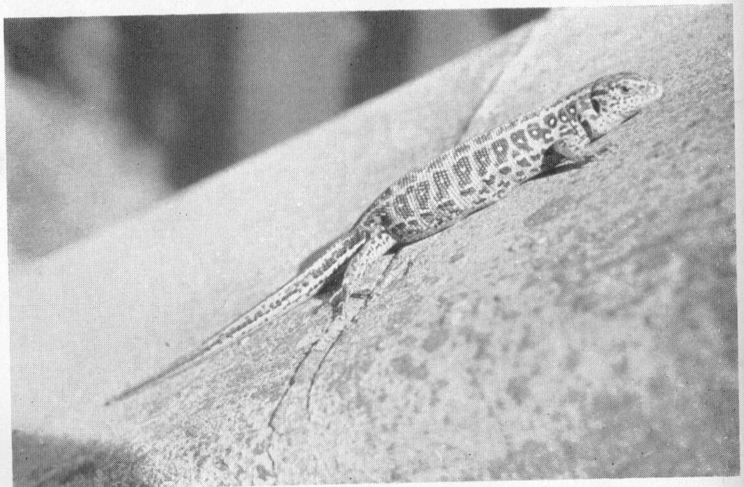
Lizards are highly suitable as inhabitants of vivaria owing to their beauty, their activity, and the fact that a great many species will become very tame. It is true that some of the larger lizards are capable of inflicting

[" *Illustrated.*"

" This attractive girl is not afraid of snakes."

[Zoological Society of London.

Royal Python.



["Illustrated."

Sand Lizard.

painful bites, but commonsense should guide the collector in this respect. None of our British lizards is capable of inflicting an appreciable wound and most others may be regarded as absolutely harmless.

Although very few species of lizard are aquatic to any extent, I think that nearly all lizards can swim. They are very thirsty creatures, and water should always be provided, though the vessel must not be so deep or difficult of egress that the lizard can drown itself.

We have three truly British lizards—the common or viviparous lizard, the sand lizard, and the slow-worm; and two species which may possibly be regarded as British if the Channel Islands are taken as being part of the British Isles. These two species are the green lizard and the wall lizard. As was the case with snakes, I intend to deal with the British species first, primarily because they are the most easily obtained and therefore more likely to find their way into the hands of the amateur.

The Common or Viviparous Lizard

Distribution. The common or viviparous lizard is not only the commonest but is the most widely distributed of the British species. It is found throughout the whole of England, Scotland and Wales, and also in many parts of Ireland (it is in fact the only reptile that exists in Ireland). Outside the British Isles it is well distributed throughout North and Central Europe and Northern Asia.

Habitat. The common lizard prefers heath-like or scrub country; it has a great liking for sitting in the sun on stone walls, or on logs of wood, or piles of brushwood. This little reptile, like most other lizards, has some favoured retiring place; and this is seldom very far away from the place where it is seen basking, so should a specimen be observed which it is wished to capture and at the first attempt it vanishes from sight, the collector should sit down quietly and wait, when after a few minutes the lizard will return to its original place and thus present another opportunity.

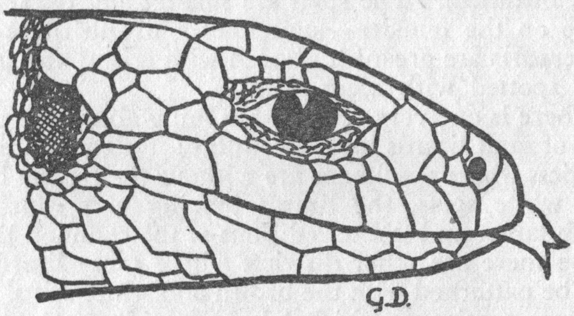
Description and coloration. A really large female may reach a length of six or seven inches, the males being slightly shorter, a six inch male being a good specimen. The general colour of the adult of both sexes is brown or reddish brown above with small dark and light spots sprinkled over the back; some specimens have dark streaks down the centre of the back, while others have these streaks paler than the ground colour. In the male the under-parts are orange, sometimes even definitely red with quite well-defined black spots. The female has a yellow or pale orange belly, sometimes with a few dark spots and sometimes without. Newly hatched young of the common lizard are almost black and are about an inch in length. All adult forms of the common lizard vary tremendously in colour. I have seen some specimens that were a beautiful pale olive green, some that were nearly yellow, or at least a very light brown, others so dark as to be nearly black. All colour varieties are, of course, much brighter after the skin has been changed, and in the breeding season the males' distinctive coloration is particularly vivid.

Special treatment. The common lizard may be kept either indoors or out of doors during the spring and summer, but I think it is best to keep it out of doors wherever possible. It is an excellent climber and will run up any surface on which it can get a grip with its long clawed fingers. It will do quite well in an enclosure suitable for toads, and it will not come to any harm if kept with sand lizards or slow-worms, though a hungry sand lizard will make short work of newly hatched young. The common or viviparous lizard, as its particular name implies, brings forth its young alive; the young vary from above five to twelve and usually make their entrance into the world in July.

Food. All kinds of insects, meal-worms, or small earthworms. Spiders are particularly relished.

The Sand Lizard

Distribution. The sand lizard is much more restricted in its distribution. In Britain it has only been recorded in East Kent, Surrey, Hampshire, Dorset and, curiously enough, another region many miles to the North in Mid and South Lancashire. It is possibly more widely distributed than this, but other records are extremely doubtful, and further investigation into this matter would be most useful. On the Continent it is found in France, the Netherlands, Switzerland, Germany, Austria, Denmark, Sweden and Russia.



Head of a sand lizard (*Lacerta agilis*)

Habitat. Dry sandy heaths and dry hedgerows are favoured by the sand lizard, and its general behaviour is similar to that of the common lizard. Some authorities persist in saying that it is less agile than its commoner relative, but this I do not believe for a moment, and I think its greater size gives rise to this belief as a large thing always tends to look as though it moves less quickly than one which is smaller.

Description and coloration. The sand lizard is larger and much more stoutly built than the common lizard. It has a broader head and a shorter, less pointed snout. A really big female will measure eight inches, and an equally mature male an inch or so less. In coloration sand lizards also differ a great deal. The female is generally brown or greyish brown above, slightly darker down the centre of the back, while over the whole area of the upper parts are large brown spots with a white or cream spot in the centre. These spots are not always round, but are sometimes almost oval or even oblong in shape. Underneath the female is cream coloured. The males show some tendency to greenish colouring on the back and sides nearly all the year round; but in the breeding season the green on the sides becomes really bright, making the male particularly beautiful. The spots are smaller and darker than those on the females—sometimes a bluish black; the underparts are greenish, shaded with cream and usually well spotted with black dots.

There is one very remarkable thing about the coloration of sand lizards in this country; for there are some districts where specimens are without the typical brown and white spots, the lizards looking very much like much larger and stouter editions of the common lizard; while there are other districts where every lizard seen will be patterned with the brown and white spots. Most of those specimens which I have seen from Lancashire belong to the former type, but in Surrey I know of two well-populated localities, not more than a few miles apart, where each type seems to have its own particular territory; that is to say, I have not yet seen the two types appearing together in exactly the same district.

Special treatment. The housing and treatment of the sand lizard need not differ in any way from that provided for the common lizard.

Food. Here again food that is suitable for the common lizard does equally well for this species. If

anything the sand lizard seems even more fond of spiders, and I do not think that sand lizards should be kept with slow-worms, at all events during the breeding season, as a young slow-worm makes an extremely good meal.

The Slow-worm or Blindworm

This harmless British reptile is probably the victim of more ignorance and superstition than almost any other. Even its common names are misleading, though its specific name, *Anguis fragilis,* is good, since it is an extremely fragile creature and parts with its tail just as readily, if not more readily, than the ordinary run of lizards. It is not particularly slow and certainly not blind. It is frequently mistaken for a snake since it has no legs; but it is true lizard all the same, having the typical lizard teeth, tongue and eyelids. It is one of the best friends the gardener can have since it devours vast quantities of the small white and grey slugs which are such a pest to a vegetable grower.

Distribution. In Great Britain the slow-worm is found in nearly every district from the north of Scotland to the south of England. There are one or two regions where either it has not been reported at all, or reports are very doubtful; one of these, curiously enough, is South Lancashire where the sand lizard is found, and I often wonder whether the liking which sand lizards have for young slow-worms has anything to do with this. Other places where it appears to be absent are Caithness, East Ross, Banff, Selkirk and Wigtown in Scotland; while in Huntingdonshire recent reports of its presence are few.

The slow-worm is also widely distributed all over the continent in Europe.

Habitat. Slow-worms like the verges of copses, mossy banks and hedgerows, and also sunny walls dividing meadows. It does not like too dry a place and it prefers somewhere where it can either burrow when the weather is cool, or a place where it can easily make its way through the undergrowth for rest or protection. The paths through the undergrowth from the basking places can very often be recognised, as slow-worms are conservative creatures and seem to use the same route every time.

Description and coloration. Though slow-worms have been reported eighteen inches in length, this is exceptionally large; and anything from fourteen to sixteen inches can be considered a good average. Although both male and females when "complete" show quite clearly where the body ends and the tail begins, males frequently appear to have shorter tails since they often lose a portion through fighting in the breeding season. Apart from difference in coloration the females are, I think, a little broader in the body, even when not pregnant. The males, too, have a much blunter head, and the head does not appear to be so separated from the body by what one might almost call a neck region as is the case with the females.

Slow-worms vary tremendously in colour, the males usually being of varying shades of gunmetal colour or a dull bronze, while the females seem less inclined to be bluey-grey and are more frequently brown in hue, sometimes coppery or even chestnut. Females may be recognised by the fact that they have darker stripes running right down the back. The males go in for very small brownish spots on the back and sides. The underparts of the females are dark bluish black with faint white markings, while the underparts of the males tend to be more of a dark slate colour. The young slow-worms when they are born are about two and a half inches in length and are the colour of the pale gold paint used in picture framing; they are very seldom silver as described by so many writers. The young also have a dark brown or black diamond-shaped spot on the head, and a thin line running down the centre of the back. This characteristic is retained in the females

but not in the males when they grow up. The underparts of the young slow-worm are almost black.

I cannot leave the subject of coloration without making some reference to the blue-spotted varieties which are reported to be common on the Continent, but were originally thought to be very rare in this country. A few years ago it was considered that these were only found in the extreme south-western counties of Britain, but efforts made by Dr. Malcolm Smith and myself to go further into this matter have resulted in reports of this variety from Sussex, Hampshire, Surrey, Kent, Scilly Islands and South Wales. I have no doubt that they are also to be found in other districts as well and any further reports will be extremely welcome. The real peculiarity of these blue markings, which are sometimes in the shape of small dots and sometimes even in stripes, is that they would appear to occur only in the males, though I do not wish to be dogmatic on this point as a sufficient number of blue-spotted specimens have not yet been examined. When a blue-spotted specimen is about to slough its skin, the blue spots turn brown, and sometimes when the sloughing is finished the spots show up in their original blue shades, whereas at others they remain brown at first and turn blue later.

Special treatment. The slow-worm will do well either in a vivarium indoors or in an open-air enclosure; but it is better to keep them out of doors. They like to bask in the sun, but must have some thick grass, herbage or fernery into which they can retire. They like a drink and should have a water vessel. They are very expert burrowers so care must be taken that they do not tunnel under the walls of the enclosure and escape.

Food. Earthworms are a good stand-by, though slugs are much preferred. As far as my experience goes, they will not touch the black and reddish-brown slugs, and they seem to feed exclusively on the small white and grey species.

The Green Lizard

Distribution. Channel Islands, Central and Southern Europe.

Habitat. Although like other lizards it likes to drink it is fond of dry banks and sandy situations. It can climb very well, and a large log, branch, or rockwork will show it off to advantage.

Description and coloration. Sixteen inches is a very large specimen, but anything from twelve to fifteen inches, if complete, is average. The predominating colour is, of course, green, but the shade of green varies from very light grass green to quite a deep emerald hue. The underparts are yellow or creamy yellow, while the sides shade off from the back to a pale green down to the true cream colour on the belly. In the breeding season the males have rather beautiful turquoise blue throats, while their backs will often be mottled with tiny little black or bluish black spots.

Special treatment. While the green lizard will do quite well out of doors if the weather is warm and dry, it must not be allowed to get very damp; and therefore an open-air enclosure for them must be particularly well sheltered and provided with places where they can get out of the cold wind or rain. On the whole I think they do better indoors than out of doors, but the vivarium must be large as they are very active creatures. They do not seem to hibernate well, and to do this successfully I think that great care must be taken to feed them up towards the end of the summer until they are really fat, and then allow them to hibernate in peat moss and dry leaves in a box which is put away and kept in an even temperature.

Food. Practically any kind of insect. They are very fond of spiders, moths, butterflies, some beetles, and even earthworms, while, of course, the meal-worm is the perfect stand-by. They are very fierce in attacking

their prey and will pick up a worm and shake it just like a dog shakes a rat.

The Wall Lizard

Distribution. Widely distributed in Europe, Mediterranean Islands, North Africa, Southern Asia, and the Channel Islands.

Habitat. These lizards like rocky, stony places, and, as their name implies, in their native haunts they spend a great deal of their time running about rough walls in search of insects.

Description and coloration. Six to eight inches is a good average length. The coloration varies tremendously and there are many races and local varieties. In the typical form the upper parts are brown or greyish olive with dark spots or splodges which sometimes have a greenish sheen. The underparts are sometimes cream or yellow, and in the males bear black spots. There is also a very pretty darkish green variety, peppered over the back with tiny dark spots.

Special treatment. Obviously the great climbing abilities of the wall lizard must be given due respect, for they will run up anything on which they can get a good hold. I do not think they are really suitable for keeping out of doors, but they will do well in a vivarium made out of a wooden box, as they can run about this with great ease. I have never found them quite so easy to keep as the foregoing species, but I cannot suggest the reason for this.

Food. Similar in all respects to the green lizard.

The "Glass Snake"

This curious reptile, which is not unlike a large slow-worm, owes its name to its absence of legs and its extreme fragility. Although to all intents and purposes it is legless, it has some minute traces of hind limbs which can easily be over-looked, as they have the appearance of being some loose scales.

Distribution. South and south-east Europe.

Habitat. A reasonably damp situation is preferred, with light soft soil.

Description and coloration. The glass snake grows to a considerable length ; some have been reported of over four feet ; thirty inches or more is not uncommon. The tail is frequently nearly twice as long as the body and head, and the males are said to have longer tails. The scaling of the glass snake is nothing like so smooth as the slow-worm ; in fact if a finger is run down the back the separation of the scales can be felt, and to look at they give the impression of being arranged in little furrows. In colour, glass snakes are reddy brown or dark brown on the back and a paler brown on the underparts. The young are brownish grey streaked with brown on the head and neck, with dark brown bands across the upper surface of the body.

Special treatment. Glass snakes can be kept out of doors, though the situation must be warm and obtain plenty of sun. They are excellent burrowers, so precautions must be taken. Personally I think they do better in an indoor vivarium as they do not like changeable weather.

Food. A rather more substantial diet is preferred than that described for the preceding lizards. It will eat large earthworms, some slugs and snails ; it will even eat mice as it has very strong jaws. Several authorities say that it will take dead food, but of this I have no personal experience.

They are quite hardy and do well in captivity, but should be hibernated indoors.

The Eyed Lizard

Distribution. Southern Europe ; North-west Africa.

Habitat. Similar to that of the green lizard.

Description and coloration. The eyed lizard is bigger than the green lizard and can attain a length of from eighteen to twenty inches. The general coloration is green, similar to that of the green lizard, with dark bluish-black net-like markings on the back with large dark blue spots on the back and sides which slightly resemble an eye, hence the name. These spots vary a great deal in shape and shade of blue.

Special treatment. The eyed lizard can be kept out of doors, but only if the situation be really warm and sunny. On the whole it does better in a large indoor vivarium. It is a temperamental creature and sometimes requires a great deal of coaxing to make it feed well.

Food. Once it has got the feeding habit it will take cockroaches, beetles, mealworms, large earthworms, or even small mice. It must be hibernated indoors.

All the preceding species of lizard may be regarded as species from temperate zones. It may well be, however, that the collector has a desire to go in for some tropical or semi-tropical species ; and I shall, therefore, now deal with such of those lizards as are suitable for the amateur collector but which will not stand life in an enclosure out of doors, and have to be given special heating conditions. There are nearly four hundred species of skinks, and these interesting and sometimes very decorative lizards will do well in heated vivaria. Not many of them are likely to come into the possession of the amateur, but the following may be regarded as typical.

The Stump-tail Lizard

Distribution. Australia.

Habitat. Dry, sandy, stony places.

Description and coloration. A very quaint lizard with a long stout body, short legs and a very abbreviated tail. This tail is so shaped that when at rest or dozing, which this lizard does frequently, it gives the impression of having two heads ; in fact it is sometimes referred to as the " Two-headed Lizard ". Some specimens measure just over a foot in length, and the body is covered with large rough scales which give the lizard a superficial resemblance to a pine cone. The belly scales are smoother and smaller.

The ground colour of the back is brown marked with yellowish spots and sometimes bands. The lower parts are yellowish mottled with brown.

Special treatment. Should be kept in a vivarium at a temperature of about seventy to seventy-five degrees. A good covering of sand and gravel on the floor is essential.

Food. Snails, slugs, small pieces of raw meat, soft fruit ; water to drink.

The Common Skink

Distribution. North and West Africa.

Habitat. Sandy wastes.

Description and coloration. The common skink when fully grown measures about eight inches in length. Its head is shaped like a blunt wedge and seems to appear straight out of the shoulders without any neck. The tail, though longer than that of the stump-tail lizard, is very short in proportion to the body, and is rounded and pointed. The limbs, as with most skinks, are very short ; the scales are quite smooth.

In colour it is yellowish brown on the back, sometimes a light grey, often marked with dark crossbands ; the underparts are creamish white.

Special treatment. This should also have a heated vivarium with a deep layer of dry earth or fine sand. No particular shelter need be supplied as these skinks bury themselves whenever they wish to hide.

Food. Mealworms, beetles, cockroaches ; in fact nearly any insect acceptable to other lizards.

The Green Sand Skink

Distribution. Canary Isles.

Habitat. Sandy, stony places.

Distribution and coloration. This very beautiful little skink is quite small, seldom exceeding five inches in length.

The upper parts are olive green with black-edged spots ; the sides of the body and the limbs and lower parts are much darker, sometimes almost black.

Special treatment. A heated vivarium with sand and a piece of virgin cork or a stone under which it may hide.

Food. Similar to the preceding species.

The Three-toed Sand Skink

Distribution. South of France, North Africa, Morocco and Mediterranean regions.

Habitat. Similar to preceding species.

Distribution and coloration. This is a very odd looking lizard ; generally speaking it resembles the common slow-worm with tiny little legs which look as though they were almost useless, and in fact are nearly so. It reaches a length of just over a foot, and is coloured on the upper parts in shades of olive or browny grey, marked with long streaks of a darker colour down the back.

Special treatment. Similar to the preceding species.

Food. Similar to the preceding species.

The foregoing will serve as an introduction to the skinks. The next species to be described is the not very aptly named Horned Toad which is, of course, not a toad but a lizard and is related to the iguanas.

The Horned Toad

Distribution. The dry and desert regions of North America, Texas, Mexico, California. This is one of the few creatures found in the so-called Death Valley of Colorado.

Habitat. Desert and sandy scrub.

Description and coloration. This is a really remarkable looking little lizard, and like other horned toads is quite small, six inches or less. Its most notable feature, as its name implies, is the possession of what look like spiky horns on the head and neck, with rows of smaller spiky protuberances all down the back, on the sides and on the legs and tail. These give it a rather terrifying appearance, which however is no indication of its disposition, as it is a tame little creature and quite inoffensive.

In colour it is brown or greyish brown on the back with a lighter coloured streak down the middle. The spines have paler edgings and sometimes red tips. To some extent it has the ability to change colour, particularly when irritated or alarmed. The horned toad has a most curious method of defence, which consists of the ability to squirt a red blood-like liquid from the corners of the eye. It is said that a jet of this liquid can be shot a distance of over a foot.

Special treatment. The vivarium for horned toads must be kept at eighty to eighty-five degrees, and the floor should be covered with thick sand, with perhaps a few small stones.

Food. They are rather specialised in their diet, and for that reason are perhaps not as easy to keep as some other lizards. They are particularly fond of ants. They are also said to take spiders, small cockroaches and flies in captivity. They will not eat anything which is dead.

The Chameleons

The chameleons are, of course, very popular lizards in captivity. Their ability to change colour in harmony with their surroundings or when stimulated by fear, is well known, and as they will generally oblige by showing off this phenomenon they are objects of great interest. They also have other features which single them out among the lizards. They have most remarkable eyes which are cone-shaped, the actual eye itself apparently deeply encased in its scaly covering. These eyes are capable of being rotated in all directions and quite independently of each other ; that is to say, the chameleon can look forward with one eye and backward with the other. They have very curiously shaped claws which look like hands rather than anything else, and they are arranged with five toes on each foot which are separated into twos and threes. The set containing two claws is placed on the outside of the fore-feet and on the inside of the hind feet, and the chameleon is able to grasp a twig or small bough with surprising firmness.

The chameleon's tail is also remarkable, as it is long and prehensile, and it can be used as a fifth grasping limb. The tongue, however, is really the most curious feature of all. It is very long and sticky with a sort of club-like end, and when not in use it is folded back inside the very large mouth. When about to take food, such as a fly or moth, the chameleon will very slowly approach the victim and before shooting out its tongue the throat can be seen moving up and down ; then the mouth opens and the tongue will be shot out for a distance of anything up to six inches or so ; the food is then seized and withdrawn like lightning into the jaws.

There are many species of chameleon, but few find their way on to the market, and the common chameleon may be taken as typical of the family.

The Common Chameleon

Distribution. A very wide range: Spain, North Africa, Asia Minor.

Habitat. Arborial, in as much as it spends most of its time in the smaller branches of trees, shrubs and bushes.

Description and coloration. The common chameleon is about a foot to thirteen inches over-all. The body is covered with what may be described as scaly granules rather than true scales. The head is large, rather helmet shaped, and the limbs are long, as is the tail. It is, of course, a little difficult to describe the typical colour of the chameleon, since although they are not able to assume quite so many shades as is popularly supposed, they can range from a dirty white down to a deep brownish black, brick-red or a very pale olive; various shades of brown and green will also be observed. The most general colour in the average natural surroundings is green.

Special treatment. The chameleon must have a heated vivarium, and in my opinion they do not feed at all well at a temperature of much less than seventy degrees. The vivarium should be reasonably roomy with some stout ferns or small branches to enable the creature to get near to the live insects on which it feeds, and which will, of course, crawl about the cage. The floor of the cage can be covered with sand or a mixture of sand and peat moss.

Food. Flies of all kinds are probably the best food, though chameleons will take a great many moths, and are very fond of cabbage white butterflies. They can be fed on mealworms, if the mealworm is held a suitable distance from the chameleon in a pair of tweezers, or on the end of a piece of wire, and allowed to wriggle about in an attractive manner; but I do not think mealworms are really appreciated. Small grasshoppers

are excellent and they have the advantage that if some growing grass is placed in the vivarium they will remain alive for a reasonable time. Fly and bluebottle pupæ may be put in a small dish in the vivarium and allowed to hatch out of their own accord. Many people think that chameleons never get thirsty. This is a great mistake, but it is sometimes difficult to provide water in a natural way. Actually, water should be sprinkled on the leaves or herbage in the vivarium—not too generously—about once a day, and it is important to see that the vivarium is properly ventilated.

The Geckos

These are attractive lizards to keep, and although they are all tropical or semi-tropical they do quite well in a vivarium so long as the temperature is kept between sixty-five and eighty degrees. It should certainly not be less than sixty-five, and seventy to seventy-five is a reasonable average.

The geckos are noteworthy for their ability to climb up walls and across ceilings by means of their specially constructed toes. These have on the underside little sucker-like pads which enable them to cling to the smoothest surface. They are nocturnal in their habits and are therefore most active at night. They feed on all kinds of insects, but large flies or bluebottles are perhaps as good as anything. One word of caution should be given: it is that geckos are very well provided with sharp teeth, and the larger ones are capable of inflicting a painful bite. The bite will do no serious harm but it is quite sufficient to draw blood.

A vivarium for geckos should always be kept well covered, as in addition to their ability to climb up anything, they are amazingly quick, and will be out of their case like a flash if given an opportunity.

The Great House Gecko

Distribution. Widely distributed throughout Asia.

Habitat. Houses, outbuildings.

Description and coloration. This is a large gecko which sometimes reaches a length of twelve inches. The sexes are very similar. The head is very broad; the eye is large with a vertical pupil and, like all the geckos, the tail is particularly brittle. It is not necessary for the tail to be grasped for it to be shed. If taken in the hand the gecko can literally shake off its tail.

The general ground colour is best described as a pale pinkish brown, with darker reddish brown bands. The skin is very granulated and is covered with very tiny bluish spots, particularly on the throat and neck. The under-parts are generally a greyish fawn.

Special treatment. The vivarium can be quite simply laid out with sandy soil on the bottom, and pieces of rough bark leant against the sides, or with even a stout plant or two. The vivarium should not be too dry, nor too damp, and must be very well ventilated, as geckos drink by licking droplets of water off vegetation or the sides of the vivarium. This should be provided by sprinkling as in the case of tree frogs, but if ventilation is not sufficient there will be a tendency to too great a humidity.

Food. Flies; all kinds of insects.

The Wall Gecko or Moorish Gecko

Distribution. Mediterranean regions; North Africa.

Habitat. Similar to preceding species.

Description and coloration. Smaller than the great house gecko, only reaching six inches in length. The head is rather broad behind the eyes; and the males have a row of small spines at the base of the tail on each side. The colour varies considerably. Generally speaking the back and sides are grey, occasionally varied with lighter coloured streaks, the under-parts being either a pinkish white or a very pale grey.

Special treatment. Similar to preceding species.

Food. Similar.

Brook's Gecko

Distribution. This gecko originally hailed from West Africa but has spread, largely through human agency, to a great many countries all over the world. It finds its way into fruit crates and similar merchandise, and in this way has been accidentally introduced into many countries.

Habitat. Similar to preceding species.

Description and coloration. A small gecko, only reaching about four inches in length. The general coloration is light fawn above with darker markings; pale greyish underneath.

Special treatment. Similar to preceding species.

Food. Similar.

The Larger Tropical Lizards

The monitors and iguanas are, in my opinion, quite unsuitable for life in the average vivarium. In the first place most of them attain a considerable size, some of them reaching a length of from four to six feet. In addition to this many species do not do well without expert attention; while the monitors, at all events, are inclined to be bad tempered, and can inflict painful bites and very unpleasant scratches with their massive claws. Both families would require much more cage space than the amateur is likely to be able to afford; and to keep them in a vivarium less than twice their own length is definitely cruel. Particularly is this so in the case of iguanas, as they are extremely active, and if not given sufficient exercise are bound to suffer. They are far more suited to zoological gardens than a private collection, and I think that if by any chance a specimen of these large lizards should come the way of any reader, he will be well advised to seek the advice of the nearest authority before deciding to try to accommodate it himself.

When the great number of species of lizards are considered, it will be obvious that it is impossible to deal with anything but a fraction of them. Families and species which have already been dealt with, however, offer a good selection. If even a proportion of those referred to in the preceding pages are successfully kept, the collector will be able to congratulate himself; while at the same time he will have learnt a good deal, and he will have had the satisfaction of watching at close quarters a great many attractive, interesting and beautiful creatures.

CHAPTER ELEVEN

THE AMPHIBIA

INTRODUCTION

The amphibia which will be recommended include frogs, toads, newts and salamanders. As was the case with snakes and lizards, there is such a vast number of species that it is in no way practicable to do more than select those which are likely to be obtained; which will feed well in captivity; and which do not offer any very great difficulties from the point of view of housing. That there will be many omissions I am well aware; and that my selection may not please every reader means that I shall simply share the lot which falls to anyone who has to assume the role of a selector. I shall, however, endeavour to recommend typical species from each family, and it may be taken for granted, unless otherwise stated, that any specimens other than those with which I shall treat can be kept under much the same conditions, so long as the general advice in the earlier chapters is borne in mind.

Amphibians are frequently spoken of as creatures that are "equally at home on land or in the water". This is, in my opinion, a misleading description. Amphibians are animals which have some form of larval life and which metamorphose from the larval stage into the complete state; nearly all require to resort to water for the purpose of breeding; but, having fulfilled that function, spend the greater part of their lives on land. The common frog, for instance, while able to swim excellently and remain submerged in water for a long time, and which has to go to the water to spawn, does not care for the water particularly once the breeding season is over. In fact, if at midsummer the common frog is put in a pond, the first thing it will do will be to swim out again and hop away. Similarly newts, when they have finished breeding, leave the water and lose to a large extent their moist skins, assuming a sort of velvety texture. If re-submerged in water at this stage they look unhappy and get out again as fast as possible. It follows from all this that in keeping amphibians in captivity their particular requirements in particular seasons must be catered for. Nothing is more undesirable than for newts to be kept in a tank of water with no provision made for their coming out; while nearly all the toads and most of the frogs spend much more time on land than they do in water.

It is perfectly possible to breed many species of amphibians in captivity, our own frogs, toads and newts being comparatively simple; but unless the specimens are such as can be kept in an outdoor enclosure with a pond provided, it will be found better, where possible, to secure the spawn and hatch that out rather than take the actual mating pairs and try to spawn them in an indoor vivarium. Another point worth noting is that the tadpoles of frogs and toads go through both a vegetable and an animal feeding stage. When first hatched the tadpoles feed on the minute algæ which grow on various water plants, rocks, stones, the sides of the aquaria, etc. After a short time this diet requires to be supplemented by animal food. Many authorities recommend small pieces of raw meat, but personally I think that portions of earthworm are much better. The best way to present this food is to take a reasonably large earthworm and slit it longitudinally, then cut off pieces about an inch or so in length and place these in the vessel containing the tadpoles. Naturally the amount given must be proportionate to the number of tadpoles, as if too much is fed at one time the dead earthworm will decompose, foul the water and kill the tadpoles. It is better to give too little than too much. Healthy tadpoles will take all the flesh away, leaving

just the thin skin which can be later removed with a glass tube. There will inevitably be casualties, but if these are not too numerous they need cause no alarm, as tadpoles are frightful cannibals and will soon convert their dead relatives into a meal.

Newt tadpoles in the earliest stages of their lives will get sufficient food from the microscopic organisms which infest any well-matured aquarium water. After a while they will seek larger prey, when daphnia, mosquito larvæ, and other small aquatic creatures will serve them well. When they get to the stage of growing their legs they will readily accept very small earthworms. The most difficult stage for the feeding of young amphibians is when they have just metamorphosed; for where frogs and toads are concerned they will leave the water, and must have a supply of minute flies to keep them going. If it is possible to transfer them to an open-air enclosure they will, of course, fend reasonably well for themselves, but if they are to be kept indoors, then a liberal supply of greenfly is the best staple diet.

Not much need be added to what has already been said on the subject of the lay-out of vivaria for amphibians, but it may be as well to emphasise once again the necessity for retiring places, the provision of water, and the maintenance of the correct degree of moisture required by the particular species. In the case of tree frogs, these must be provided with suitable broad-leaved herbage or plants in order to give them resting places, and to enable them easily to reach the flies on which they will have to feed.

In the following pages I shall deal first with frogs and toads, then with the newts, and finally the salamanders.

CHAPTER TWELVE

FROGS AND TOADS

THERE are about three thousand species of frogs and toads in the world, but of these the British Isles has only one strictly native frog, and two "introductions". Many people confuse frogs and toads, but it is perfectly possible to distinguish between the two families without going into very great zoological technicalities. In the first place, frogs are more agile than toads; the skin of a frog presents a moist appearance and is moist to the touch; while toads' skins are generally dry and rough. Frogs are more aquatic than toads and their feet are generally more fully webbed. Frogs have a round patch of skin behind the eye, known as the tympanum; this patch of skin, which is generally paler in colour than its background, covers the eardrum and it is usually quite easily visible. Toads, although they can hear just as well as frogs, do not have this feature. Frogs have teeth in the upper jaw and in the front of the palate, while toads have no teeth.

With regard to the sexes, it may be taken as a general rule that the females are larger than the males; and in addition, during the breeding season male frogs grow rough pads on the inner side of the first finger for the purpose of grasping the female firmly. These pads are very easily seen at mating time, and although they decrease in size afterwards, can still be discerned even then.

The Tree Frogs

The tree frogs are to my mind the most attractive of all. They are nearly all small in size, some of them are beautifully coloured, and they have amusing

habits. They are, however, mostly unsuited to keeping out of doors, and they are not particularly easy to feed—except during the height of the warmer seasons—owing to the fact that they exist chiefly on flies of various kinds; so that unless the collector is going to breed flies—a tiresome and none too easy task—it will be found that tree frogs are more difficult to feed than most. The best way of getting out of this difficulty is to obtain some larvæ of bluebottles or house flies from fishing-tackle or bait stores, allow these to pupate and place some of the pupæ in a dish or saucer in the vivarium. All the tree frogs likely to be obtained may be treated in the same manner, so that only one or two species will be separately described; but a list of further species will be included. There is no need to segregate the various species of tree frogs, and this is an advantage since to keep several different types in one vivarium not only saves space, but tends to be more decorative. All tree frogs are most active at dusk and at night, and in the breeding season are very vociferous. They have a remarkable variety of calls ranging from a definite croak to a noise like the ringing of a bell.

The tree frog most likely to be easily obtained is the common or the European tree frog.

The Common or European Tree Frog

Distribution. Europe, Northern Africa and sub-tropical Asia.

Habitat. As its name implies, it spends practically the whole of its time on the broad leaves of plants or trees.

Description and coloration. Seldom exceeds two inches in length. The general colour is bright green, but this colour will vary from time to time according to the light and the background on which the frog is sitting; these variations generally taking the form of shades of green or brown with occasional light or dark spots.

Special treatment. The vivarium should be high in proportion to its length in order to accommodate either some broad-leaved ferns or a branch of laurel. These can be placed in a jar of water sunk in the earth which should cover the bottom of the cage. A vessel of water should be provided, and something which will make it easy for the frogs to get out of the water should be placed in position. Owing to the little sucker-like discs on their toes, these frogs can sit on or climb up the glass sides of their vivarium with the greatest of ease. It should therefore have a firm cover, preferably perforated zinc.

Food. All kinds of flies ; small moths, earwigs.

The Changeable Tree Frog

Distribution. Canada and North America.

Habitat. Trees.

Description and coloration. A little larger than the common tree frog, the changeable tree frog has a rather warty appearance on the upper surface, while the lower parts are granulated. The back is greyish with large regular darker spots. The sides of the thighs are yellow, edged with red, the under-parts are uniformly white.

Special treatment. Similar to the common tree frog.

Food. All kinds of flies. It is alleged to have a partiality for small cockroaches.

White's Tree Frog

Distribution. Australia.

Habitat. Same as preceding species.

Description and coloration. This is a much larger frog, sometimes exceeding four inches in length. The colour is a dark bluish green above, whitish underneath.

Like the changeable tree frog, however, it has the power of varying its colour to a considerable degree. The head is broader than it is long, and the snout is rounded. It has a large eye and a very distinct tympanum. The fingers are webbed for about one-third of their length, and the toes are very fully webbed.

Special treatment. Owing to its greater size, this tree frog requires quite substantial vegetation on which to sit. It is, however, not such a great climber as some.

Food. All kinds of flies ; and it is stated that White's tree frog sometimes descends to the ground to feed, when it will, of course, take earthworms, mealworms, etc.

The Golden Tree Frog

Distribution. Australia.

Habitat. Same as preceding species.

Description and coloration. This is another rather larger species, sometimes reaching four inches in length. In general shape the golden tree frog resembles the common English frog. The colour above is bluish or olive, sometimes spotted with blue and brown. There is sometimes a golden band on each side of the back with a vertebral stripe of the same colour. The lower parts are a beautiful bluish white. The skin is rather warty above, and granulated below.

Special treatment. Same as preceding species. It is alleged to be a very hardy frog and a good feeder.

Food. It will eat anything that the other species will eat and is said to have a definite partiality for cockroaches.

Special Note. All tree frogs in their natural state enjoy a shower of rain and become much more active after one. At intervals, therefore, the vegetation in the tree frog vivarium should be sprinkled with water in order to simulate nature. The temperature of this water should be a little less than the actual temperature of the vivarium, but it should not be absolutely cold.

The American Bull Frog

Distribution. Widely distributed throughout the United States; also in southern regions of Canada.

Habitat. Marshes, and the banks of sluggish rivers.

Description and coloration. The most usual colour is a brownish green above, with whitish underparts, sometimes with dark marbling and with yellow shades under the legs. The tympanum of the male is very large indeed—much larger than that of the female. A fully grown bull frog will measure just over eight inches.

Special treatment. The vivarium for bull frogs should, of course, be as roomy as possible; for although it is unlikely that sufficient accommodation will be available to allow for the tremendous leaps of this species, it must be given sufficient room to take a little exercise. The vivarium should be kept as damp as possible, without becoming literally water-logged; as, if this occurs under artificial conditions, the vegetation is apt to rot. The usual retiring place should be provided.

Food. Little comes amiss to the bull frog. Large earthworms may be regarded as the best staple food, though young common frogs, toads, newts, and even mice will be eagerly taken. In the wild state bull frogs have been known to eat young ducklings and small snakes.

The Marsh Frog or Hungarian Frog

Distribution. According to Boulenger this frog is widely distributed over most of Europe, with the exception of North-west and Central Europe and Italy.

It is found in Western Asia, as far East as Afghanistan, and in some parts of North Africa. It has lately been introduced into England.

Habitat. As its name indicates, it is a frequenter of marshes and the verges of dykes, canals and slow-moving waterways.

Description and coloration. As the marsh frog is the latest addition to our British fauna, it is desirable to say a little more about it than has been said about previous species. In the first place it has not yet been definitely decided whether the marsh frog is truly a species on its own, or whether it is a variety of the well-known edible frog. Whatever may ultimately be the decision on this point, the marsh frog is easily distinguished from the edible frog by reason of its greater size when fully grown, and also by the absence (in nearly every case) of the light vertebral stripe which typifies the true edible frog.

The marsh frog, like others, has the ability to change its colour to a considerable degree; but generally speaking the ground colour of the marsh frog is that of well-weathered cement with squarish spots or splodges on the back and on the thighs, these splodges being either a dark olive-green or brown. When sitting among water-lily pads or in grass this frog takes on a most beautiful green hue. It is a large frog, females sometimes reaching five inches in length and the males about an inch or so less. The tympanum is well marked and is generally putty coloured. The marsh frog, like the edible frog, is very aquatic and never leaves the immediate vicinity of the water. That is to say, it is seldom found at a greater distance from the water than it can cover in one or two leaps.

The story of its introduction into England is of some interest as it exemplifies the uncertainty which often accompanies introductions. Naturalists have many times tried to introduce new frogs and toads into this country, generally without much success, except possibly in the case of the edible frog which has succeeded in establishing itself in a few areas. The marsh frog, however, would seem to have had no difficulty whatever in establishing itself and multiplying at an almost incredible rate. In 1935 an amateur naturalist who lived on the edge of the Romney Marshes in Kent introduced a few pairs of marsh frogs into his garden pond. They soon left their restricted quarters and made for the nearby dykes. In two years' time people were reporting the loud croaking of frogs in the late spring, and in ten years from the time of the initial introduction the frog had spread far and wide over the marsh area, and at the present time there must be tens of thousands of them.

Special treatment. The marsh frog will do very well in an outdoor enclosure, the walls of which should be not less than three feet six inches in height. An adequate pond must be provided which should be well planted with some of the commoner water weeds. The ground surrounding the pond can be covered with rough grass. Mid-May can be regarded as an average time for breeding, and during this period the males will make a very considerable noise when calling their mates. The males have quite large vocal sacs, which are as big as small grapes ; and when these are inflated and deflated the resulting croak can be heard a quarter of a mile away. The spawn resembles the spawn of the common frog in the mass, but the eggs are smaller and do not float. The egg mass sinks below the surface of the water as is the case with the edible frog. When the tadpoles hatch out they grow at a great speed and are extremely voracious. However, it is not yet certain whether metamorphosis is always completed in the season of hatching ; it seems very likely that "over-wintering" frequently takes place.

Food. There is no great difficulty about feeding the marsh frog in a well-constructed and well-placed enclosure. Considerable quantities of insects will find their way into the enclosure, but it will be as well to supplement these by introducing into the pond some

dragon-fly larvæ, fresh water shrimps, or even newts. These will all be eaten, as the marsh frog can feed either on land or under the water. Earthworms are taken readily, as are moths, grasshoppers, beetles, etc.

The Edible Frog

Distribution. North and Central Europe and Italy. In Great Britain it has been reported as becoming reasonably well established in Bedfordshire, Kent, Surrey and Middlesex.

Habitat. Similar to the marsh frog.

Description and coloration. The edible frog is another very handsome frog which although it does not grow to quite the same size as the marsh frog, is nevertheless much bigger than our common frog. Females will reach four inches, males a little less. General coloration is either green or brown above, sometimes uniform, sometimes spotted with black or dark brown. The thighs are spotted with black. There is a light green or yellowish green vertebral stripe running right down the back, flanked on either side of the back by an irregular yellowish-gold stripe. The tympanum is large and well-defined, and is generally of a greenish yellow colour.

Special treatment. The edible frog may be treated in all respects in the same way as the marsh frog. Breeding takes place in May, but possibly a little earlier than in the case of the marsh frog.

Food. Same as the marsh frog.

TOADS

My own personal opinion is that toads are, on the whole, more satisfactory in captivity than frogs. It may be argued that they are less decorative and certainly less agile, but I think they compensate for these shortcomings by being easily seen, having less nervous dispositions, and, being more intelligent they are easier to tame. There are certainly more species of toads likely to come the way of the amateur collector, though, of course, space will not permit me to deal with more than a few typical ones.

While it is true that toads in general prefer drier surroundings to frogs, there are several species that not only like a damp environment, but which spend quite a considerable amount of time sitting in the water. In any case, however, water must be provided for all species of toad as they like to have a good soak, and this is always indulged in previous to the changing of the skin.

The Giant Toad

Destribution. South and Central America, and the West Indies.

Habitat. Fringes of forests, scrubland.

Description and coloration. The giant toad, as might be imagined, is large; a well-developed female sometimes exceeds eight inches. In general ground colour it is brownish, frequently marked with dark spots. The females are generally more patterned than the males. The eyes are very large and wide apart, very beautiful in colour; and the tympanum is also large and distinct.

Special treatment. The giant toad is only suitable for an indoor vivarium as it requires a temperature of anything between sixty-five and seventy-five degrees. The vivarium should be reasonably large with a good depth of a mixture of sand and peat moss covering the floor. A roomy retiring place should be set up and, if possible, a clear space should be left in one corner where the food can be put down in such a way that it can be easily seen. An adequate dish of water must also be given.

Food. The giant toad will eat practically anything that creeps or crawls, from mice down to gentles or meal-worms. Earthworms provide a satisfactory staple diet.

The South-American Sand Toad

Distribution. South America.

Habitat. Dry sandy places.

Description and coloration. This species is a little smaller than the giant toad, though a large female will exceed six inches in length. The general ground colour is brown, with white under-parts speckled with brown.

The females are frequently spotted on the back with greenish or brownish splodges. The males are uniformly brown. This toad changes colour very rapidly if moved from darkish earth to silver sand for example.

Special treatment. A roomy, dry vivarium with a floor covering in which sand should predominate; a retiring place, and a dish of water will complete the lay-out. Temperature should not be less than 70 degrees Fahrenheit.

Food. All kinds of insects, with earthworms as a basic food.

The Common African Toad

Distribution. Fairly widely distributed in Africa and Arabia.

Habitat. Dry places.

Description and coloration. In colour this toad varies considerably, some being a darkish olive, others being a reddish brown. This colour is sometimes uniform, sometimes spotted with a darker shade. In size it may reach five and a half inches in the female, but most specimens seen in this country are smaller—frequently the size of our own common toad.

Special treatment. This toad requires a reasonable degree of heat, say about sixty to seventy degrees, and the vivarium should be dry, with plenty of loose sandy mould. A water vessel must be provided.

Food. Some collectors say that this toad is occasionally faddy about feeding, but I have generally found that meal-worms and earthworms will be taken quite readily.

The Green Toad

Distribution. Central and Southern Europe; Mediterranean region, and South-western Asia.

Habitat. Variable. Thrives in both dampish and reasonably dry surroundings.

Description and coloration. The female green toad may reach about four inches in length, but specimens I have had have usually been smaller. The general colour is greyish olive above, with quite large greenish or olive blotches distributed over the back and legs. Whitish underneath, sometimes unmarked, sometimes slightly spotted with dark brown or black. The colour is very variable according to its surroundings.

Special treatment. This toad is quite tolerant of wide ranges of temperature and will live well in an outdoor vivarium during the spring and summer months; it should, however, be brought indoors during the winter. Its vivarium may be laid out similarly to that described for the preceding species.

Food. Similar to preceding species, taking size into consideration.

The Natterjack Toad

Distribution. Western Europe; also Denmark, Southern Sweden. Also the British Isles. In Scotland it has been recorded in the following counties: Renfrewshire, Kirkudbright and Dumfries; in England it is found in Cumberland, Westmorland, South and Mid Lancashire, Shropshire, North-east Yorkshire, North Lincolnshire, Leicestershire, and most of the southern counties from the Wash to Land's End, with the exception of Essex, West Kent, East Sussex. In Wales it is found in Denbigh and Flint; and in Ireland in County Kerry.

Habitat. Dry sandy places; sand pits and sand dunes.

Description and coloration. The natterjack is a good deal smaller than our common toad, a fully grown female never being more than three inches in length, except, curiously enough, for Irish specimens which exceed this figure. The general ground colour is greyish or greenish brown with small green or olive spots sprinkled over the back. The legs are striped with transverse bars of greeny brown. The most noticeable feature which distinguishes it from the common toad is the presence of a yellowish green vertebral stripe down the back. This little toad may also be distinguished from the common toad by its gait. It does not crawl or hop ponderously, but runs on its little short legs.

Special treatment. The natterjack will do equally well indoors or out of doors. In either case the vivarium should have a considerable thickness of light sandy soil, as natterjacks are great burrowers and spend a good deal of time almost completely covered in sand. In the natural state, particularly where they inhabit sand pits, they excavate little burrows in the sides of the pits. Here they spend a great deal of their time. The breeding season is very drawn out. In this country it generally commences towards the end of April; it may continue through May into June. The natterjack prefers shallow water in which to breed, and sometimes shows a most untoad-like lack of intelligence by selecting a shallow puddle which may easily dry up in a time of drought. It is a most attractive little toad to keep; becomes very tame and will live for a considerable time.

Food. Small earthworms, spiders, meal-worms, any kind of fly.

Fire-bellied Toad and Yellow-bellied Toad

These two species so much resemble each other in appearance, behaviour and habitat that they may well be taken together.

Distribution. The fire-bellied toad—North Europe. The yellow-bellied toad—Central and Southern Europe.

Habitat. Damp regions.

Description and coloration. Neither species exceeds two inches in length. Both are dark olive or blackish brown above. The under-parts of the fire-bellied toad are a bright orange, or sometimes vermilion and black; while the yellow-bellied toad has the under-parts marbled with yellow and black.

Special treatment. Although these little toads can be kept out of doors, they are so small that they are not easily observed under these conditions. They do extremely well in an indoor vivarium which need not be specially heated. I have found that they feed pretty well all the year round at a temperature of sixty degrees. The vivarium should have a floor covering of earth and peat moss, with perhaps a little ordinary growing moss to improve the appearance. A reasonably deep dish of water should be provided as these toads like to spend a certain amount of their time sitting in the water with their heads just showing. They must have a good dark retiring place. The two species may be kept together if desired.

Food. They are particularly fond of flies, but will take small earthworms either on land or in the water; but care must be taken to see that dead worms are removed. They do not seem very fond of meal-worms.

The Midwife Toad

Distribution. France, Switzerland, Central and West Germany, Spain and Portugal.

Habitat. Very variable. In France it is a great frequenter of gardens. It has also been found close to the sea and high up in the Pyrenees.

Description and coloration. This little toad seldom exceeds two inches in length. In colour it is generally greenish grey above, sometimes speckled with tiny spots on the back which are greenish or sometimes reddish in colour. The under-parts are greyish-white with, occasionally, dark grey speckles on the throat. The males are very difficult to distinguish from the females, but the body of the male is rather shorter.

Special treatment. Here again the small size of the midwife toad makes it more suitable for an indoor vivarium than an outdoor enclosure, though they will do perfectly well in the open, and will even hibernate successfully. They are, however, very good climbers and are difficult to keep in an uncovered enclosure. They appear to like rather damp surroundings and should have a good retiring place and a dish of water. This toad derives its name from the peculiar breeding function of the male. When the eggs have been deposited by the female the male wraps them round his hind legs, and carries them about with him. When in this state he usually sits in a nice secluded damp cranny until the eggs are about to hatch, when he goes to the water to allow the tadpoles to emerge. This they do in a more advanced state than is the case with the common frogs and toads.

Food. All kinds of flies. It is possible that very tiny worms will be taken, but midwife toads certainly do not like these.

The African Clawed Toad

Distribution. South Africa.

Habitat. Tropical swamps and small lakes.

Description and coloration. Although quite an interesting and amusing species to have in the collection, the clawed toad cannot lay any claims to beauty. It is a dull, drab, squat toad which in its wild state is said seldom to exceed four inches in length, though specimens in captivity have probably beaten this. In colour the back is generally a dirty muddy brown colour, while the under-parts are greyish-white speckled with brown. The front feet are unwebbed and its fingers present a definite claw-like appearance. The hind feet are very fully webbed. The eyes of this toad are situated almost on top of its head, giving it a most peculiar expression.

Special treatment. The clawed toad lives entirely in water and although it can flop about if taken out and put on land, its progress is ungainly. They are best kept in a glass tank or aquarium; and, except if it is desired to breed from them it is useless to plant the tank with weeds, as the clawed toads are extremely active in the water and will uproot any plants at once. They are not easy to breed, but as the tadpoles are so interesting it is perhaps worth while giving some general directions on the subject of breeding. They must be very well fed to begin with; and must be placed in a tank well supplied with pond weeds. During the period of breeding it is necessary to produce the effect of rain in the tank by either adding a small quantity of water every day through a small watering-can, or by taking out some of the water and allowing it to trickle back. If you are lucky, which I have never been, eggs may be laid among the water plants. Should the eggs ultimately hatch, the tadpoles will be found to be curious transparent creatures with long tails which are constantly vibrating. They also develop, soon after birth, a pair of long feelers on either side of the mouth. If you do get any tadpoles, remove the adult toads at once, or the larvæ will soon be gone. The tadpoles may be successfully reared, but they must be fed with "infusoria", i.e., microscopic organisms. These may be provided by floating a lettuce leaf on the top of the water and allowing it to decay, or by preparing a special infusion of chopped up hay, mixing it with dry nettle leaves, and placing this mixture into about a quart of water. This should be put on a stove and brought up to the boil, after which it should be placed in a suitable vessel; a little more water is added to it and left exposed to the open air for a week or so. By this time countless millions of microscopic organisms will have appeared, and by means of a glass pipette a few cubic centimetres of this culture can be taken out and added to the water in the tank containing the tadpoles. Two or three times a week will be sufficient.

Food. The adult clawed toads are the simplest of all the amphibia to feed. They will thrive and grow fat on an almost unrestricted diet of earthworms. They can be fed on strips of raw meat or liver, but this necessitates constant changing of water, and I do not think earthworms can really be beaten.

The Spade-foot Toad

The European spade-foot toad, sometimes referred to as the brown mud toad, is a good example of this family which used to be called toad-frogs, owing to the fact that these amphibians partly resemble frogs and partly toads. There are several American species of spade-foot toads which are perhaps more typical in that their specially constructed hind feet, which they use for digging and burrowing, are more definitely shaped; but these are much less likely to find their way into the hands of the amateur.

The European Spade-foot Toad

Distribution. Temperate regions of Europe.

Habitat. Muddy, moist places.

Description and coloration. The maximum length of this toad is about four inches, but most of the specimens which I have kept have been much less than this.

The general ground colour is a muddy brown sometimes marbled with darker brown. Beneath the fifth toe it has a horny excrescence which forms a kind of spade-shaped spur.

Special treatment. Owing to their drab colour and burrowing habits these toads are not very suitable for an outdoor enclosure, though they would stand our climate during the spring and summer. However, they do extremely well in an unheated indoor vivarium. The lay-out of this may be of the simplest kind, a small shallow aquarium tank with a glass cover being quite suitable. This should be filled with a mixture of mould and peat moss, with an adequate dish of water. The soil should be kept quite moist and a piece of bark or virgin cork provided. These toads will remain most of the time almost completely buried in the soil, only emerging at night to eat. In spite of their retiring habits they are quite interesting little creatures, becoming very tame and quite ready feeders.

Food. They will do well on small earthworms, or even small meal-worms. They also like flies.

CHAPTER THIRTEEN

NEWTS AND SALAMANDERS

MOST of the newts likely to be acquired by the average collector may be treated similarly. Particular points to remember have already been referred to, but may possibly be repeated here with advantage. These points are: The necessity for bearing in mind the fact that newts are not wholly aquatic, and that therefore their vivarium should always be provided with rockwork or something similar which will enable them to emerge from the water when they so desire. In their natural surroundings they hibernate, but they may be kept going all through the winter months in an indoor vivarium, though of course this may prohibit them from breeding. Another point to be borne in mind is that the "aquatic" end of their tank must be well provided with water plants, such as Canadian pond weed, if they are to breed successfully. If breeding is to be indulged in care must also be taken to remove the adults as soon as the young larvæ hatch, or they will be eaten at once.

The following species may be taken as typical and all do well in captivity.

The Great Warty Newt or Crested Newt

Distribution. Widely distributed throughout Europe and also in Great Britain, though it is not found in every region of the British Isles.

Habitat. Ponds, canals and the surrounding country.

Description and coloration. Males sometimes exceed six inches in length; females are rather smaller. In colour this newt is very variable, but generally speaking it is dark brown, nearly black above, the skin being covered with minute warts; the sides sometimes have numerous tiny white dots. The under-parts are a beautiful orange, spotted or marbled with black, the markings on the under-parts of the females being less vivid and less distinct than the males. In the breeding season the male develops all the way down the back, from the neck to the end of the body, a beautiful toothed crest. This crest is interrupted where the tail joins the body, but is continued along the tail in the form of an unserrated ridge. The tail also has a silvery white band along the side. The female does not grow a crest but has a longitudinal groove down the back.

Special treatment. The tank for newts should be long and broad in comparison to its height, and must always be kept well covered as newts can climb up the sides of glass without any difficulty. If an ordinary aquarium tank is being made use of, it is a good idea to have well-washed sand at the bottom, suitably planted with pond weed, which should not, however, be so excessive as to prevent the newts being seen. One end of the aquarium should have some bricks or stones placed in such a way as to raise them up well above the level of the water. It is also a good idea to introduce some growing moss among these stones.

This newt will of course do equally well or even better in a garden pond, but it will naturally be less easy to observe. In an indoor tank not too many pairs should be kept together.

Breeding habits. The warty newt in this country commences to breed about the middle of April, and its breeding habits, in common with most other newts, are of considerable interest. When the newts have got into breeding condition the males will be seen wandering about under the water along the bed of the tank as if looking for something. Then, if you are very lucky, you may see the male deposit on the sand a minute greyish-white capsule, somewhat resembling a collar stud in shape. This is known as the *spermatophore.* This little capsule contains the *spermatozoa.* When this has been deposited the female, after having been courted by the male with a great deal of tail flourishing and butting, will come along and take up this little capsule in the vent; after this the capsule breaks, releasing the *spermatophores* which fertilise the ova inside the female. A little later the female will lay her eggs with great care. She will hunt about for a suitable leaf of water-weed; having found one she will back towards it; then holding it with her feet she folds it under and deposits an egg inside the fold. Each egg is usually deposited separately. In the course of a few days, depending of course upon the prevailing temperature, the embryo newt tadpole becomes folded upon itself and gills gradually appear. When the larva hatches it is almost transparent and it spends most of its time clinging to plants by means of its claspers. In the space of a few weeks the claspers are absorbed and are replaced by the fore-limbs which appear first, in contra-distinction to frog and toad tadpoles. The next stage is the appearance of the hind limbs and then, if the season has been a really warm one, the gills may begin to diminish in size as the legs develop; and by the end of the autumn the newt may have completed its metamorphosis. As often as not, however, metamorphosis has not been completed by the autumn, and then the young newt in its natural habitat will spend the winter buried in the mud at the bottom of the pond. If it has completed its metamorphosis it will emerge from the water and hibernate on land.

Food. All kinds of small water insects; but the best food for newts in captivity is a regular supply of small earthworms.

The Palmate Newt

Distribution. Well distributed throughout Central and Southern Europe. Also present in the British

Isles. It is rather more widely distributed than many authorities state, but it is absent from some quite wide regions in this country. It is generally scarce in East Anglia, with the exception of East Norfolk, East Suffolk and Essex. It is also absent from Westmorland and Durham; while in Scotland it has not been recorded in Selkirk, Roxburgh and Berwick, nor in Wigtown or Ayr. In Wales, where it is commoner than the smooth newt, it seems to be absent from Montgomeryshire.

Habitat. Similar to preceding species.

Description and coloration. This is a small newt, seldom reaching four inches in length. The upper parts are brown or brownish olive with small darker spots; the head bears minute dark streaks. The under-parts are not very highly coloured, except the middle zone of the belly, which is orange. In the male the body has a rather quadrangular appearance caused by a fold of skin along each side which runs like a ridge from the neck to the base of the tail. Unlike the warty newt and the smooth newt, the palmate newt male does not grow a toothed crest in the breeding season, but it develops a low vertebral ridge of skin. This runs right down uninterruptedly to the end of the tail which terminates in a tiny spiky filament a few millimetres in length. Another definite male characteristic is the fact that in the breeding season the hind feet are very fully webbed with dark folds of skin; these webs are absorbed after the breeding season. The female does not have the same quadrangular body, the body being rounded but having a low vertebral ridge. The female palmate newt is very difficult to tell from the female smooth newt, the point to be remembered being that in the palmate newt the skin under the chin is a clear pale transparent creamy colour, and is unspotted; whereas in the smooth newt this region is covered with small dark spots. The female also has a small filament at the end of the tail, but this is sometimes so minute as to be almost invisible.

Special treatment. Similar to preceding species.

Breeding. Also similar.

Food. Also similar.

The Common or Smooth Newt

Distribution. Widely distributed throughout Europe, with the exception of the South of France, Spain and Portugal. Also widely distributed throughout Great Britain, with the exception of North-east Scotland, West and Mid Wales, and possibly extreme West of Cornwall and South-west Devon. In Ireland it is very locally distributed, being present mostly in the Mid-western Counties.

Habitat. Similar to preceding species.

Description and coloration. Larger than the palmate newt, but smaller than the great warty newt, the smooth newt grows to a length of about four inches in the males, the females being slightly smaller. In coloration there is a tremendous variety. It is possible to have a tank with as many as fifty newts in it with hardly any two being marked and coloured exactly alike. In general the upper parts are brown, pale brown or olive, plentifully sprinkled with darker spots; these are large and rounded in the male and smaller in the female. The under-parts of the males are yellowish or orange with large round black spots; in the female the colouring is less vivid and the spots are much smaller. The tail of the male is normally bordered in red above with a pale blue line which is broken up by black spots, while the tail of the female has a uniform orange edge on the lower side. During the breeding season the male grows a really beautiful crest and is really much more entitled to be called the crested newt than the species which has been given that name. This crest runs right down from the nape to the end of the tail and is uninterrupted; it is toothed, though not so sharply as in the warty newt, and is beautifully patterned with dark spots. The female of course does not bear this crest.

Special treatment. Similar to preceding species.

Food. Also similar.

The Alpine Newt

Distribution. France, Belgium, Holland, Germany, Switzerland, Austria and Italy.

Habitat. Similar to preceding species.

Description and coloration. Maximum size four and a half inches in length. In coloration the upper parts are darkish brown, sometimes black, sometimes even greyish. Occasionally marbled with a darker hue. A row of small black spots on a whitish ground along the sides. In the breeding male these spots are bordered below by a sky-blue band. The under-parts are a beautiful orange or red, unspotted except for the throat which occasionally has black dots. In the breeding season the males develop a long low straight-edged crest running uninterruptedly from behind the eye to the tip of the tail.

Special treatment. Similar to preceding species.

Food. Similar.

The Marbled Newt

Distribution. France, Spain and Portugal.

Habitat. Similar to preceding species.

Description and coloration. This is one of the most beautiful of the newts. In size it sometimes reaches a length as great as that of the warty newt. In general shape it is rather flatter and stouter than the other species described. In colour the marbled newt varies a great deal, but is generally a beautiful olive green above, marbled with black. In the breeding season

the male develops a large straight-edged crest which is interrupted suddenly at the junction of the tail and the body. The males also develop a silvery-white band along the side of the tail. The under-parts of both sexes are brown or greyish, sometimes with darker spots with white centres.

Special treatment. Similar to preceding species.

Food. Also similar.

SALAMANDERS

Salamanders are newt-like amphibians, and the family contains a great many species, many of which do well in captivity, but only one or two of which need be described in detail. The breeding habits vary considerably, some laying eggs, some producing quite well developed living larvæ, while some, like the axolotl, have the peculiarity that they can actually breed in the larval state. With the exception of the last named, salamanders do well in a damp, mossy environment, but they are on the whole rather dull pets as they are very secretive and nocturnal.

The Spotted Salamander

Distribution. Widely distributed over most of Europe and Northern Africa.

Habitat. Damp places.

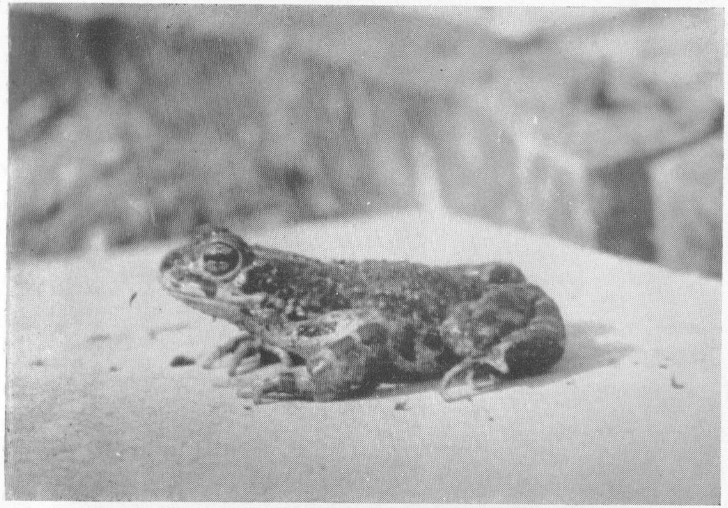
Description and coloration. This is the commonest salamander and is the one most likely to come into the possession of the amateur, as it has been bred freely in this country in captivity, and does well under artificial conditions. In size it will reach a length of six or seven inches, or even a little over. The ground colour is black, with bright yellow or pale orange mark-

markings on back and sides. In general appearance it is like a large stoutly built newt without, of course, the breeding crests.

Special treatment. These salamanders do not like extremes of heat but are very tolerant of cold, and can be quite easily kept in an outdoor enclosure, though I do not think this is very suitable as they are seldom likely to be seen. Their vivarium should be covered with moist earth and peat moss, with perhaps some growing moss as well, and an adequate water vessel should always be provided. They must also have a suitable flat stone or piece of bark under which to retire.

Breeding. If it is wished to breed this species it is better to have the tank in which they are kept filled to a depth of about four inches with water, with brick- or stone-work so arranged that the salamanders can emerge from the water if they so wish. This species is ovoviviparous. When the female from her size seems about to produce young, she should be provided with some clean " soft " water. The young, which are born in the larval state, vary from a dozen to twenty at one birth. These are sometimes given birth to in the water and sometimes on land; but when the latter birth takes place they seldom seem to survive. As soon as they are born the adults must be removed or they will immediately make a meal of their own off-spring. The young at first are about an inch in length, of a very pale brownish colour covered with darker spots. They should be fed on minute water creatures, such as daphnia. As with the newt larvæ, when metamorphosis approaches, the fore-legs will develop first, then the hind limbs, and finally the external gills will be absorbed. When this stage is reached, care must be taken to see that the young salamanders can escape from the water, and as soon as they come on to land they must be provided with very small garden worms.

Food. Nearly all soft-skinned insects will be taken, but earthworms should form the principal diet.



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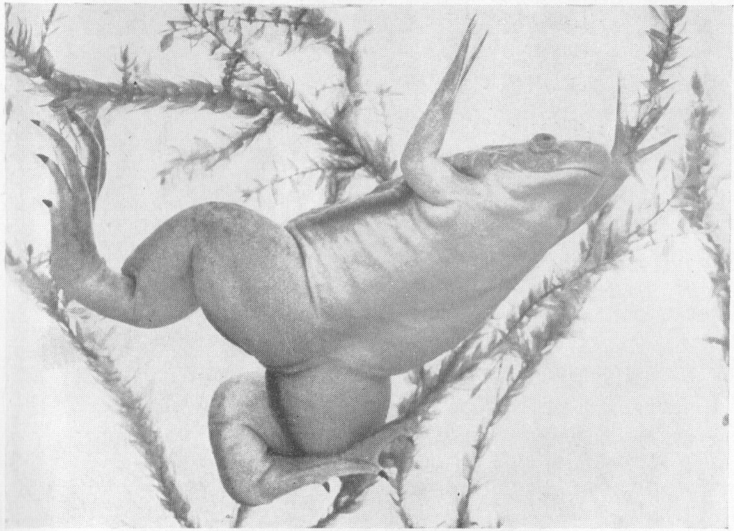
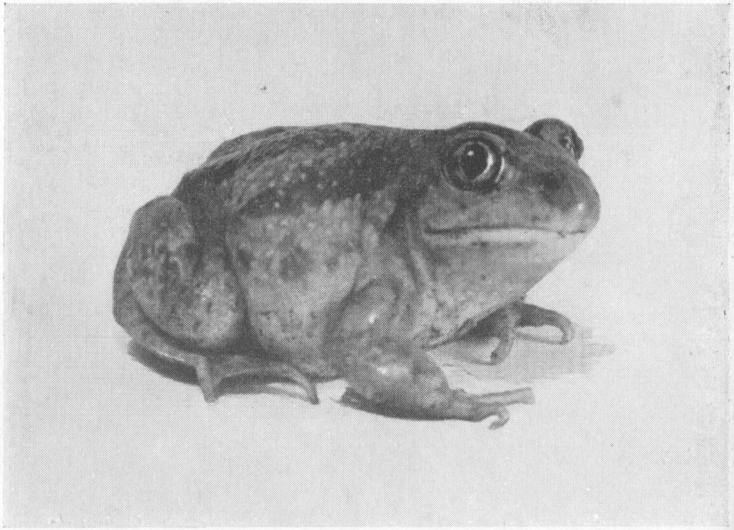
Green Toad.



[*Lionel E. Day, F.R.P.S.*

African Clawed Toad.



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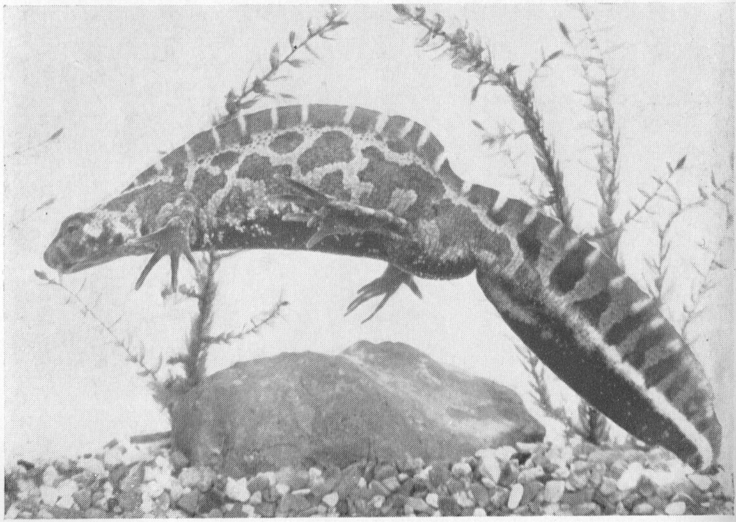
European Spade-foot Toad.



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Marbled Newt.

The Black or Alpine Salamander

Distribution. Alpine regions.

Habitat. Similar to above, but of course at high altitudes.

Description and coloration. In shape it is very similar to the spotted salamander, but it is smaller in size, seldom exceeding four inches, and is perfectly black in colour. It is much more terrestrial than the foregoing one and only resorts to the water for literally a few hours for the purposes of breeding.

Special treatment. Similar to preceding species.

Breeding. The young of the black salamander are born fully developed, though only one or two young are produced at a time. The adult, of course, should be removed and the young fed on very small earthworms or small slugs. The young grow very quickly and will attain their full size in less than two years.

Food. Similar to preceding species.

Other Similar Species

The Caucasian salamander.
The Spanish salamander.
The Spectacled salamander.

The Axolotl

The axolotl or amblystome is a native of North America and Mexico; the species which is easily obtainable in this country being known as the common axolotl or tiger salamander. This is the salamander which breeds in its larval state; in fact the specimens to be obtained in this country resemble enormous larval newts. By reducing the amount of water in their tank, and by liberal feeding, the axolotl can be induced to metamorphose, when it will absorb its massive feathery gills and emerge on to land and take up its life as a normal salamander.

Distribution. North America and Mexico.

Habitat. Lakes and ponds.

Description and coloration. In its usual larval form the axolotl will grow to about ten or eleven inches in length, and in coloration is either a bluish black or dark brown, sometimes greyish; while an albino variety has been bred. If metamorphosis is induced, the resulting salamander has black upper parts spotted or blotched with yellow; the under-parts being greyish, sometimes dotted with white.

Special treatment. If it is wished to keep the axolotl in its larval state, I consider that they do best in an ordinary aquarium tank containing about eight inches of water. In my opinion it is useless to try and decorate or plant the tank since gravel or stones at the bottom merely serve to prevent uneaten and dead worms being seen, while water plants will simply be up-rooted by these vigorous creatures. While they are tolerant of wide ranges of temperature, they will feed better if kept at a temperature of sixty or sixty-five degrees.

Breeding. If breeding is to be embarked upon, some vegetation will have to be provided, and the best plant to introduce into the tank is one known as willow moss. This grows very thickly in a bunch, and the best way of arranging it is to cover the bottom of the tank with well washed sand and anchor clumps of willow moss to some large stones, making sure that the roots are held well down by the weight of the stones. Then in late winter or early spring the eggs, which will vary from fifty to two hundred, will be deposited. These will hatch in anything from a fortnight to three weeks, according to the temperature of the water; and as soon as the tadpoles appear the adults must be taken away. It is also a good idea to have several small tanks

to accommodate the tadpoles, as if they are over-crowded and under-fed, they will not only attack each other but may develop fungus. To begin with, the tadpoles should be fed on daphnia or small aquatic fly larvæ; while later, on blood-worms, which are the larvæ of a species of gnat, make an excellent food. As they develop, the tadpoles may be put on to a diet of small earthworms. If well fed the young axolotl will become sexually mature at about twelve months.

Food. The food for adult axolotls, or for the mature tiger salamander must be plentiful. Earthworms are the easiest to come by and are eaten in considerable quantities, but they will also take dragon-fly larvæ, frog tadpoles or small newts.

PART TWO

COLD WATER AQUARIA AND GARDEN PONDS

CHAPTER ONE

INTRODUCTORY

PART TWO of this book is intended to be a general guide to those who may wish to set up some cold water aquaria, or even indulge in the luxury of a garden pond. Scores of books have been written on this subject, many of them really excellent; and it is of course impossible to deal with the whole of this subject from A to Z in what is, after all, only a portion of one book. But it is hoped that the principles to be laid down will be adequate for the purpose of initiating a newcomer into the fascinating and educative study of cold water fish. In the list of books at the end of the volume will be found several titles which will enable the beginner to improve on the knowledge he has gained, and I feel that enough will have been achieved if this part of the present book introduces some fresh enthusiasts to the world of aquaria.

In the ensuing chapters much more space has been devoted to the setting up and care of aquaria than to the inmates. This is partly because of limitations of space and partly because a long list of fish which differ but little in their individual treatment is, in my opinion, no great recommendation. It is the basic rules of aquarium and pond keeping that matter. If these are properly carried out, all the more usual cold water fish may be kept successfully.

I am frequently asked—" What is meant by cold water fish? "—and although this query may seem elementary it is perhaps worth devoting a little time to its discussion. I think a reasonable definition is that for the purposes of the aquarist a cold water fish is one which can be kept in an aquarium in an ordinary house without any artificial means of raising the temperature. Most tropical fish require to be kept at a temperature of not less than 70 degrees Fahrenheit, and to maintain this temperature artificial methods of heating are of course absolutely necessary. In spite of this definition, however, I am not at all sure that aquarists would not be more successful if they could manage to maintain their " cold " tanks at an average heat of a little above 50 degrees Fahrenheit; for although a given quantity of water at this temperature will support fewer fish than an equal quantity at a lower temperature, it is a fact that most illness among fish is caused or promoted by either too low a water temperature, or by sudden changes of temperature. This point will be more fully dealt with later on.

CHAPTER TWO

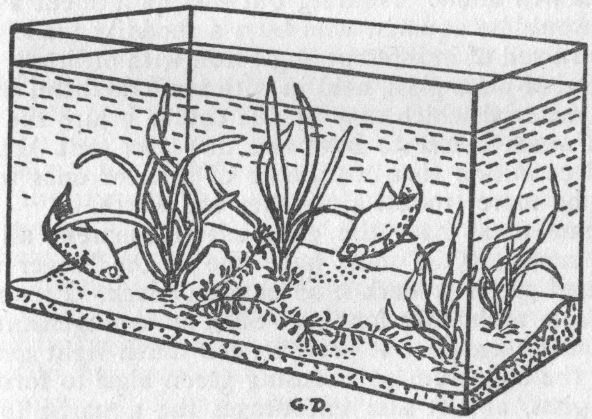
SETTING UP THE AQUARIUM

I THINK it is a good idea first to consider the question of what an aquarium is meant to be. It should, I think, be designed to represent a small section of under-water life including fish. It therefore follows that if this is to be the aim of the aquarist an effort should be made to reproduce as accurately as possible the conditions of nature. The aquarium should look like a section, as it were, of a pond or stream ; and not, as even to-day so many are, a tank full of doubtfully clean water ornamented with dreadful little artificial castles and sunken ships which make the whole look more like a mid-Victorian mantelpiece than a well set up aquarium.

What then are the natural conditions which the aquarist must try to reproduce? In the first place he must have adequate space in relation to the number of fish, for in nature no fish really thrive if they are overcrowded. Next he must have an aquarium which is properly " balanced ". This means that the relationship of water, fish and plant life should be adjusted so that the maximum good is possible for all.

First things coming first, therefore, let us begin by dealing with the tank itself. Practically any decent sized glass vessel can serve as an aquarium so long as it is not round. It ought not to be necessary in these enlightened days to condemn once again that abomination of all aquarists, the *fish bowl* ; but in spite of repeated warnings in countless books these horrible things continue to be sold. They are bad in every way and little more need be said on this point. Naturally the best type of aquarium is a properly constructed article made of steel framework with plate glass sides ; but even a large battery jar can make quite an effective

aquarium so long as it is remembered that area of surface is much more important than depth of water. Should a battery jar be utilised it will be necessary to have a considerable depth of sand at the bottom in order that the depth of water may not be out of proportion to the surface presented to the air. This is because, quite apart from any oxygen which may be given off by the plant life in the aquarium, water actually absorbs oxygen from the atmosphere. It is clear then that the greater the surface exposed to the air the more oxygen will be absorbed.



Aquarium. Sagittaria, Vallisneria, Elodea

Individual aquarists will obviously differ in their ideas and their means, and so it is not much use laying down rules about the number or size of tanks in a haphazard way. What the amateur wants to know is how many fish, no matter of what species, he should keep in the tank which may be available to him. This is a problem which was settled many years ago by successive fish experts who worked out that a gallon of water should be allowed to each inch of fish. This means that a twelve-gallon tank, for instance, would accommodate six fish of two inches in length, or four fish of three inches in length. This is quite a reliable guide, and if this rule is adhered to, no difficulty will be experienced in working out the population for any size of tank.

Properly manufactured aquaria are made to various dimensions; such as 36 in. long, 15 in. deep and 15 in. wide; or 18 in. long, 10 in. deep and 10 in. wide; or 24 in. long, 12 in. deep and 12 in. wide. The point to be emphasised in this connection is that the ideal tank should be roughly twice as long as either its depth or its breadth.

It is always economical to buy the best aquarium that funds will allow. Nothing but disappointment awaits the would-be aquarist who buys a shoddily made tank constructed of indifferent angle-iron with ordinary glass instead of plate glass, held in with some doubtful putty-like material which may in due course injure the fish. It is much better to have one first-class tank kept in good condition than a number of inferior ones which will be more trouble than they are worth.

Some tanks have the glass left transparent all the way round, while some have one of the longer sides painted green or dark blue or even black. Personally I have a preference for this. Such an arrangement has the advantage that it prevents too much light getting into the aquarium and causing green algæ to form on the glass, and it also encourages the aquarist to use top lighting of an artificial nature for illuminating the aquarium at night. This top lighting is very decorative in addition to having a mildly stimulating effect on plant growth.

SETTING UP THE TANK

A suitable tank having been acquired, the next thing to do is to consider its setting up; and before anything is done in the nature of sand or compost, or plants or fish, it is highly desirable to test it for leaks and see that the inside is thoroughly cleaned. I therefore

recommend that the aquarium should be filled with clean water up to within an inch of the top, having first stood the aquarium on an absolutely dry sheet of newspaper. Care should be taken in filling the tank to see that no water is spilled over the side on to the paper. Having filled the tank, leave it for, say, half an hour, having first made sure that there is nothing in the nature of a major leak. When this time has elapsed have a good look round all the seams—that is, where the glass is fixed in to the angle-irons, and, of course, all round the bottom. If there is an appreciable amount of water finding its way on to the newspaper the leak must be traced to its source, and if necessary the tank should be returned to the supplier for repair. If all that can be seen is a faint film of water on top of the cementing substance used for fixing the glass, no alarm need be felt, for this very often happens with a new aquarium. A piece of blotting paper should be pressed on to the portions showing moisture and the tank left for another half hour. If no increase of moisture is apparent the tank may be safely left all night, after once more taking up the moisture with some more blotting paper. On inspecting the next morning there should be no more than the original film of moisture. It should not have trickled down the iron on to the newspaper. If all now seems to be in order, then have a look at the surface of the water by glancing along it at an angle. If it is free from anything in the nature of a faint oily film or scum, then you are ready for the next stage.

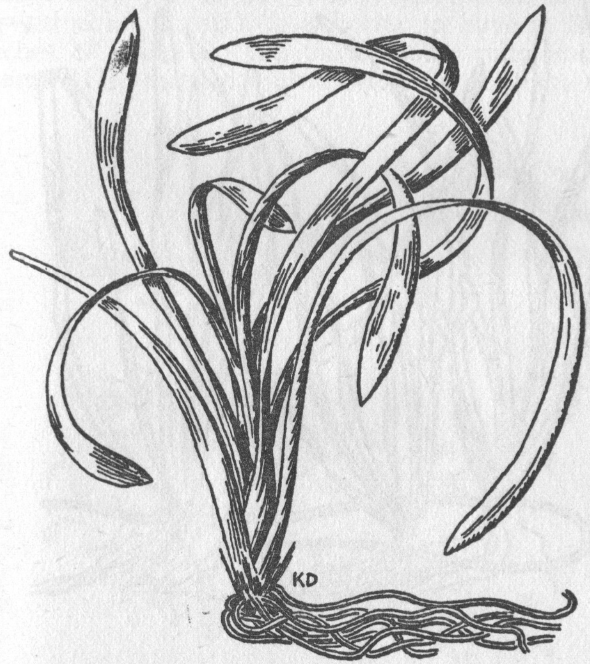
The water should be syphoned out, not poured by tilting the tank; and when the tank is empty it should be cleaned out by wiping it well all round with a clean non-hairy cloth. Now the real business begins, and the bottom of the aquarium may be covered with whatever compost is going to be used. There are many ready-made up composts on the market and most of these are perfectly satisfactory. Personally I have a distinct prejudice in favour of fine sand of the type which may be purchased at any good aquarist stores. In spite of the fact that the bag in which it is supplied usually describes it as "well-washed sand", no notice should be taken of this and the sand should be thoroughly washed again before being introduced into the aquarium. This washing is best done in a big basin, and the method I use is as follows: About half fill a basin with sand; stand the basin in a sink under a tap; let the tap run fairly fast, but not too fast, into the basin, and stir the water up with a wooden spoon. All sorts of dust and bits and pieces will emerge from the sand when this is done. When the basin is just about to overflow, turn off the tap, give a few extra stirs, then tilt the basin and allow the water, together with the floating debris to run away. Repeat this process at least three times. Then put the sand which is by now thoroughly clean into the tank. Repeat with the remainder of the unwashed sand until you consider you have enough to cover the bottom of the aquarium to a depth of at least two inches, preferably a little more.

When you think you have sufficient sand in the tank it should be arranged so that the sand at the back of the tank is a little higher than the level of the sand in the front; that is to say, it should gradually slope from the back down to the front. This is in order that when the fish are introduced waste products and debris will tend to go towards the front of the tank, thus making their removal easier. It is also a good idea to see that the sand is not absolutely dead smooth all over the bottom. Let it undulate a little; this will eventually give the tank a much more natural appearance.

PLACING THE AQUARIUM

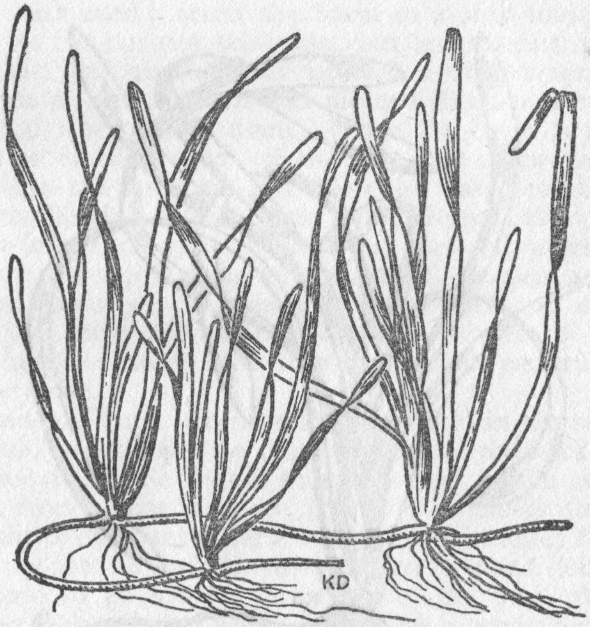
When the tank has been proved to be satisfactory and water-tight it should be placed in position before introducing the compost or the water. Some care must

be taken with regard to the location, and its position in the room must be chosen with the question of light well to the forefront. If there is not enough light, then the plants will not produce sufficient oxygen, and consequently will not thrive. If there is too much light, however, minute green algæ will cover the inside of the



Sagittaria

glass and eventually obscure the inmates. If the back of the tank is painted as has been suggested, this will help to control the amount of light, and with an aquarium treated in this fashion it is quite all right to place the tank in a window. If such a situation is not available and the tank has to be placed away from the light, it will be necessary to provide some form of artificial lighting which can be switched on for, at the very least, four hours a day. There are on the market many metal covers for aquaria which incorporate an electric light bulb or bulbs ; but if this expense is not desired, the same result can be obtained by covering



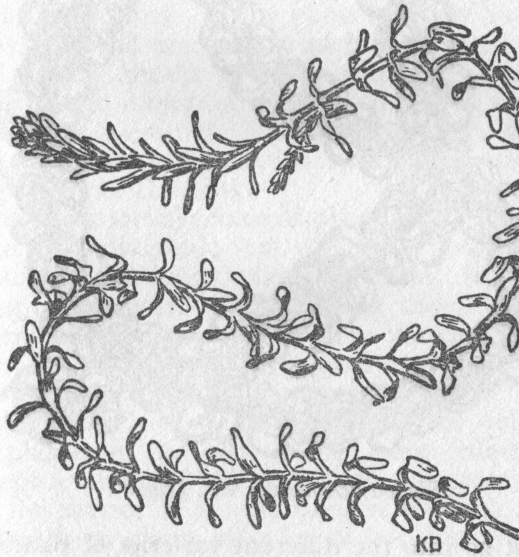
Vallisneria

the tank with a piece of plate glass which should be rested at the corners on four triangular pieces of cork cut from an old cork mat. This will keep dust out of the aquarium and yet allow sufficient air to circulate under the glass. Over this glass an ordinary adjustable reading lamp may be placed. The light should be fairly close to the top of the glass but not, of course, touching it ; and if a well-adjusted shade is used in

conjunction with the lamp, a forty watt bulb will be quite adequate for a tank twenty-four inches long.

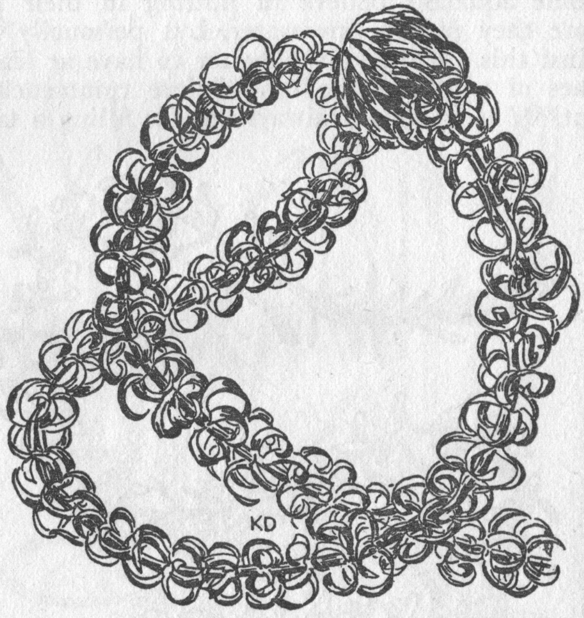
FILLING THE TANK

Some aquarists believe in putting in their plants before they put in any water, but personally I am against this. I think it is better to have at least six inches of water in the tank before commencing to plant. The method I always use for filling a tank is



Elodea canadensis

as follows. Get an ordinary saucer and place it in the centre of the aquarium. On this saucer put a two pound jam jar ; then commence to pour in the water, either through a hosepipe or from a jug. Pour the water into the jam jar, but not too vigorously. The jar will of course overflow into the saucer and then out into the tank. By using this little device it will be noted that the sand at the bottom is not stirred up and the water will remain clear. When sufficient water has been introduced to come level with the top of the jam jar, take out the jam jar and saucer. If desired your plants may now be put into place. At this stage



Elodea canadensis var. *crispa*

I will not go into the different varieties of plants suitable for an aquarium, but I will just deal with basic principles.

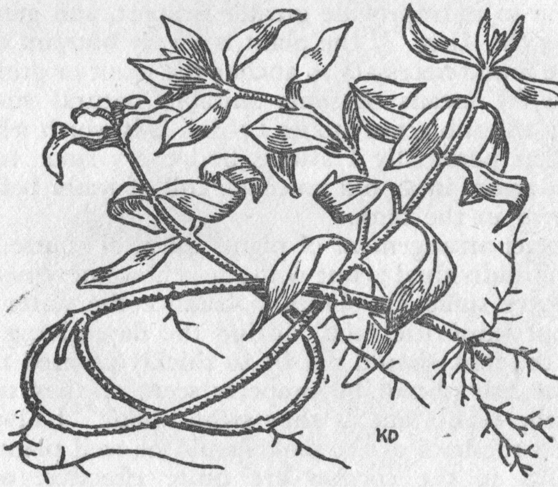
Aquarium plants may be roughly divided into those which have a number of long rootlets and those which are self-rooting; that is to say, those which can be simply broken off from a big clump and planted in the sand and left to take hold themselves. Whichever type of plant you are going to use your procedure should be

the same, and for this job you will require one, or possibly two, planting sticks. These are easily made from a strip of wooden lath about half an inch wide and long enough to be manipulated easily. At one end of the stick cut a V-shaped notch; then, having taken your plant and decided exactly where you wish to place it, let the plant float for a moment at the top of the water, then press it down with the notched stick and work it gently about until the bottom of the plant, or the roots, as the case may be, are firmly embedded in the sand. Then, with the other stick arrange a little extra sand so as to provide greater support, and gently take away the stick. If the plant is a very buoyant one it may be found necessary to anchor the plant or groups of plants by means of some suitable natural stone. While on the subject of stones I think it is worth while stating that personally I always boil every stone used in an aquarium in an old saucepan full of water before using them in the tank.

The exact arrangement of plants must, of course, be left to the individual; but while it is absolutely necessary to have sufficient plants to balance the water by taking out impurities and, during the day, giving off oxygen, the tank should not be so thickly planted that either the fish cannot be properly seen, or they tend to pull the plants out as they swim about. I always think that the back of the tank should be well planted, and plants in the corners are quite effective, with perhaps a clump of one of the more decorative species near the centre. The very front of the tank should be left free from plants in order to facilitate cleaning.

SUITABLE PLANTS

Vegetation for the aquarium can of course be collected from ponds and streams in your neighbourhood, or they can be purchased from aquarist stores. There is, I think, some advantage in purchasing from a reputable dealer, for most of the plants supplied by the trader have actually been grown artificially and are less likely to harbour harmful creatures such as leeches. If, however, the aquarist wishes to economise and collect plants himself, it is a good plan to disinfect them before their introduction. This should be done by immersing the plants in a solution of potassium permanganate. The solution should be in the proportion of half a teaspoonful to two gallons of water. The plants should be left in this solution for about an hour,



Ludwigia

after which they should be washed in clean water until no trace of colour remains. They may then be safely put into the aquarium.

The following plants are good oxygenators: *sagittaria ; vallisneria ; elodea.* The last of these is the common Canadian pond-weed which has become such a pest in many of our British ponds. It spreads rapidly and sprouts quite freely, while it has the advantage that any piece a few inches long may be broken

off and successfully planted. It is probably one of the best oxygenators of all. For more decorative vegetation *ludwigia* or *ceratophyllum* may be used.

Now, while on the subject of plants it must be borne in mind that to thrive, water plants require adequate light. When this light can come from the top it is, in my opinion, much better ; and the health of the plants and an indication as to whether they are getting suffi-

Ceratophyllum

cient light, can be gauged by seeing whether they remain nice and upright in the water and maintain their vivid green hues. If they droop or tend to turn brown something is wrong, and they should be replaced.

When the aquarium has been going for some time and its fish population has settled down, it will be noticed that a sort of light-brown deposit will form on the bottom. This is known to aquarists as "mulm" and is composed of small particles of the excreta of the fish, small bits of vegetation in natural decay, etc. If not excessive this mulm is useful in promoting growth of the plants and can be left where it is unless it becomes so heavy as to stir up every time the fish swim about, thus making the water look dirty. If this does happen the mulm can be syphoned off the bottom with a small rubber tube.

Fontinalis antipyretica

If the foregoing hints are borne in mind the aquarium should become well-balanced and it will be quite unnecessary to change the water in the tank, except of course to make up for natural evaporation. The aquarium should be finally filled up to within an inch from the top of the tank by holding the saucer

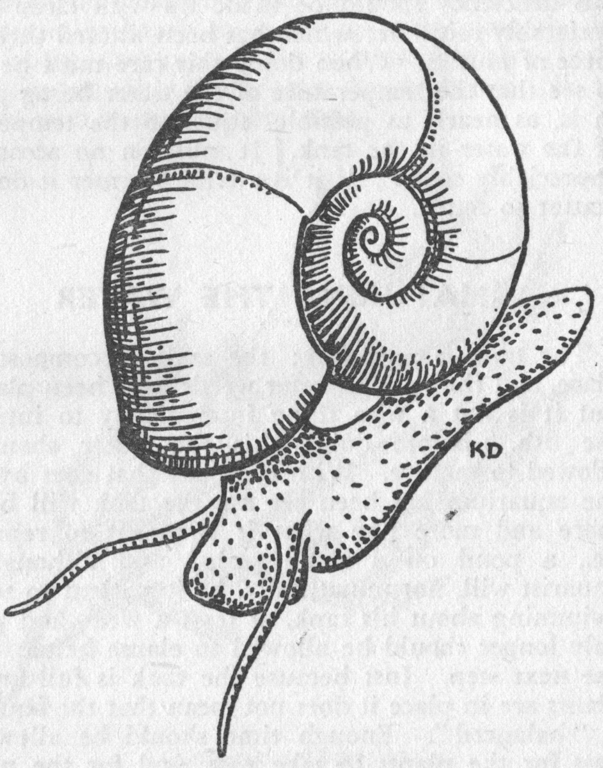
referred to before just above the level of the water and pouring water into the saucer when it will trickle over the edge, and the aquarium will be filled without disturbing either the sand or the plants. As time goes on the level of the water will of course drop a little, and this deficiency should be made up with clean water, preferably rainwater which has been filtered through a piece of muslin. When doing this care must be taken to see that the temperature of the water being poured in is, as nearly as possible, equal to the temperature of the water in the tank. It must on no account be appreciably cooler; if it is a trifle warmer it does not matter so much.

MATURING THE WATER

The tank is now full; the sand or compost is in place, and the various water weeds have been planted; but it is not a wise thing immediately to introduce the fish. Before doing this the water should be allowed to mature. With each day that goes by, once the aquarium has been set up, the tank will become more and more like what it is meant to represent, i.e., a pond on a small scale; and although the aquarist will, not unnaturally, be impatient to see fish swimming about his tank, at least a week and preferably longer should be allowed to elapse before taking the next step. Just because the tank is full and the plants are in place it does not mean that the aquarium is "balanced". Enough time should be allowed to pass for the plants to take root, and for the natural processes under water to function. This is unlikely to happen in less than seven days. During this waiting period the aquarist can test the general efficiency of the aquarium by observing whether the plants look as though they are settling down; or it may be that they may require some re-arrangement, and this is obviously better done when the tank is without fish.

There are other things, too, which may profitably be done while waiting for the water to mature.

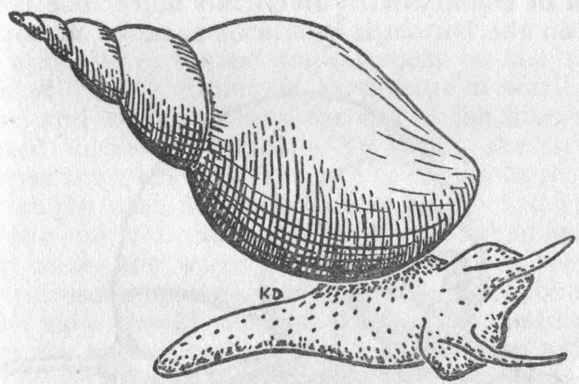
Reference has already been made to the algæ which will inevitably form on the sides of the tank to a greater or less degree, according to the amount of light. A



Ram's-horn (*Planorbis corneus*)

certain amount of this growth is in no way harmful; in fact it may be regarded as slightly beneficial, but it must be kept within bounds. One way to accomplish this is to introduce some pond snails. These useful creatures will not only do a certain amount of window

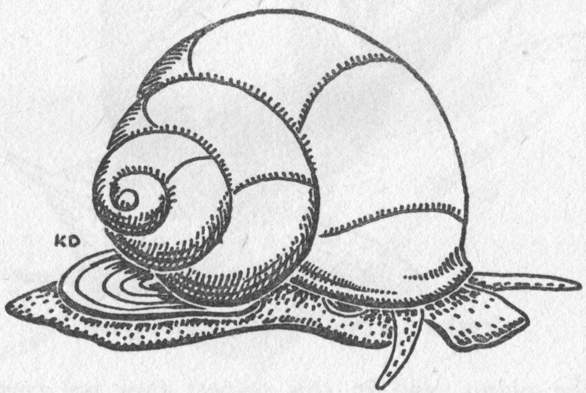
cleaning so to speak, but will perform other useful duties besides. The extravagant claims of the keepers of pet shops with regard to pond snails should be treated with great reserve. They are often advertised as being guaranteed "to keep the glass perfectly clean", "to eat up all waste products", etc., etc. This they will certainly not do; for they cannot be expected to clean off the algæ in such a perfect and symmetrical fashion as to satisfy the aquarist. Snails will, however, keep the algæ from getting too firm a hold on the leaves



Freshwater winkle (*Limnaea stagnalis*)

of the plants, and in this respect they are certainly useful. As to their general abilities as scavengers I am also a little doubtful. They will, of course, eat up a certain amount, but snails must not be regarded as an efficient substitute for a conscientious and clean aquarist. Some pond snails, far from doing any good, will only be a nuisance as they will pay far more attention to the plants in the tank than they will to their household duties.

The following species of snail may be recommended: the ram's-horn snail and the red ram's-horn snail are both good. These snails are not too big and are not great plant eaters. They may be recognised by having a flat shell of the usual coiled type. The freshwater winkle is also satisfactory. The freshwater whelk, which looks very like its marine relative, is a diligent worker but rather more inclined to eat the plants than the other species. An important point in connection with snails is not to introduce too many; for a ten or twelve gallon tank half a dozen snails is ample, and the aquarist will be wise always to know exactly how many snails are put into the tank, for a dead snail will pollute the water very speedily. They should be counted fairly frequently and if one is seen lying on the bottom it should be removed at once.



Freshwater whelk (*Paludina vivipara*)

The ram's-horn snails and freshwater whelk will lay their eggs on the weeds or on the sides of the tank. These eggs look like lozenge-shaped pieces of jelly, through the transparent sides of which the small ova can be seen. Unless the eggs are too numerous they may be left, as some fish are very fond of eating them. The freshwater winkle brings forth its young alive, and when really small these will also be eaten.

Since we are now dealing with scavenging it is just

as well to consider a task which will have to be faced from time to time: the periodical cleaning of the tank. This, of course, will not be necessary for some little time, but it will have to be done when the mulm on the bottom becomes excessive, or when the algæ on the sides requires more attention than the snails can give it. With regard to the mulm, this may be syphoned off the bottom by means of a piece of rubber tubing about half an inch in diameter and of sufficient length that the end inside the tank shall be just clear of the bottom, while the outer length should reach well below the level of the bottom of the tank; in fact it is as well to have it sufficiently long for it to be directed into a bucket. A great improvement on the simple piece of rubber tubing is to procure a small glass funnel and insert that into the end of the tube which is used inside the tank. To work the syphon, immerse the whole of the length of tubing in the tank and let the tube fill itself with water by first closing the long end with thumb and finger, and then opening it up under the water. Unless the tube is too long this will usually prove quite effective. The rubber end of the tube should then be pinched shut while still under the water, lifted out and brought down to below the bottom of the aquarium and over the bucket. If the finger pressure is then released, the water should begin to trickle out; the end in the tank with the funnel attached can now be gently moved about according to where the mulm is thickest. If any difficulty is found in starting the syphon, water can be sucked up the tube with the mouth, but some little practice is required in order to prevent a jet of fishy water being swallowed by the inexperienced!

In addition to some form of syphon a simple apparatus for scraping the sides of the aquarium is essential. An excellent device can now be purchased from any aquarist stores. This consists of a metal rod with a holder at the end to take a safety razor blade. This holder is set at such an angle that with the blade in position the scraper can be moved up and down the glass, and it will be found that the algæ will come off quite cleanly. The loose algæ can then be removed with the syphon.

Another useful appliance is a long pair of wooden forceps. These may be purchased, or they can be quite simply made by shaping two long pieces of pliant wood into the form of two blades, the broad end of the strips of wood being screwed or wired to a small block of wood or a cork in order to give some spring. These will be most useful for removing bits of dead plant, uneaten worms, dead snails, etc. Special aquarist's thermometers may be purchased quite cheaply. These are constructed in two patterns—one to fasten on the sides of the aquarium with a rubber sucker, while the other is weighted at the base so that it floats. Personally I prefer the former, as the weighted kind have an infuriating habit of drifting away behind plants, or turning round so that the temperature cannot be read. One last little gadget perhaps deserves mention, and that is a floating food tray or cup. These are little domed receptacles, now generally made of perforated celluloid with the outer rim made of cork. Practically any form of fish food can be placed in these. A pinch of dried food will gradually find its way out through the holes, ably assisted by the buffetings of the fish, while bloodworms or white worms may be placed in the tray and allowed to wriggle out.

A certain amount of light scum may eventually form on the surface of the water. The usual method of removing this is to cut a sheet of ordinary newspaper to the same size as the surface of the water; after which it is gently placed flat on the water and drawn along the surface. If one operation of this kind does not remove all the scum repeat in the opposite direction with another piece of paper. Many aquarists, however, prefer to have some floating weed in the tank, and if this is desired by far the best species is the small water plant known as Riccia. The common duckweed will do, but it has the disadvantage that it spreads amazingly rapidly and, being very difficult to disinfect, it is liable to harbour parasites. It may be mentioned in passing that a floating weed also serves the purpose of keeping down the amount of light in the event of the aquarium having been placed where direct sunlight can get at it. This however should not be interpreted as a suggestion that the aquarium should be in perpetual gloom. As I have said before adequate light, but not too much, should be the aim of the aquarist.

AERATION AND FILTERING

Nearly all tropical fish keepers now use some form of artificial aeration of their tanks, and although I think this is not absolutely necessary with a cold water tank the practice has much to commend it. Briefly, the system used is to purchase one of the many excellent commercial aerators which can be plugged into the electricity mains. This aerator is connected up on its output side with a rubber tubing, which in turn is connected either to a glass tube or a tube made of some waterproof composition ; at the bottom end of this is a porous stone through which the air eventually escapes in the form of minute bubbles. When the apparatus is working the bubbles rise in a continuous stream which not only aerates but circulates the water in the tank. While producing generally beneficial results this also much improves the look of the aquarium and makes the whole thing seem more " alive ". These commercial aerators are amazingly efficient, and even the smallest will serve more than one tank ; their consumption of current is almost negligible. If a further refinement is desired the rubber tube, instead of being connected to the ordinary aerator, can be connected to a very ingenious little celluloid tank filled with a filtering compound (generally sand and charcoal). This tank is so arranged that water is pumped from the bottom of the aquarium, up through a tube which dribbles it into the filter tank and out again into the aquarium after the impurities have been removed. If this filter is so adjusted that the output pipe is an inch or so above the level of the water, this apparatus both filters and aerates. Such a filter is not absolutely necessary, but it certainly does help to keep the tank clean and the water clear. The filtering material must of course be renewed from time to time.

INTRODUCING THE FISH

We must now assume that the tank is properly set up and any additions in the way of aerators or filters have been fixed and are working satisfactorily; the tank has been standing for a sufficient time, and the water may reasonably be considered to have matured. The fish may now safely be introduced. This sounds a simple procedure, but nevertheless it is one which will repay a little care and thought. The general principles for this operation remain the same whatever the species of fish may be; but greater care must be taken when wild fish are being dealt with than is the case when fish are being bought from a reputable dealer. Many of our native fish, such as small carp, tench, rudd and gudgeon do quite well in aquaria, and if the aquarist is also an angler they are not difficult to come by. However if they are to be caught they have also got to be handled and transported, and it is here that care is necessary. Everyone knows that fish are naturally covered with a film of protective mucus, and if this is wiped off or removed through rough handling the fish are very likely to develop fungus. Therefore, when they are being removed from the hook or from the net, as the case may be, they should always be grasped with a wet hand, or better still, held with a few pieces of smooth water weed in the hand. As little pressure as possible should be exerted, and they should be immediately placed into the largest possible receptacle for

their journey from the source of capture to the tank. There should also be no undue delay between the time of capture and their liberation from their temporary quarters. A few pieces of pond weed placed in the carrying can will help to protect the fish from being bumped about by restricting their activities. On arriving home it is not a bad idea first of all to transfer them to a temporary tank for observation. This tank may be half filled with rainwater, or if this is not available, tap water; and if possible the carrying can should be gently immersed in the temporary tank, being slightly tilted at the same time so that the fish can swim out of their can into the temporary tank without having to be handled again. Before doing this, however, make sure that the water in the temporary tank is within a degree or two of the temperature of the water in the carrying can. When the fish are in their temporary tank they should be examined as carefully as possible, and if any of them show any signs of frayed fins, or if they look very red about the gills—particularly at the edge of the gill cover—they should be discarded. Similarly if any signs of a white threadlike fungus is seen on the fish they also should not be used. It is perhaps not a bad idea to leave the fish in their temporary tank for a day or so to see whether they behave in a lively fashion, swim naturally, and are inclined to feed. If the aquarist can satisfy himself on all the foregoing points the fish may then be introduced into the aquarium proper. Here again scrupulous care should be taken with regard to the temperature of the two waters, and if all is well the best way of transference is to syphon off a certain amount of the water in the temporary tank, and then either net the fish in a small aquarium net—being as gentle as possible in the process—or better still induce the fish to swim into a glass jar or similar receptacle of their own accord. This may then be lifted out of the temporary tank, tilted slightly on the surface of the aquarium and the fish allowed to swim gently out.

FOOD

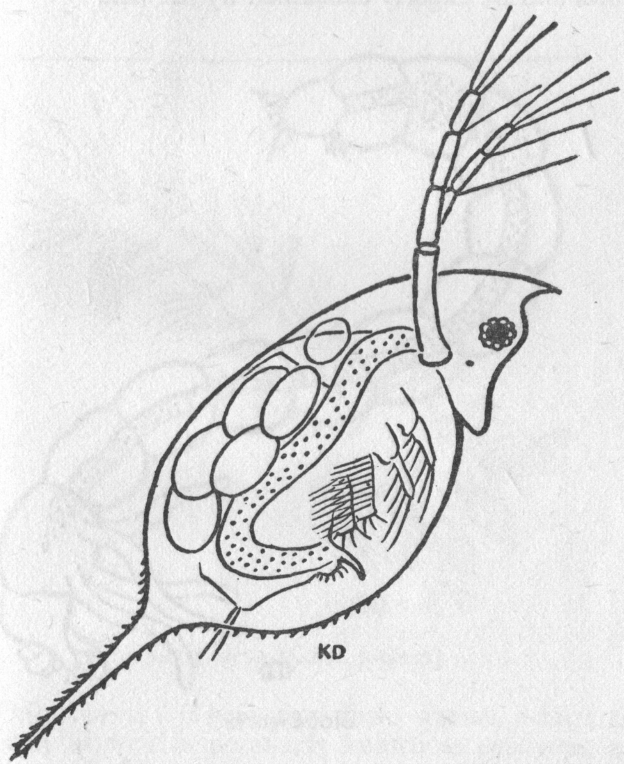
The fish are now installed, and with luck all should be well. The next thing that will occupy the mind of the aquarist is the question of food.

Feeding the Fish

As a general rule I have no hesitation in saying that the best food is natural food, and this in nearly every case means live food. A little live food with plenty of variety is a great deal better than a lot of artificial food, and I will therefore now give a list of the live foods which are obtainable and which I have found to be quite successful. Probably the most popular of these is daphnia.

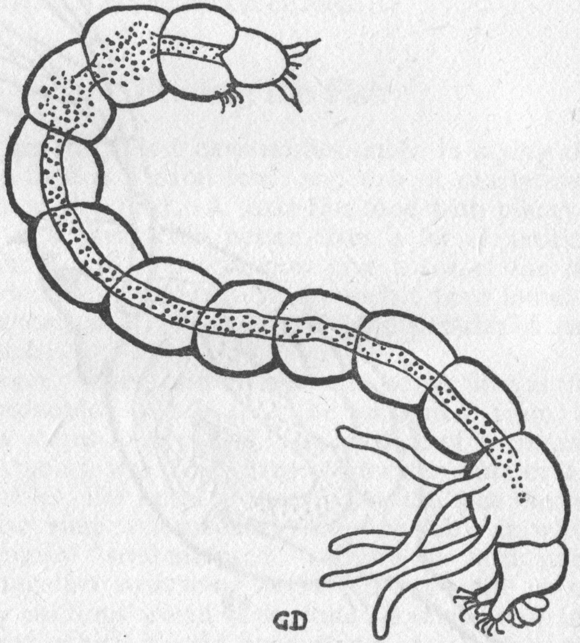
Daphnia. These minute creatures, water fleas as they are commonly called, may be obtained from all aquarist stores as required; or a stock of them may be kept going if a fairly large rainwater butt or tub is available. For keeping them going the best method is to have some well-matured water available in which some equally "well-matured" manure has been introduced, together with some well-rotted vegetable refuse. If a few shillings' worth of daphnia are introduced into this water, which should have plenty of light but not too much direct sun, they will breed quite satisfactorily and an adequate stock may be kept up. They may be collected as necessary by means of a small muslin net drawn to and fro through the water with a figure of eight motion. Daphnia, like some other live foods, have the great advantage that those which are not eaten at once remain to be eaten on another occasion.

Bloodworms. Although these may be found in some ponds and streams, among rotted leaves, they are much better obtained from a dealer. These bloodworms are



Daphnia

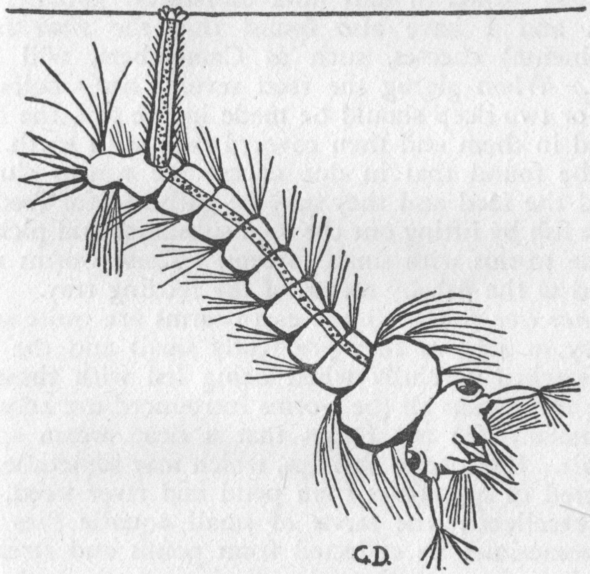
really the larvæ of a certain species of gnat. They are quite small and blood-red in colour. A small pinch of these worms should be placed in the feeding tray already described, when they will swim out through the holes and be eagerly consumed by the fish.



Bloodworm

Mosquito larvæ. If the aquarist has a garden rain-water tank or butt he is almost certain to have a supply of these available during all the warmer months. It is easy to tell if there are any there, for on approaching the butt little wormlike creatures with big heads will be seen suspended from the surface film on the water, and at the slightest disturbance they will wriggle away down into the depths. They can however be captured

in much the same way as daphnia. These little creatures are very delicate and it is much less trouble simply to immerse the net with the larvæ in it into the aquarium and let them swim out, rather than try to transfer them to a feeding tray.



Gnat larva (*Culex pipiens*)

White-worms. These tiny little worms, which are properly as well as popularly known as *enchytræ*, are relatives of the common earthworm. They may be obtained from aquarist stores, and with a certain amount of trouble they may be bred at home. The method to be adopted for breeding these is to procure a wooden box of not less than fourteen inches square and about six or seven inches in depth. This should be filled with rich garden soil, well sifted, and mixed with leaf mould. The stock which has been purchased should be scattered over this soil, after which a piece of glass should be laid flat on the soil. This is in order to maintain the correct degree of moisture, for if the soil is allowed to become dry the worms will die. They should be fed about twice a week and several methods of feeding may be adopted. Little squares of bread soaked in sour milk or mashed potatoes are good, and I have also found that the rind from Continental cheeses, such as Camembert, will also serve. When giving the food several little holes an inch or two deep should be made in the soil, the food placed in them and then covered over with earth. It will be found that in due course the worms cluster round the food and they may be gathered for feeding to the fish by lifting out the food substance and picking off the worms with small forceps. These worms may be fed to the fish by means of the feeding tray.

Other live foods. Small earthworms are quite satisfactory so long as they are really small and the fish are watched carefully when being fed with these in order to see that all the worms introduced are actually consumed. Do not forget that a dead worm spells trouble. Freshwater shrimps, which may sometimes be gathered in quantities from pond and river weed, are also excellent; the larvæ of small aquatic flies can also sometimes be collected from ponds and streams, though it is as well to familiarise oneself with the different species before feeding them indiscriminately to the fish. Any good book on pond life will serve as a guide for this purpose.

Artificial food. There are now on the market many dried foods which are quite suitable for aquarium fish, particularly if used as a stand-by; but these ought not to be regarded as a substitute for at least a certain amount of live food. Do not be deceived into buying cheap dried foods of unknown reputation. Any good aquarist stores will recommend a high-class product. These dried foods should be given very sparingly and it is much better to feed too little than too much.

Finally it must be borne in mind that the majority of cold-water fish are omnivorous and in their natural state consume a certain amount of vegetable food. This generally takes the form of nibbling small quantities of aquatic plants; and in a well-balanced and well-planted aquarium this will automatically be provided without any noticeable decrease in the vegetation.

CHAPTER THREE

DISEASES

IF a beginner consults an exhaustive list of the diseases from which cold-water fish may suffer it is highly likely that he will give up all ideas of being an aquarist; but because there is an imposing array of illnesses which may affect your fish it is not in the least inevitable that they should contract them. It may be as well, however, to refer to the list of the commoner complaints and to give some directions for dealing with those most likely to be encountered. It will be remembered that the point was made earlier on that sudden drops in temperature were very inclined adversely to affect the health of fish. This is primarily because when the drop in temperature occurs the fish rapidly lose condition, but it is also true that the organisms which cause some of the most fatal diseases become very active at low water temperatures, but do not thrive if the temperature of the water is raised. As a general rule the water temperature should not fall below 55 degrees Fahrenheit, and anything between 55 and 60 degrees should be quite satisfactory for most cold-water fish, particularly goldfish during the winter months. During summer months the temperature may possibly rise above this figure, but so long as the tanks are well stocked with plants and do not contain too many nor too big fish, little trouble should be encountered.

Whatever disease attacks one's fish, it is important to start treatment in good time, and for this reason anything very unusual in the behaviour of the fish should be noted at once. For instance, if the fins of a fish droop or do not stand upright when the fish is active, as in the case of the dorsal fin, then there is probably something wrong. If the fish rests on the bottom of the tank for long periods, or if it stays head downwards and almost motionless, trouble may be expected—while really eccentric behaviour, such as a fish which cannot rise to the surface or one which lies at the top of the tank belly uppermost, not only shows that something is radically wrong but will tell the aquarist at once that the sick fish is suffering from some abnormality in connection with the air bladder. The air bladder of the fish is a little sac filled with a gas, the chief component of which is nitrogen, and its purpose is to enable the fish to rise and fall or to swim at this, that or the other depth at will. The bladder performs its functions by altering the specific gravity of the fish; in other words the fish can become more or less buoyant when it wishes to do so. Generally speaking if the fish is really suffering from air bladder trouble it is better to be ruthless and put it painlessly out of its misery, for no real cure is known for this disease. On the other hand, de-arrangement of the air bladder is sometimes suspected when the real cause of distress is a much commoner complaint from which fish as well as most other creatures can suffer. This is constipation.

Constipation

The symptoms are usually sluggish behaviour, an undue amount of time spent at the bottom of the tank, and a distended abdomen. The cause is generally either over-feeding or, what is much more likely, too much feeding on artificial food. It will of course be necessary to effect some alleviation before thinking about preventing the recurrence, and this is best done by removing the fish gently to another small tank of water which may be at a temperature a few degrees higher than the tank from which it has been taken. This tank should be about half filled with a solution of half an ounce of Tidman's sea salt, or failing that, kitchen salt—*not table salt*—and half an ounce of Epsom's salts to one gallon of water. See that the water in this tank does not lose much of its temperature, and allow the fish to remain in it for not less than one day and not more than two days. During the whole of the period of treatment the fish should be starved. At the end of this time, or when the symptoms appear to have died down, the fish may be replaced in its own tank, care being taken, at least temporarily, to bring the water in the main tank up to the level of the water in the treatment tank. This may be done by adding very gently a small amount of warmish water to the tank. The next thing to do is to see that the fish have less artificial food and more live food ; and several authorities strongly recommend small earthworms as not only an excellent form of live food, but as a particular preventive of constipation.

Dropsy

A fish suffering from this disease presents very definite symptoms, chief of which is that the scales, instead of looking sleek and smooth and flat, become pushed out of place owing to the distension of the body and are seen to be standing out and presenting a ragged appearance. This disease is said to be incurable, and although fish will frequently live for months in this condition, my personal opinion is that it is better to do away with the fish. Little is known about the cause of the disease and therefore nothing much can be done about prevention. One comfort is however that it does not appear to be in any way communicable.

Consumption

Fish, like many other creatures, can develop a form of tuberculosis, and the symptoms are somewhat similar

to those shown by human victims of the disease. The fish loses condition, gets much thinner, goes off its food and generally looks as though it is wilting away. The disease is of course caused by a bacillus, but bad feeding and over-crowding are mistakes which lead to development of tuberculosis. Fish have been cured many times by moving the sick fish as soon as possible to a larger tank which should be well aerated artificially, and feeding it exclusively on live food. If the fish gets to the stage when it refuses even the most tempting living delicacies there is not much hope for it.

White-spot

This is probably the most sinister disease from which aquarium fish can suffer, and it is a very difficult disease to cope with, particularly as if drastic steps are not taken all the fish in the tank will contract it ; and even this is not the worst. If several tanks are maintained infection will spread to the other tanks unless sterilisation of every piece of apparatus used is not regularly undertaken.

The most marked symptom of the disease is the appearance on either the body or the fins, particularly the tail fin, of very small white spots. Very soon after the fish is affected it will lose condition, the fins will droop and if the gills have been attacked it will remain at the surface of the water and gasp. Before indicating any treatment it is necessary to give a very brief description of what causes the disease. White-spot is a parasitic complaint, and the parasite when it is in its free swimming state comes in contact with the fish and manages to break through the surface tissue. Having made this entry it remains, feeding on the vital portions of the tissue until it grows to maturity. When the mature condition has been reached the parasite breaks out from its covering of skin and leaves the fish. In this state it will swim about for a little time, finally settling on the bottom of the tank for the purposes of division. It divides into two equal parts which in turn divide again, and so on, and so on. Each of these minute creatures are provided with cilia (minute hair-like structures which enable the parasite to swim), and eventually all these young parasites emerge into the water again in order to seek out a fresh victim.

As regards treatment, there are two principal ways of endeavouring to cope with this disease; one is a temperature treatment, while the other is a chemical one. In the first place it was discovered some time ago in America that the white-spot parasite would not thrive at a temperature of 45 degrees Fahrenheit, while a temperature of anything over 85 degrees Fahrenheit also proves fatal. Now it is clearly foolhardy to expose one's fish to such a low temperature as 45 degrees Fahrenheit as the remedy will be likely to be worse than the disease. On the other hand, it must be borne in mind that a temperature of 90 degrees Fahrenheit is getting near to the extreme for most cold-water fish, particularly the goldfish; for at this temperature a great deal of the oxygen is removed from the water. An effort must be made, therefore, to strike a happy medium, and the best way of doing this is to find some means of raising the water in the tank at first to a temperature of about 70 to 75 degrees Fahrenheit. After about half a day this temperature can be increased another five degrees or so. When the temperature is getting towards the 90 mark the fish must be watched very carefully for the reason already stated; and if they show signs of great distress steps must be taken to aerate the water very fully, either by means of the mechanical pump referred to before, or by taking out a certain amount of the water in a small vessel and pouring it back slowly into the tank. This treatment is of course difficult as it is dependent upon having the requisite means of producing high temperatures, but at least it can be said that the treatment is effective.

The other treatment, which is a chemical one, consists of using a solution of the chemical named mercurochrome. This may be purchased in solution which should be of a strength of two per cent. Now it has been discovered that mercurochrome will not affect the parasites which are actually on the fish, even if it is subjected to treatment for several days. It is, therefore, clearly necessary to endeavour to deal with the parasites when they are swimming about. Many experts have tried many variations of the mercurochrome treatment, but one of the most satisfactory appears to be to raise the temperature of the water to approximately 65 degrees Fahrenheit and add to the water in the tank eight drops of the mercurochrome solution to each gallon of water; that is to say, if the tank holds twelve gallons of water, ninety-six drops of the solution should be introduced. The tank should be allowed to remain in this condition for about three weeks. After this period has elapsed the temperature of the water should be very gradually allowed to drop back to its normal figure, and the water may equally gradually be renewed by syphoning off a certain amount each day, replacing it with well-matured water of a similar temperature. It is said that the addition of the mercurochrome to the tank is quite harmless to the fish, and plants are not adversely affected.

At all costs bear in mind the extremely contagious nature of this disease and never fail to disinfect, preferably by boiling, everything which has been brought into contact with the affected fish and tank.

Fungus (*Saprolegnia*)

This disease is one of the most common. The fish get attacked by the spores of this fungus which appear always to be present in the water but which attack the fish if they lose condition, or if the water suddenly drops in temperature. If taken in time it can be successfully dealt with by a period of treatment in salt water. The affected fish should be removed from the aquarium and put into a dish or small tank containing water with salt solution to the proportion of one ounce of salt to each gallon of water. At the end of one day another solution must be made up in which the salt content is increased by a quarter of an ounce. The fish should be left in this solution for another day. On the third day a fresh solution in the proportion of one and a half ounces to the gallon should be made up and the fish removed into that. All but the really persistent cases will usually yield to treatment in this time, but if this is not the case a further day's treatment should be given with a solution of two ounces of salt to the gallon. The greatest care must be taken when transferring the fish from one tank to another to keep the temperature of the water at the same level. If after the prescribed period of time the fungus has been seen to clear up, steps must be taken to bring the water in which the fish is swimming back to normal. This is done by gradually diluting it in the treatment tank until it contains no further traces of salt. This may take anything from half a day to one and a half days, and a very satisfactory way of doing this is to allow a constant drip or trickle of water from the tap to fall into the tank containing the fish, the only difficulty about this being the question of temperature.

While all this treatment has been going on the aquarium must be thoroughly disinfected. I do not believe in any half measures for this, and I think that by far the best way is to draw off all the water in the aquarium, take out the compost which should be thoroughly washed in a solution of permanganate of potash in the strength of about a saltspoonful to a gallon of water. The aquarium should also be well scrubbed out with a similar solution, while the plants may be also immersed for about two or three hours. When all this has been done rinse everything in clean water and set up the aquarium again.

Fin Congestion

This disease will show when the fins appear frayed and ragged and present red streaks. The complaint is caused by over-feeding, too low a temperature, or not enough oxygen. It must be taken in time and the fish should be given a similar treatment to that described for fungus.

Tail Rot

This is rather similar in appearance to fin congestion, but differs from the preceding disease in that it is an infectious one. If taken in time the salt-water cure will generally prove effective. Complete sterilization as described before must be undertaken.

Fish-louse

This parasite, which is quite wrongly called a louse as it is in actual fact a crustacean, can be very troublesome. It is visible and can be seen swimming about the tank, or equally it can be seen attached to the side of its victim. It is a flat, rather oval creature, transparent and olive in colour. It is about a quarter of an inch in length. It attaches itself to the fish and feeds on its blood. The argulus, as the fish-louse should properly be called, will have to be dealt with individually. As soon as they are perceived the fish should be taken out of the tank, put on to a clean linen rag well soaked in water of the same temperature as that in the tank, and an attempt made to pick the parasite off with fine-pointed forceps. If it does not come off easily it should not be forced. An ordinary small artist's paint-brush should be dipped in paraffin and the argulus just touched with this. It will then usually drop off. After removing all the parasites that can be seen the fish should be given the salt bath for about a day, the bath being in the proportion of about one ounce of salt to a gallon of water.

There are, of course, many other diseases which may attack aquarium fish, but the principal ones have been dealt with here. As with every other kind of domestic pet, prevention is so obviously better than cure that it seems hardly necessary to emphasise this, but at the risk of being wearisome I will repeat the importance of plenty of live food, plenty of room, and plenty of oxygen.

CHAPTER FOUR

BREEDING

THE breeding of fish, like the breeding of many reptiles and amphibians, can be quite a complicated and highly skilled procedure, and no attempt will be made to do more than give a brief description of the spawning of a typical species, i.e., the goldfish, together with a few general hints and tips. If the novice, encouraged by any success he may have, wishes to go further into the matter, he should do two things. The first is to join one of the many excellent aquarist societies which are distributed all over Great Britain ; and the second is to buy some work which deals solely with fish-keeping.

Goldfish may successfully be bred either in an aquarium or in a garden pond. In fact unless some very special species are to be dealt with, goldfish in a well-balanced and carefully tended garden pond will breed quite happily over a long period of years, and without requiring very much attention. If the breeding is to be done in an aquarium it is, generally speaking, a good idea to transfer the young fish into a garden pond if at all possible. If this is not done and the spawning has been successful to a reasonable degree, the aquarist may find himself faced with the task of accommodating possibly hundreds of young fish.

Goldfish usually begin to spawn in the spring. In a garden pond, of course, the exact time depends very largely upon the prevailing weather. In an aquarium the fact that the breeding season is at hand will be obvious from the behaviour of the fish. The female or hen fish will be seen to develop a very rounded and promising looking abdomen ; and the male or cock fish will be noticeable for the amount of attention he devotes to the hen. The male fish will pursue the female all round the aquarium and give her little rest. When this sort of behaviour is seen the actual spawning may be anticipated within two or three days.

If breeding is going to be considered by the aquarist he must of course make some special preparations. These are:—

(*a*) To see that the aquarium is in good condition at the time.

(*b*) To see that, if possible, not more than one pair of fish remain in the tank in which the spawning is to take place, though two males to one female are sometimes used.

(*c*) To see that the tank contains many more plants than normally. These will not only keep up the oxygen supply, but they are absolutely necessary for the purpose of catching up the eggs and affording them protection as they actually fall from the hen fish.

The number of eggs laid will of course depend upon the age and size of the fish, but what might be termed an average female fish will lay approximately eight or nine hundred. A reasonable proportion of these eggs will probably be unfertilized, and if this is so they become whitish in appearance, instead of transparent. These unfertilized eggs also fall a victim to a fungus in the form of white filmy threads. If it is found possible to remove such eggs this should be done, but it is not absolutely essential, as the fungus is not thought to be detrimental to the fish. When spawning has taken place the aquarist must do one of two things. He must either remove the plants to a separate tank, or remove the parent fish; the latter, of course, is rather more easy. The reason for this is obvious, namely, that if not done there will soon be no eggs left.

The incubation period naturally varies with the temperature of the water; but anything from three to five

days is usual. When the young fish hatch out they will be found to be rather less than a quarter of an inch in length, and the uninitiated may think that something is seriously wrong on account of a blister-like protuberance upon the young fish's body. There is, however, no cause for alarm as this is only the yolk sac on which the fish will live for the first two or three days of its life. When the young fish has taken in all the nourishment from this yolk sac that it is capable of getting, the sac is absorbed and the young fish appears more normal; but it must not be expected that newly hatched fish will be seen swimming merrily about the tank, for they will not do so. They will remain attached, sometimes to the plants and sometimes to the sides of the aquarium, for at least forty-eight hours, though they may occasionally show signs of life by a brief shaking of the tail.

When the young fish commence an independent life they naturally feed on the most minute organisms, and to begin with these organisms belong to the *infusorians* of which there are naturally many thousands always present in a properly balanced aquarium. There will, though, not be sufficient to keep a reasonably large brood of newly hatched fish in good trim; and it will be necessary to supplement the natural population of *infusoria* by cultivating some and adding a small quantity of the culture to the main tank from time to time. Reference to the cultivation of *infusoria* has been made before, but it may be as well to reinforce the instructions. A water-tub or zinc bath should be procured, on the bottom of which should be placed a layer, about two inches deep, of well-rotted leaves. These should be covered with filtered rainwater to a depth of another two or three inches and allowed to stand out in the open. Simultaneously with this a culture should be prepared by chopping up some hay together with some dried nettle leaves and boiling them up. The total quantity of the "brew" should be such as will fill a quart measure. When the brew has cooled down the whole contents should be tipped into a prepared bath and left for a week or two. After this time the water in the bath will contain millions of the desired organisms. A small test-tube of this culture may be added to the tank containing the young fish about three times a week. Naturally the preparation of this culture should be well under way before the fish start to spawn.

After a few weeks the young fish will have grown quite appreciably and will require something more substantial, and they may then profitably be fed on small daphnia. In about a month or five weeks they should be able to take mosquito larvæ or even small white-worms.

Live food is always preferable, but if it is impossible to obtain, prepared foods may be given, though these will not produce such big or such healthy fish as those reared on a more natural diet. There are various excellent prepared foods on the market, but the following have been successfully used by many experienced aquarists:—

(*a*) The yolk of a hard-boiled egg, which should be given in small pinches crumbled between the finger and thumb so that it appears like powder in the water.
(*b*) Small quantities of very fine oatmeal.
(*c*) Dried liver well pounded up.
(*d*) When the fish are of sufficient size to take it in, finely chopped up earthworm.

Once again I should like to emphasise that prepared foods of this nature must be fed sparingly, and uneaten food should not be tolerated in the tank.

When the fish get to a size when they may be easily observed, the beginner may wonder why his beautitful goldfish have produced such dull and uninteresting-looking children, for young and immature goldfish are always a pale olive or bronzy green colour ; and they

do not assume their normal colours, either gold or gold and black, or silver or silver and black, for some months. If in really good condition they sometimes begin to turn at about six months old, while sometimes it may be twice as long before the colour change is complete.

In an indoor aquarium enemies of the young fish need not be anticipated, but in a garden pond every care should be taken to see that such villains as the dytiscus beetle, or its even more villainous larvæ do not take up residence. Neither should the larvæ of dragon-flies be allowed. Very roughly speaking, both these larvæ look like elongated beetles, varying in length from about an inch to two inches. They are extremely fierce and voracious and will create havoc among young fish. Some aquarists erect a sort of screen of fine wire-netting over their breeding ponds in order to keep out the parent insects, and this is undoubtedly the best course to adopt, as prevention is always better than cure. At the same time, as I have said before, goldfish will breed quite readily if simply left to their own devices in a garden pond, though the aquarist must not expect such a high proportion of young as would be the case in an aquarium where he is able to separate the parents from their progeny.

CHAPTER FIVE

GARDEN PONDS

GARDEN ponds may vary in size from something which is a square yard or two in area to something which is almost as large as a small garden in itself. They may be combined with rockeries, have waterfalls, be surrounded by bog gardens, and in fact can have almost every type of elaboration which pleases the fancy and suits the purse of the owner. At the same time it is safe to say that the more elaborate and decorative garden ponds tend to distract attention from what is presumably the principal object of readers of this book; the keeping of fish under natural conditions. Consequently the main emphasis of this chapter will be on the construction and setting up of a modest garden pond for the purpose of keeping fish. More ambitious readers, who are also inclined to water-gardening, will be able to indulge all their fancies once they have mastered the more important of the underlying principles.

While I myself enjoy looking at a well-constructed and well-stocked garden pond as much as anybody else, I always feel that in many ways, from the aquarist's point of view, a garden pond is not necessarily a definite improvement upon an aquarium; for whereas in an aquarium practically everything that goes on may be observed with ease, such is not the case in a garden pond; and a beginner must be prepared to make up his mind that what he will see in his pond will be different in both amount and perspective from what he has seen in his various tanks. If all this is thoroughly understood disappointments will be avoided and a great deal of pleasure will result.

The Site for a Pond

The exact site for a garden pond should be chosen with care and should have reference to shelter from cold winds; provision of adequate shade; avoidance of over-hanging trees, particularly pines and firs; and also the position which the pond will occupy in relation to the amount of direct sunlight which the garden itself receives.

Shelter from cold winds is necessary because too sudden changes of water temperature are just as bad for an artificial pond as they are in an aquarium, and a sudden easterly breeze springing up may cool the water of the comparatively shallow pond very rapidly. Adequate shade as a protection for the fish is absolutely essential; and although shade can actually be provided under the water by means of plentiful aquatic vegetation, it is quite a good idea to see that a certain amount of shade can be given irrespective of the plant life. The actual lay-out of the owner's garden will probably solve this problem as the shadow cast by a wall, fence or hedge may be utilised. Although leaves which fall into a pond and go through a process of natural decomposition at the bottom may have some beneficial effect in connection with the provision of nutriment for the pond's vegetation, falling leaves are a terrible nuisance in the autumn; and it is not a good thing to have the whole surface of one's pond covered with leaves. It is better so to place the pond that this does not occur, rather than to have to spend a great deal of time in keeping the surface of the water clear. Another disadvantage of the over-hanging tree is that some trees are inclined to exude resinous substances which drop into the water and are the reverse of beneficial; in fact, the only good point about an over-hanging tree is that at certain times of the year caterpillars and other insect larvæ, and even beetles will fall into the pond

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and provide a small quantity of live food. In my opinion, however, this slight advantage is outweighed by the disadvantages.

With regard to sunlight, while this is absolutely essential in order to promote proper growth of plants, and therefore a proper supply of oxygen, too much sun will mean constant trouble due to a superfluity of algæ, to say nothing of the fact that it is possible for the plant life to become unbalanced and therefore upset the main balance of the pond. If it is possible to sum up the question of sunlight and shade in a few words, I should say that the ideal is a pond which has some portion of its area always in the shade throughout the hours of daylight.

The Shape of the Pond

It is very difficult to lay down hard and fast rules on the question of shape, for personal taste must obviously play a big part. Ponds may be rectangular, circular, oval, in fact, they may be any shape that the owner may prefer. I have a slight preference for a pond which does not look too symmetrical or like a miniature reservoir; but apart from this I do not feel that shape is a point on which advice can reasonably be given. What is important, however, is the shape of the pond below the level of the surrounding land. This of course means the actual depth, or rather depths of the pond.

The Depth of the Pond

It is on this question of depth that the novice is inclined to make mistakes, and ponds are frequently seen which are nothing more nor less than a hole in the ground, covered with concrete, with sides going straight down, and of a uniform depth all over. This is bad; and the reason it is bad is that practically nothing like it will ever be found in nature. A natural

pond is nearly always shaped something like a saucer; that is to say, the sides of the pond slope towards the maximum depth, or are composed of a series of shelves. An example of the latter may be seen if a gravel pit or a sand pit is examined. Such pits very frequently ultimately become filled with water and take their place among the ponds. There are other reasons why the sides of the pond should be sloped, one being that different aquatic plants function best at different levels of water, and therefore one will get more satisfactory results from the plants if their natural conditions are catered for. Another point in this connection is that fish sometimes like to frequent shallower water than at other times, generally in search of a particular kind of food; and this is not going to be possible if the whole of the pond is of a uniform depth. In any case the construction of a pond on the principles suggested is no more difficult than constructing one which looks more like a grave than a natural pool. As was pointed out in connection with aquaria, the one really important principle which must be rigidly adhered to is to have the greatest possible surface area in relation to depth; that is to say, that the deeper the pond the greater must be the surface area. There is often a tendency to make garden ponds too deep, and I think that for the average pond anything over four feet in depth at its maximum point is unnecessary and probably harmful. The pond which has a maximum depth of between three and four feet should have its minimum depth at about six inches. Intermediate depths can be provided at the will of the constructor.

Constructing the Pond

If ten different authorities are consulted on the subject of constructing garden ponds there will probably be found to be ten varying opinions on certain points; but on fundamentals all will be found to agree. These fundamentals are: the necessity for not being mean with the concrete; the exercise of the greatest care in mixing the ingredients, both in their dry state and when water is added; the vital necessity of adequate thickness at the bottom; the avoidance of straight right-angle sides to the pond, which only invites trouble in frosty weather; and finally, a willingness to consult expert advice from a local builder if in any doubt as to the exact nature of the soil in which the pond is going to be constructed, or about the quality or type of any of the ingredients.

In some countries abroad, ponds are frequently constructed rather roughly in brick to begin with, and afterwards given the necessary coat of concrete; but for the average garden pool nothing so fortress-like is necessary. Perfectly satisfactory results can be obtained by using a normal concrete mixture, which should consist of one part of cement to two of sand, with half a part of either clean shingle, granite chips, or some similar substance. In estimating the total amount of concrete required it must be remembered that the bottom of the pond should be nearly, if not quite, half as thick again as the sides; and for an average pond of, say, six feet by four feet the thickness of the concrete on the sides should not be less than three to four inches. When the bottom and sides are nearly complete large rough stones can actually be set into the concrete for the purpose of providing shelter, or some variations of depth.

Regarding the actual excavation, do not make the mistake of forgetting that the over-all dimensions of the hole to be dug must allow for the thicknesses of the concrete sides and bottom. The shape, we have already agreed, will largely depend upon taste, though it is as well to remember that an elaborately shaped pond with lots of curves and corners will be infinitely more difficult to construct than one which is not full of such deviations. It is quite possible to strike the happy medium between what is hard to lay out and what is too formal to be pleasing. When the digging has been finished,

the next thing to do, unless the soil in question is either very hard or consists of clay, is to see that a really firm bed is provided. This can best be done by stamping in two or three inches of builders' rubble so that the whole of the bottom and the first inch or so of the sides has a really firm foundation. In digging the sides it will be found much easier to lay the concrete if these are not straight, but slope gently. If straight sides are necessary for any reason, it will be essential to have some temporary walls made of posts and boards in order to control the concrete. The consistency of the concrete is important, and the warning already given about the thorough mixing of the dry ingredients must not be forgotten. If boards and posts are to be used as an aid to building the walls, the concrete should be mixed to a consistency of a thick paste so that it can just be poured. If, however, boards are not required, the concrete should be of such a nature that it can be easily worked with a builder's trowel. With regard to this question of boards, these are, of course, only temporary aids, and should be well greased or oiled when put into position, in order to allow of their easy withdrawal when the concrete has begun to set. About three or four days is a reasonable time to allow for proper setting; in fact too hasty drying is a mistake.

The actual concreting having been done, and everything appearing to be in order, the next step is to fill the pond, partly in order to see whether all is satisfactory and the pond is really watertight, and partly to allow a certain amount of absorption to take place. It must not be imagined that a pond can be finished on Monday and fish introduced on Tuesday or Wednesday. Many a beginner has lost valuable fish by doing this. It is absolutely essential to wash out the pond completely in order to remove the excess of alkalinity which will be present in the finished concrete. This should be done by several fillings and emptyings, together with scrubbings with a long-handled scrubber; and at least three weeks or a month should elapse from the time the concrete has set to the time when fish are introduced, though plants may be introduced a little earlier. There are several patent substances on the market which may be used for dressing the completed concrete. These have a neutralizing effect, and if properly used, can reduce the waiting period by as much as three weeks. Particulars of these products can be obtained from any reputable aquarist stores.

One final word before leaving the actual construction of the pond. If the person building the pond is completely inexperienced, let him go to a friendly builder and get some practical advice on the actual mixing and use of concrete. This is good advice no matter how many books he has read on the subject.

Setting up the Pond

Plants should be introduced at least a week before the fish, and the pond should be prepared for their arrival by having some good heavy soil put on the bottom to a depth of approximately two inches. When the plants which are to be used are of a very buoyant kind they should be anchored to large pieces of stone and pushed down into the soil.

As to the plants themselves: taking the oxygenators first, most of those already recommended for the aquarium will do well in a pool. Canadian pond-weed (elodea), vallisneria, ceratophyllum, sagittaria and willow-moss are all very good; though the first one, once well established, will spread rapidly and will have to be curtailed from time to time; while the last, willow-moss, seems to be rather temperamental and does not always take root properly, and will therefore have to have a careful eye kept upon it. Regarding other under-water plants, most of the potamogetons are good and quite decorative; while water crow's-foot is both decorative and a good provider of shade. Plants for

ponds do not begin and end with the under-water varieties, for the whole pond may be made to look much better if a few marginal varieties are used. There are a great many of these, ranging from irises to various bog plants; flowering rushes, water-mints and brook-limes are all attractive and do reasonably well.

It will be noticed that not much has been said about water-lilies. This is because, while they are undoubtedly very beautiful when in flower, and second to none in providing shade, they are, I think, apt to provide too much shade and cut off the light from the more valuable oxygenating plants. Therefore, if the primary object of the pond is the maintenance and the observation of fish life, then I think that water-lilies do very little which cannot be done more satisfactorily by plants such as the water crow's-foot. Another point about water-lilies is that they also are very temperamental and seem to refuse to flower in some ponds. If the aquarist really insists in going in for a few, then he had better consult someone who has a higher opinion of them and has had more success with them than I have.

Just as it was necessary to allow a few days for the tank plants to establish themselves, and for the aquarist to make careful observation in order to see where attention may be required, so this is necessary in the case of ponds. Rather more so, for whereas it is easy to see what is going on in a tank, it is not so easy in the garden pool. However, if everything seems to be satisfactory after a week has elapsed, little more remains to be done before introducing the fish, except to introduce some water snails in proportion to the size of the pond; and I always think it is an excellent thing to have a good supply of daphnia already swimming about in the pond when the fish first make their appearance. Some of the small crustaceans, commonly referred to as fresh-water shrimps, may also be introduced with advantage. These can generally be purchased from any of the well-known trout farms in different parts of the country.

CHAPTER SIX

FISH

THE most popular aquarium fish is naturally the goldfish with its many varieties and diverse colouring ; but there are many other freshwater fish which do equally well, both in the aquarium and in the pond. In fact, some of the other species do rather better in the pond than some of the varieties of goldfish. The ultra fancy kinds, with their exaggerated fins, are not really suitable for the pond as many of them are much more delicate ; their fins are liable to attacks from predacious insects ; and in any case, as their chief charms lie in the shape of their fins and tails, these are not normally visible in the pond. As the goldfish holds obvious pride of place, it will be dealt with first.

The Goldfish

The term " goldfish " has become accepted through common usage as a generic name, though all goldfish are of the carp family. They are sometimes referred to as Japanese carp, and sometimes as golden carp. The former name is due to the influence of the Japanese years ago in respect of the breeding of fancy fish, although for some time before the 1914—1918 war the trade in goldfish was chiefly centred in Italy. The term " golden carp " is not used very much to-day. Even the time-honoured name of " goldfish " is not really truly descriptive since these fish may be found to vary in colour from a deep bluey-black to a silvery-white, with all sorts of variegations and other shades in between, these variations being, of course, in addition to the more orthodox golden-red colour.

Goldfish vary nearly as much in shape as they do in colour ; and while some of the fancy varieties are most graceful and decorative, some, to my mind, are nothing more nor less than grotesque. Speaking purely personally, I have never found anything to admire in such monstrosities as the telescope goldfish, with its eyes protruding right out of its head, making it look as though it suffered from some fell disease. Neither can I see any beauty in the so-called lion-head: the goldfish with a head so misshapen that it looks as though it had some sort of fungoid growth surrounding its face. The oranda is another freak ; and while, I suppose, there will always be aquarists who dote on these abnormals, I think it is as well for the beginner to heed the warning that the more bizarre types of goldfish are much less hardy than the normal ones ; and for that reason, quite apart from personal prejudice, they are not really suitable for one who is just thinking of taking up fish keeping.

The Common Goldfish

This is the gracefully shaped fish well known to everyone who has taken even the slightest interest in aquaria, the only unusual thing about it being its colour ; for in its original state the coloration was a dull bronzy-green, all other colour variations having been evolved by specialised breeding. All the ordinary varieties of the goldfish do excellently in a well-balanced aquarium, and equally well in a garden pond. They are omnivorous feeders, liking to nibble at water plants in addition to taking up any live food which may come their way. They are comparatively easy to breed and will probably always remain the most popular type of fish.

The Fantail

This is probably the commonest of the fancy varieties, and the fish is distinguished by the extra length of the tail which becomes separated into two lobes—one on the right and one on the left. The dorsal fin is also considerably elongated, and the anal fin, too, is doubled. In body the fantail is less graceful and more chubby than the common goldfish. In this variety the eyes may be quite normal or they may tend towards the telescopic. It is quite easy to keep, though it is not really suitable for the garden pond.

The Veiltail

This variety may be roughly described as an exaggerated version of the fantail. The tail fin, which is doubled like that of the fantail, grows to a very considerable length ; in fact, a tail, which is nearly twice the length of the body of the fish, is one to be highly prized. All the remaining fins are also greatly exaggerated, and as its name implies, the fish gives the impression of being enveloped in a veil. Here again the eyes may be either normal or telescopic. It is not so hardy as the fantail, and the lengthy fins are very liable to fin congestion and other similar troubles.

The Moor

In spite of the fact that this fish always has more or less telescopic eyes, it is quite a handsome fish, for the really deep bluey-black colour on the back and sides, with perhaps a shade of bronze on the under-side, is most effective. The tail is lobed and generally very long, and the other fins are also exaggerated. A really dark moor is something of a prize possession, particularly if it remains dark, for this breed is rather inclined to revert to the original golden colour.

The Shubunkin

This variety is an extremely popular one, and many experienced aquarists are what may be termed shubunkin specialists. Many variations, both in fin and in colour, are to be found ; and breeding for further variations is continually going on. The special feature of these fish is the scaling. The scales are transparent, and therefore the fish does not have the same metallic appearance of other types of goldfish. In general shape, the shubunkin does not differ much from the common goldfish ; and with regard to its fins, it may show nearly every type of fin development from the perfectly normal to the fairly prolonged. The eyes of shubunkins are never telescopic, and the tail and anal fins are not lobed. There are an immense number of colour varieties ; and although blue is the hue most sought after, others, which are generally irregularly blotched with the various colours, may be either mauve, pink, gold, grey, silver or black. It is usually spoken of as quite a hardy fish, though I have heard some aquarists complain that they find them singularly susceptible to chills ; but as these should be guarded against in any case, this word of warning should be sufficient.

OTHER SUITABLE AQUARIUM AND POND FISH

The Golden Orfe

The golden orfe is a really lovely fish, longer and more slender than most types of the common goldfish, and growing to a very considerable size if housed in a sufficiently large volume of water. They are pond fish rather than aquarium fish, though the small ones will do very well indeed in an aquarium so long as it is well planted and well aerated. In colour they are not quite such a deep gold as the various varieties of goldfish; and the colour shades off on the sides to a much paler hue, sometimes almost silvery, while the belly is a silvery-white.

The Rudd

The common rudd, which is plentiful in many ponds and lakes in England, does reasonably well in an aquarium if not more than three inches in length, and if not over-crowded. The larger rudd will thrive in a big garden pond and grow to a considerable size, well over a pound. To be kept in good health the rudd should have plenty of live food. In appearance the rudd in general resembles the roach, but the rudd is much deeper from back to tail. The scales tend to a golden colour, whereas those of the roach are silvery, and the fins are a beautiful bright red of quite a different shade to those of the roach.

The Roach

While some people seem to do quite well with small roach in an aquarium, personally I have never done so. They do not seem to be so hardy as rudd, and they do not seem to like restricted quarters. However, others may be more successful than myself. They are omnivorous feeders.

The Tench

Small tench up to four or five inches long may reasonably be kept in a large aquarium, though they are not very interesting fish to watch owing to their habit of frequenting the bottom, and retiring out of

sight for a great deal of the time. For all this they are rather lovely fish and they are covered with very tiny scales of a beautiful olive green mingled with bronze. The fins are sometimes brownish, sometimes even a deep violet colour. The eye is particularly pretty, the iris being red ringed with yellow. Tench will do very well in a large garden pond; but, of course, given sufficient space and food they will soon outgrow any ordinary artificial pool, for in nature tench frequently exceed five or six pounds in weight. I do not think they are particularly good fish for a garden pond, as they are not often seen, except in hot weather when they roll about on the top of the water, while their grubbing habits tend to stir up the bottom and uproot the plants.

The Common Minnow

This much despised little fish, so often wrongly confused with the stickleback, is really very beautiful if a number of them are kept by themselves in an aquarium. Their artificial markings of steely blue and bluey-black mixed with silver and bronze catch the light as they swim about, and they are always on the go. They should, however, have an extremely well aerated tank as they are not normally pond fish, preferring rivers and streams. They will eat nearly anything, but must have a proportion of live food. Small gentles, or small earthworms, bloodworms, etc., will be attacked with surprising vigour.

The Pike

I can never understand why more aquarists do not go in for small pike. Although they are predacious fish, small ones can easily be kept in a cold-water aquarium, and fish up to about six inches long will take lob-worms readily. They can, of course, also be fed on any small fry if such are obtainable. A pike of anything from three to six inches long does not want a very large tank, as it does not move about much except when seeking for food ; but their habits can easily be studied, and they do get quite tame. The tank should be well-planted with weed to provide cover, and must be well aerated. Not more than one pike should be kept in the same tank, though it is possible to keep them with other fish so long as their companions are a little larger in size than the pike. They are good jumpers so the tank must be covered.

Pike are not suitable occupants for a garden pond, since if they thrive at all they are bound eventually to do so at the expense of the other occupants.

The Gudgeon

The gudgeon is another fish which is not frequently seen in aquaria, although it will do quite well in a tank so long as there is sufficient aeration. Gudgeon will also get along all right in a garden pond, though they prefer gravelly situations to muddy ones. In a pond they are unlikely to be seen very much as they keep almost exclusively to the bottom ; but in a tank they are quite amusing little fish to watch as they go searching about among the debris for anything they can find. They are mainly live feeders, and will take daphnia, freshwater shrimps or small worms. In shape the gudgeon is very elongated in comparison to its depth, and the body is nearly cylindrical. The mouth, which is situated almost underneath the chin, so to speak, is horizontal ; and it has two barbs or wattles which hang down from the corners of the upper lip. In colour, the back and sides are brownish fawn,

mottled with dark green ; the scales are rather large, and the fins are sometimes yellow with dark spots, and sometimes quite reddish. The under-side is silvery.

The Crucian Carp

This fish may be described as a smaller edition of the common carp. It seldom exceeds about eight inches in length, but even so it reaches a weight of one and a half pounds. Small crucian carp will do well in an aquarium, and they are quite reasonably decorative. They will, of course, do even better in a pond. In shape the body will be found to be very deep in comparison to its length, approximately one half. The eyes, instead of being a golden hue as in the common carp, are generally silver, and the prevailing colour is a rather beautiful bronze on the side, darker on the back, and shading into a more brassy colour towards the under-parts, which are themselves almost white. The fins show some diversities of colour ; the dorsal fin is generally bluish-grey, tail, pectoral and ventral fins are a dark purple, while the anal fin is a dull red.

The Sunfish

The so-called sunfish, which may sometimes be obtained from dealers, is an extremely pretty fish. It is rather pugnacious and not suitable for a community tank ; but does quite well if housed alone. Sunfish are something like a perch in shape, and their scales, when they catch the light, reflect nearly every colour of the rainbow. There is a rather spiny long dorsal fin, and a hungry, bad-tempered-looking mouth. Sunfish feed very well on almost any kind of worm, garden or otherwise, and will even take dry food in moderation.

The Three-spined Stickleback

This fish does not receive the attention which it should from serious aquarists. It is too often dismissed contemptuously as "the tiddler" of the small boy, but it is in fact a very beautiful and extremely interesting little fish. They are, of course, quarrelsome and pugnacious, and well-armed with their three spines, so they should not be kept with other fish; but in a roomy tank well planted with suitable weeds they will not only thrive, but may even breed. Their breeding habits are particularly interesting in as much as they are nest builders, and in the spring build a cylindrical nest in which the eggs are deposited. This nest is composed of portions of water-plants cemented together with a substance produced by the fish. It is a really wonderful piece of work. It is constructed by the male fish, and it is generally formed right on the bottom in a slight depression which is excavated by the male stickleback. Sometimes it is actually suspended from a water-plant an inch or so from the bottom. When the nest is completed the male stickleback courts his mate by driving her about, giving her gentle nips, and generally showing himself and his colour off to the greatest advantage. After this courtship about sixty eggs are deposited in the nest by the female, sometimes more than one female; and when the egg-laying is over the wives are sent about their business in no uncertain manner, after which the male takes up guard. He drives away all intruders and keeping closely to the vicinity of the nest contrives to see that the water circulates properly in the nest by the vigorous use of his fins. After a period of anything from ten days to a month, according to the prevailing temperature, the eggs hatch, and the male fish continues his parental duties by looking after his large family, and the female takes no part in this. However, after a time, when the

young fish begin to develop properly, they realise that discretion should be their watchword, and disperse before their father can change his mind about looking after them and devour them instead.

The stickleback is not a large fish, seldom, if ever, exceeding three inches in length. In the breeding season the male stickleback puts on the most magnificent colours; the throat and breast are bright red, and the sides show bronze, blue and green, according to the way they catch the light. The female is generally a browny-green, or green, with the sides and belly silver.

Other well-known British freshwater fish which have been kept in tanks and ponds, but which I do *not* recommend for the reasons shown, are:—

Perch. Too active to adapt itself really well to life in a tank; and being, if anything, more predacious than a pike, an unwelcome addition to a garden pond.

Chub. Not suitable for a tank; will do moderately well in a garden pond; but if they grow they grow very quickly, and are apt to take more than their fair share of food.

Dace. Not really suitable for either pond or tank, as they are really river fish, and seldom seem to thrive unless they are in running water.

Eels. A very small eel makes an interesting pet if kept in a tank by itself, and will become extraordinarily tame, even feeding from the fingers; but in a pond will either escape, or grow so quickly that it will become a menace to other fish. In any case it will probably bite and tear their fins.

CHAPTER SEVEN

DOS and DON'TS

Dos and Don'ts for the Herpetologist

Always see that the vivarium is so laid out as to conform with the natural habits of its inmates; i.e., don't put damp-loving creatures on dry sand, nor desert dwellers in mud.

Always provide an adequate and suitable retiring place.

Remember to feed up your reptiles and amphibians before the onset of winter. They will then stand a much better chance during hibernation.

Remember that very few reptiles or amphibians will feed at a temperature below forty degrees Fahrenheit, but on the other hand do not cook them.

Avoid exposing snakes to hours of uninterrupted sun.

Provide your snakes with a rough log or stone in order to make it easier for them to slough their skins.

While most species like to drink, not all species want to bathe. Therefore adjust the size of the water vessel to the habits of the creature concerned.

When keeping tree frogs never forget the regular sprinkling of the leaves among which they dwell. They must have some moisture.

Never allow a dead worm to remain in the vivarium or water vessel.

When feeding such things as meal-worms and gentles to your collection, it helps if these are put into a small dish out of which they cannot easily climb. The inmate will soon learn to associate the dish with food, and it will prevent these larvæ creeping out and getting hidden.

Remember the virtues of a varied diet. For species that like insects, a little time spent with the sweep net in the field will amply repay the trouble expended.

Don't forget that ventilation is extremely necessary, as is drainage.

Don't keep a sick animal with healthy ones.

Dos and Don'ts for fish keepers

Never overcrowd your fish. Stick as nearly as possible to the gallon of water per inch of fish.

Remember the necessity for oxygen, and use oxygenating plants in preference to more decorative but less useful ones.

Provide the largest tank that your circumstances will permit.

Never leave dead food in the aquarium.

See that a proportion of live food is always available. *Don't over-feed.*

Keep a sharp look-out for unusual behaviour on the part of your fish. This usually means disease, or pending disease.

See that your plants receive sufficient light to permit healthy growth.

Remember that sudden chills cause more illness among fish than almost any other single factor.

When you have constructed a pond, don't be in a hurry to introduce plants or fish. See that it is free from alkali, and thoroughly clean before stocking it.

Remember that with both tanks and ponds it is the surface area of the water which matters. Length and breadth are far more important than depth.

A LIST OF USEFUL BOOKS AND PERIODICALS

Title.	*Author.*	*Publisher, etc.*
"Amphibia and Reptiles."	Hans Gadow.	MacMillan & Co. One of the Cambridge Natural History Series. This volume is now only obtainable secondhand.
"The Snakes of Europe."	G. A. Boulenger.	Methuen & Co. Only obtainable secondhand.
"Fauna of British India—Reptilia and Amphibia."	Malcolm A. Smith.	Taylor & Francis.
"Reptiles and Amphibians"	Thomas Barbour.	Harrap.
"The Vivarium."	The Rev. G. C. Bateman.	Now out of print, but obtainable secondhand. Although written well over fifty years ago this is an excellent practical book on the keeping of reptiles and amphibia.
"Snakes Alive."	Clifford H. Pope.	The Viking Press, New York. Probably obtainable secondhand.
"The Field-book of Snakes."	Karl P. Schmidt and D. Dwight Davis.	Putnam, New York. Deals with snakes of U.S.A. and Canada, but full of useful information. Obtainable through leading book-sellers in England.

Title.	*Author.*	*Publisher, etc.*
"The Field-book of Ponds and Streams."	Ann Haven Morgan.	Putnam, New York. Obtainable through leading book-sellers in England. An excellent book on aquatic life
"Life in Ponds and Streams."	W. Furneaux.	Longmans, Green & Co. Out of print but obtainable secondhand.
"Fresh-water Fishes."	A. Laurence Wells.	Warne & Co. (The Observer's Series.)
"Garden Ponds, Fish and Fountains."	A. Laurence Wells.	Warne & Co.
"British Reptiles and Amphibia."	Malcolm A. Smith.	King Penguin.
"British Amphibians and Reptiles"	Malcolm A. Smith.	Collins. New Naturalist Series.
"The Aquarist."		A monthly periodical full of valuable information for aquarists and herpetologists.
"Water Life."		A periodical.
		Both the last two may be obtained through any newsagent; and are excellent journals for all interested in the subjects dealt with in this book.

POPULAR AND SCIENTIFIC NAMES OF SPECIES MENTIONED IN THIS BOOK

Popular name.	*Scientific name.*
Aesculapian Snake	*Elaphe longissima.*
African Clawed Toad	*Xenopus laevis.*
African Toad (Common)	*Bufo regularis.*
African Python	*Python sebae.*
Agile Frog	*Rana dalmatina.*
Alligator (Common American)	*Alligator mississipiensis.*
Alpine Newt	*Triturus alpestris.*
American Bull Frog	*Rana catesbiana.*
Anaconda	*Eunectes murinus.*
Arrowhead	*Sagittaria* sp.
Axolotl	*Ambystoma tigrinum.*
Black Racer	*Coluber constrictor.*
Black Salamander	*Salamandra atra.*
Boa (Common)	*Constrictor constrictor.*
Brook's Gecko	*Hemidactylus brookii.*
Caspian Terrapin	*Clemmys caspica.*
Canadian Pond Weed	*Elodea* sp.
Changeable Tree Frog	*Hyla versicolor.*
Chicken Snake	*Elaphe quadrivittata.*
Chub	*Leuciscus cephalus.*
Corn Snake	*Elaphe guttata.*
Crucian Carp	*Carassius carassius.*
Crystal Wort	*Riccia fluitans.*
Dace	*Leuciscus leuciscus.*
Dark Green Snake	*Coluber jugularis.*
Diamond Python	*Python spilotes.*
Dice Snake	*Natrix tessellata.*
Duck Weed (Common)	*Lemna minor.*
Edible Frog	*Rana esculenta.*
Eel	*Anguilla anguilla.*

Popular name.	*Scientific name.*
European Terrapin	*Emys orbicularis.*
European Tree Frog	*Hyla arborea.*
Eyed Lizard	*Lacerta lepidus.*
Fire-bellied Toad	*Bombina bombina.*
Four-lined Snake	*Elaphe quatuorlineata.*
Freshwater Whelk	*Limnae stagnalis.*
Freshwater Winkle	*Paludina vivipara.*
Garter Snake	*Thamnophis* sp.
Giant Toad	*Bufo marinus.*
Glass-snake	*Ophisaurus apodus.*
Golden Orfe	*Leuciscus idus.*
Golden Tree Frog	*Hyla aurea.*
Goldfish (Common)	*Carassius auratus.*
Grass Snake (Ring Snake)	*Natrix natrix.*
Greek Tortoise	*Testudo graeca.*
Green Lizard	*Lacerta viridis.*
Green Sand Skink	*Chalcides viridanus.*
Green Toad	*Bufo viridis.*
Gudgeon	*Gobio gobio.*
Horned Toad	*Phrynosoma cornutum.*
Hornwort	*Ceratophyllum demersum.*
Horseshoe Snake	*Coluber hippocrepis.*
Iberian Terrapin	*Clemmys leprosa.*
Iberian Tortoise	*Testudo ibera.*
Indian Bull Frog	*Rana tigerina.*
Indian Python	*Python molurus.*
King Snake	*Lampropeltis getulus.*
Leopard Snake	*Elaphe situla.*
Marbled Newt	*Triturus marmoratus.*
Margined Tortoise	*Testudo marginata.*
Marsh Frog	*Rana ridibunda.*
Midwife Toad	*Alytes obstetricans.*
Minnow	*Phoxinus phoxinus.*
Moorish Gecko	*Tarentola mauritanica.*
Natterjack	*Bufo calamita.*

Popular name.	*Scientific name.*
Painted Terrapin	*Chrysemys picta.*
Palmate Newt	*Triturus helveticus.*
Perch	*Perca Fluviatilis.*
Pike	*Esox lucius.*
Ram's-Horn Snail	*Planorbis corneus.*
Red Ram's-Horn Snail	*Planorbis corneus rubra.*
Reticulated Python	*Python reticulatus.*
Roach	*Rutilus rutilus.*
Royal Python	*Python regius.*
Rudd	*Scardinius erythopthalmus.*
Sand Lizard	*Lacerta agilis.*
Skink	*Scincus scincus.*
Slow-worm	*Anguis fragilis.*
Smooth Newt	*Triturus vulgaris.*
Smooth Snake	*Coronella austriaca.*
South American Sand Toad	*Bufo arenarum.*
Spade-foot Toad	*Pelobates fuscus.*
Spanish Salamander	*Chioglossa lusitanica.*
Spectacled Newt	*Salamandrina terdigitata.*
Spotted Salamander	*Salamandra salamandra.*
Stickleback	*Gasterosteus aculeatus.*
Stump-tailed Lizard	*Trachydosaurus rugosus.*
Sunfish	*Euphomates gibbosus.*
Swamp-plant	*Ludwigia palustris.*
Tape Grass	*Vallisneria spiralis.*
Tench	*Tinca tinca.*
Three-toed Skink	*Chalcides tridactylus.*
Viperine Snake	*Natrix viperina.*
Viviparous Lizard	*Lacerta vivipara.*
Wall Lizard	*Lacerta muralis.*
Warty Newt (Crested Newt)	*Triturus cristatus.*
White's Tree Frog	*Hyla caerulea.*
Willow Moss	*Fontinalis antipyretica.*
Yellow-bellied Toad	*Bombina salsa.*

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