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The
Aquavivarium
Fresh & Marine.

POPULAR WORK ON BRITISH FERNS.

FULLY ILLUSTRATED, PRICE HALF A CROWN,

A PLAIN AND EASY ACCOUNT

OF

THE BRITISH FERNS,

WHEREIN

Each Species is described under its respective Genus,
and the Characteristics of those Genera given
in words of common use.

WITH

A GLOSSARY OF TECHNICAL TERMS.

BY THE

REV. E. BOSANQUET, M.A.


SECOND EDITION, ENLARGED AND RE-ARRANGED.

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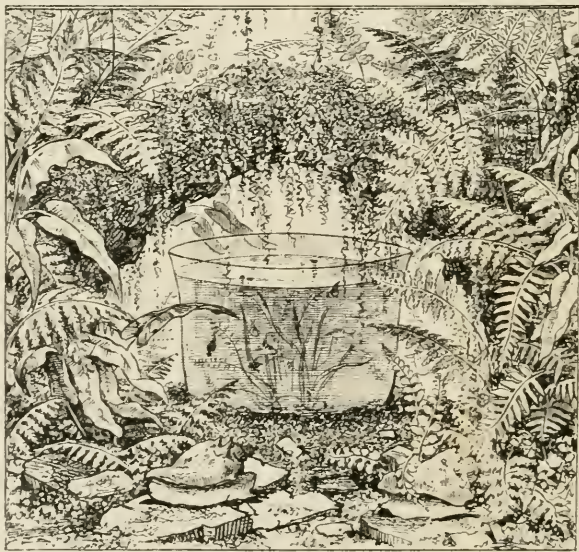
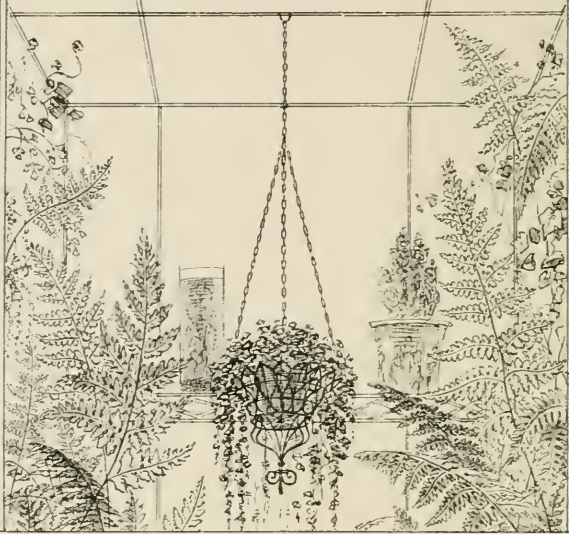
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FRONTISPIECE.



Staircase Window arranged for Aquarivarium and Fernery

THE
AQUAVIVARIUM,
FRESH AND MARINE;

BEING

AN ACCOUNT OF THE PRINCIPLES AND OBJECTS INVOLVED IN THE
DOMESTIC CULTURE OF WATER PLANTS AND ANIMALS.

BY

E. LANKESTER, M.D.

“Omnes tanquam ad vivaria currunt.”—JUVENAL.

With numerous Illustrations.

LONDON:

ROBERT HARDWICKE, 26, DUKE ST. PICCADILLY;
AND ALL BOOKSELLERS.

PREFACE.



HAVING taken considerable interest in the domestic culture of plants and animals in water, and written the article "Aquavivarium" for the English Cyclopædia, I was induced, at the request of the Publisher, to put together the following remarks. I have done so in the hope that they will in some manner contribute to make the prevailing taste for establishing domestic Aquavivaria subservient to the teaching of Natural History, and the study of God's Works.

E. L.

8, SAVILE ROW,
September 26th, 1856.

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THE AQUAVIVARIUM.

CHAPTER I.

FIRST PRINCIPLES.

ALTHOUGH it is not necessary to the practice of human arts that men should be acquainted with the scientific laws involved in the processes they perform, yet it is admitted on all hands, that an intelligent workman is better than an ignorant one ; and that a man who knows the nature of the materials on which he has to work, will perform his labour more successfully than one who does not. It is on this account we think it necessary to introduce our little book on the Aquavivarium, by laying down the principles on which it is constructed and maintained. Nor let any one suppose that mastering these is a needless waste of time. We promise the student that it will afford him instruction, illustrate great laws, and save him much trouble, anxiety, and expense in the management of his Aquavivarium.

A vessel of water containing plants and animals must be looked upon as a little world ; it may, in fact, be so constructed as to have no communication with the great world in which it exists, and of which it forms a part, and yet all its inhabitants live and prosper. In order that this result may

be secured, such an arrangement of plants and animals must be made in the vessel of water as we find made upon the surface of the earth. There must be such a relation between them that the one may supply the other with what it wants. If we take a jar of spring or river water, and put into it some gold fish, they die in the course of a few days, unless the water is changed; but if we put them into cold boiled water they die in a few minutes, and no amount of fresh boiled water will keep them alive. If, now, we put in some plants which naturally grow in the water, we shall find that our fishes will live in it without a change of the water. These, then, are the problems we have to solve:—What caused the death of the fishes in the spring and boiled water? and, Why do they live in the water with plants? Having explained these phenomena, we shall see how they bear on the construction of our Aquavivarium.

The fish, although it lives in water, has as much need of fresh air as animals that live and breathe in the atmosphere. If we put a bird, or a mouse, under a glass jar, it dies in the course of a few minutes: and there are two causes for its death;—first, it needs a fresh supply of oxygen to aërate its blood, which is not supplied in the closed glass jar; second, it is necessary that the carbonic acid gas,—which is generated in its system, and which acts upon it as a poison,—should be got rid of, which cannot be effected in the closed glass jar. Thus the animal dies because two necessary processes of its life are not carried on.

The fish, it is true, has not lungs into which it takes air, but it has gills, which are adapted for absorbing air from the water in which it lives. All water, then, which is to support the life of animals breathing by means of gills, must contain

oxygen gas. All water naturally contains this gas ; it descends from the atmosphere in the form of rain containing it, and in passing through the earth, and bubbling up in springs, or rolling down to the sea in rivers and forming the great ocean itself, it never loses its oxygen gas but as it is withdrawn from it by the aquatic animals that live in it. It is thus that well-water and river-water—even that of the dirty Thames—contains enough oxygen to support the life of fishes for some days. But the time comes when the fish will have consumed nearly all the oxygen, and then they begin to die ; they are then like the animals in the closed glass jar ; for although there may be plenty of oxygen in the air above the water, they cannot breathe this by means of their gills, and they die for want of oxygen. They also convert the oxygen into carbonic acid gas, which accumulating in the water becomes a source of poisoning to them as to the animals in the closed glass jar ; the fish then die of suffocation, and are as much drowned in the water as a man would be.

It is on this account, then, that if we put fish into water which has been boiled, they die immediately, because the boiling expels the oxygen gas : no amount, therefore, of cold boiled water will keep fish alive.

But now we find, that by putting growing plants into the water, our fish will not only not die in the course of a few hours, but that if we manage our plants skilfully, they will live on for any length of time without any change of the water at all. Let us inquire how this is. If we take a water-plant and place it in a jar, and expose it for a few hours to the light of the sun, we frequently find streaming up from its leaves a succession of little bubbles of air : if we catch these bubbles,—and this can

easily be done in a tube inverted over water,—and test them, we shall find they consist of pure oxygen gas. The leaves of all growing plants are constantly engaged in giving off oxygen gas; here, then, is the source, not only of oxygen to the atmosphere, replacing what animals take away in breathing, but also to the water in which plants live. We now begin to see why it is that fish will live in water where plants grow, and die where they are not. But this is not the whole of the functions performed by plants; in the atmosphere they would not save animal life from destruction if they only restored the oxygen. There is the carbonic acid. This gas, so destructive of animal life, is constantly being produced by animals. It is the great distinguishing feature between animals and plants, that animals take up oxygen and throw out carbonic acid; the animals would therefore be poisoned by their own secretion, but for the fact, that what is the poison of the animal kingdom is the food of plants. They live on carbonic acid; they abstract it from the air and the soil, they absorb it from the water. It is in this way that plants purify the water. The carbonic acid is composed of carbon and of oxygen, and plants have the power of separating and using the carbon for forming the tissues of which they are composed, and letting go the oxygen gas.

It is thus that we find that our jar of water with plants and animals is truly a microcosm,—a miniature world, in which all the great changes go on which are necessary to the life of man, and the maintenance of animals and plants on the surface of the earth.

But these changes, although the most essential, are not all that go on in plants and animals, and constitute a mutual relation between them. Thus,

animals require the substance called nitrogen to form the flesh of their bodies ; and this they obtain either directly from plants, or from other animals which have fed on plants. Plants obtain the nitrogen which they possess from animals, or animal substances in a state of putrefaction. The nitrogen, when it is given off from the animal body, unites with another gas, hydrogen, and the two form a third gas, called ammonia, and which is well known on account of its pungent odour ; it forms the basis of smelling-salts, and the spirit of sal volatile. In this way plants are supplied with another kind of food from the animal kingdom, and the animals in turn derive their food from the vegetable kingdom. Such is the absolute dependence of these two great kingdoms one upon the other. The interchange of the four elements,—carbon, hydrogen, oxygen, and nitrogen,—in the vegetable and animal body constitutes the principal phenomena of life. There is no existence for plants or animals but as these four elements re-act upon each other ; at the same time other substances exert a remarkable influence on the life of both plants and animals : thus we find fish living in one pond and not in another, plants flourishing in one river dying directly they are transported to another. The most remarkable instance of this is the peculiarity of the forms of plants and animals living in the sea as contrasted with those living in fresh water. This does not depend upon any of the general conditions to which we have alluded, but simply on the substance contained in the water ; the sea-water contains common salt, with a few other saline matters ; and it is mainly the common salt that the varied forms of animal and vegetable life which live in the sea require in order to thrive and grow. That this is a fact, and not an hypothesis, is proved by the arti-

ficial marine Aquavivarium. In this arrangement for cultivating plants and animals, fresh water is converted into sea-water by simply adding the common salt and other substances. Marine plants and animals introduced into this liquid live as well as in their native element. It is in this way that we are able to cultivate in our drawing-rooms, not only the living animals of rivers, and lakes, and ponds, but those of the great ocean itself.

Between sea-plants and animals and fresh-water plants and animals there are many gradations; some forms requiring brackish water,—some requiring this mineral ingredient and others that; and a little study of the composition of water in which plants and animals are found will enable persons to succeed in the culture of even greater varieties than have hitherto been attempted.

In the above facts we have an illustration of the principles which are necessary to secure life, but nevertheless we cannot prevent death. It is one of the characters of organic life, that its forms should perish, and ample provision is made in the structure of the plant and animal for the maintenance of the species. Both animals and plants die, and the elements of which they were composed are ultimately reduced to a state in which they may again become the food of plants. But before this takes place, a process of putrefaction sets in, which has a power of spreading from the dead to the dying and from the dying to the healthy, so that putrefaction is a process to be avoided as much as possible. In order to prevent this in the great field of the world, certain animals are formed who prefer dead to living prey, whose digestive powers enable them to convert putrefying tissue into the substance of their own bodies. Such animals are the vultures and carrion crows

amongst birds ; the crocodiles amongst reptiles ; the sturgeons amongst fish ; the beetles amongst insects ; and the water-snails amongst the Mollusca : these are the scavengers of nature, and if man imitated nature more closely, we should find a larger number of scavengers in all our great towns than we do at present.

If we would, then, avoid mortality from putrefying substances which spread cholera and fevers amongst our water pets, we must employ some scavengers. These are best selected from the various forms of Mollusca. It is, however, necessary in our selection to remember that many of our molluscos scavengers, like human ones, have a taste for something better than garbage, and unless due discrimination is used, our living plants as well as our dead ones will fall a prey.

Another point to be attended to in the management of an Aquavivarium is the regulation of temperature. With regard to the endurance of change of temperature, man is altogether the most remarkable animal—he endures and flourishes wherever other animals are found ; but the great mass of the lower animals are made for special temperatures. Those which dwell in polar regions die on going north and south. The limits of the extension of many animals are found within the tropics. Species in the North Sea cannot, for the heat, pass to the south, and *vice versâ*. In like manner, the denizens of our water vivaries are limited to certain temperatures, above or below which they will not exist. Some will bear lower and some higher temperatures better than others ; a frost that will nip off all the *Actinæ* in a sea-tank will produce no effect upon gold fish in a fresh-water tank. The same with plants ; a frost that will fatally blight *Valisneria spiralis*, will leave

Anacharis alsinastrum more vigorous than ever. The habits of our plants and animals in this respect must be studied. As a rule, it is safer never to let the temperature fall below 40° or to rise higher than 65° or 70° . Hence the importance of selecting proper situations for permanent tanks. If they are exposed to the north, they must be looked after in the winter, lest they get too cold; and if to the south, in summer, lest they get too hot.

The world is supplied with light from the same source as heat; at the same time, it is most important to distinguish between the action of these two agents: we can always command heat but not light. If we grow plants in a dark cellar, we shall find, although they have plenty of heat, that, for the want of light, they become pale and die. Plants exposed to a northern aspect will die, whilst those in the south will flourish and produce their flowers and fruit: this arises from the action of light. Not only do our large water-plants grow best in the light, but a thousand minute forms of plants start into existence when the Aquavivarium is exposed to the light of the sun. This wonderful agency of light seems to arise from its chemical action on the material of which the plant is composed: this action is the same as that which takes place when a sun-picture is produced. Just in proportion to the light of the sun is the change produced on the photographic paper; and just in proportion to the light of the sun is the growth of vegetable matter in the Aquavivarium. We have thus a powerful means in our hands of increasing or decreasing the growth of the plants which we are cultivating.

CHAPTER II.

HISTORY OF THE AQUAVIVARIUM.

IF there has been no open controversy, there has been a good deal of latent feeling on the subject of the invention of collections of plants and animals in water. The subject has not appeared to me to be one of so great interest as to demand original research, and I shall therefore speak of the history as far as my own memory serves me. To whomsoever credit may be given for perfecting these arrangements, I cannot for a moment doubt that the original idea was taken from the success attending the cultivation of plants in closed glass cases, on the plan recommended by Mr. Ward. It was his genius that saw, in the accidental sprouting of a fern in a glass bottle, the means of maintaining fresh vegetation in the midst of the smoke and dirt of London. When he had succeeded in fitting up his first fernery in Wellclose Square, he was not long in discovering, that in the little pools which he so ingeniously constructed there, gold fishes and other creatures would live in the water, provided plants were present, as animals lived in the air of his fernery. The culture of ferns in cases, by Mr. Ward's friends, led naturally to the culture of water-plants in the same cases, and air-breathing and water-breathing animals were introduced, to increase the interest of the scene. As early as June, 1849, Mr. Ward stated, at a meeting of the British Association at Oxford, that he had succeeded, not only in growing sea-weeds in sea-water, but in sea-water artificially made. This must certainly be regarded as the first step towards realizing

the marine Aquavivarium. From this time experiments of various kinds were tried, for the purpose of enabling persons away from the seaside to keep marine animals. A lady in London frequently surprised the scientific societies by exhibiting beautiful living specimens of rare marine animals; and these she succeeded in keeping for many months by aërating the sea-water by pouring it from one vessel to another.

Previous to the year 1850, many experiments had been made in London of keeping sticklebacks, gold fish, and other animals, in jars containing *Valisneria*. I find, from some of my own notes, that I had sticklebacks in a jar containing *Valisneria* and Water Starwort, in 1849. In March, 1850, Mr. Robert Warington read a paper before the Chemical Society, which was afterwards published in the journal of that Society, in which he described the general conditions necessary to the growth of plants and animals in jars of water, and gave an account of his own arrangements for that purpose.

The practicability of establishing arrangements of this kind had been often discussed in the council of the Zoological Society, and in 1852 they determined to erect, under the skilful guidance of Mr. Mitchell, a house in their gardens in Regent's Park, large enough to hold several water-tanks for marine and fresh-water animals. In the spring of 1853 this house was opened, and at once gave an immense impetus to the establishment of water-vivaries. Most of the marine creatures contained in it were obtained by Mr. Gosse, who had previously cultivated marine animals with plants in sea-water. An account of his experiments is given in his very interesting "Rambles of a Naturalist on the Devonshire Coast." In 1854 Mr. Gosse

published a beautiful volume, entitled "The Aquarium," in which he describes minutely the structure and habits of a large number of marine animals adapted for domestication in vessels of sea-water.

After the success of his experiments with fresh-water plants and animals, Mr. Warington commenced operating upon marine plants and animals with sea-water. In this he has been more successful than any other operator, probably arising from the care with which he constructed his tanks. An account of his experiments is given in the "Annals of Natural History" for November, 1853. Many important hints and suggestions will be found in Mr. Warington's other papers in the "Annals of Natural History."

Since the opening of the house in the Zoological Gardens, numerous papers and books on the subject of the Aquavivarium have appeared. Mr. Gosse has written a little book, containing directions for managing the marine aquarium. Mr. Shirley Hibberd has devoted considerable space, in his work on "Rustic Adornments for Homes of Taste," to the management of the Water vivaries. Dr. Badham also, who has made Felixstow a classical spot for the marine naturalist, has contributed his experience on the subject. We ought also to mention Mr. William Thompson, of Weymouth, who has been a collector of specimens for domestication from the first, and Mr. W. Alford Lloyd, of London, who, by his enterprise in securing specimens for his beautiful collections, has done much to extend our knowledge of how to manage the Aquavivarium, as well as to create a taste for its adoption.

Having said thus much with regard to its history, I must say a word or two on the name. "What's in a name?" is a question often asked to

defend the use of inappropriate, absurd, and even wrong names. If you are going to give a thing a new name, then, indeed, it does not much signify what name you give it. A high authority, Sir John Herschell, says, that under these circumstances, a "nonsense name" is best. Perhaps it is. But it is one of the glories of our English language that we can make use of words from other languages without corrupting our own; and we have a habit of naming new things significantly—let Panopticon, Perambulator, and Polytechnic, stand as examples.

All parties are agreed that to use old names in a new sense is bad. The collections of water-plants and animals that we have been speaking of have been called a "Vivarium" and an "Aquarium." They are both Latin words, used by Roman folks in times of old. By a "Vivarium" they meant a collection of any living animals: a wild-beast show, a hutch of rabbits, or a pond with fish, was equally a Vivarium. To call our water collections vivaria, then, is correct enough, but not distinctive. We might as well call it a show; and if we must Saxonize the word we want, it would be a water-beast-plant-show. It is clear, however, that we cannot use so uncouth a word as this, although our German friends might.

The objections to Vivarium have led to the use of Aquarium; but here we have another Latin word with already a definite meaning. A Roman Aquarium was a reservoir for water, whether used for drinking, bathing, or other purposes. It may be applied to a jug or a pond: it expresses but one-half of our show. We have not only water but living creatures. When it became necessary to write the article Aquarium in the "English Cyclopædia," these objections occurred to the word, and

in a conversation with Mr. Charles Knight, he suggested, what appeared to me to be a very happy word — Aquavivarium — as expressing both the characters of our show. It was accordingly adopted, and published in that work in June, 1853. Mr. Gosse says, “The objection to this is its awkward length and uncouthness, which render it unsuitable for a popular exhibition or domestic amenity.” I cannot think that the word is either awkward from its length, or uncouth. That it is unsuited for a popular exhibition can hardly be urged, when such words as Polytechnic, Zoological, Pantehnicon, Amphitheatre, and others, are popularly used. With regard to its interference with domestic amenity, I must leave to the decision of those who use it in their family circles. Several of my friends employ the word, and I have not heard of any “domestic amenity” having been destroyed. For those who prefer the analogies of our own language, there is the Saxon-Latin word, Water-vivary, or the more purely Saxon, Water-show.

CHAPTER III.

HOW TO FORM AN AQUAVIVARIUM.

ANY vessel that will hold water can be converted into an Aquavivarium ; a hand-basin, a foot-bath, a finger-dish, a soup-plate, or a pickle-bottle, may be made the subjects of a first experiment. It will soon be found, however, that vessels which are not transparent, and which you have to look into, especially if they are deep, are not so convenient and interesting as those made of glass. For observa-

tion, the clearer and more transparent the glass is, the better. Thus, for small collections, white glass bottles with wide mouths, or jars such as are used by confectioners and druggists, will be found useful. Bottles are convenient for transporting things, but very inconvenient when objects need to be removed from them. Deep jars, such as Fig. 2, Plate IV., 111 are well adapted for growing such plants as *Valisneria* and *Anacharis*, but become troublesome when you require to fish for any of the creatures they contain. Glass jars can be had of all sizes, and the best form is undoubtedly one in which the top and bottom are of equal size, and the depth equal to the breadth; they can be had, however, of various shapes, and some persons prefer the form of the vase. All such vessels are, however, expensive compared with the hand-glasses, or propagating-glasses, which are made in large quantities for the use of the gardener; they have a slight green tinge, but not enough to interfere with a clear view of the objects contained in them; they are made of all sizes, and have a knob at the top for the convenience of moving them. In order to use these for the Aquavivarium, they must be inverted, and various devices may be had recourse to for the purpose of sustaining them. For temporary purposes, they may be inverted over a flower-pot, or a pickle-jar, or a saucer containing sand; more elegant stands are turned from wood (Fig. 3, Plate IV.). These may then be placed on a pillar of marble, stone, or scagliola-work; or these glasses may be arranged in wire stands, and surrounded with plants (Plate II.). One of these vessels is seen under a rough stone arch, and inclosed in a Ward's case, against a window, as represented in the Frontispiece. Many other arrangements may be made with them, according to the taste of the cultivator.

Where a fall of water can be procured, as from a cistern at the top of the house, a pipe may be introduced at the bottom, and a fountain formed. Secured in a glass case from the evil effects of smoke and dryness, a most charming vegetation with a variety of aquatic plants and animals may be secured in the midst of the poisonous atmosphere of our cities and manufacturing towns.

It must be confessed, however, that these glass vessels have their defects. The rays of light, in passing through their rounded sides, distort the objects contained in them, and often give the observer very indistinct notions of their form and size. They are liable, also, to break, not only with a slight blow, but even with a noise at a distance : this is a very unhappy occurrence ; no one can contemplate without sorrow the treasures of weeks and months of anxiety all scattered in an instant, and perhaps the drawing-room table, with its books and ornaments, saturated with water. Such accidents lead us to think of tanks. The vessels to which this term has been applied are made of sheet glass ; they can be made of any size, and are not only less liable to break, but the objects are seen better through them. The jars admit too much light for some things, but in the tank one or more sides may be made of opaque materials, as slate. It is hardly necessary, perhaps, to describe how these tanks can be made ; they are now articles of extensive manufacture, and a selection is kept for choice in almost every establishment where glass is sold.

It will be found in most cases, in London, necessary to have covers both for the jars and tanks ; their principal object is to keep out the soot, which is a fertile source of inconvenience in all our large towns, and leads to the very injurious

practice of keeping the windows of our dwellings closed winter and summer. Fortunately, no evil arises from sealing up our Aquavivarium, and we may cover it in with what material we please. Mr. Warington originally strained a piece of muslin over his jar to keep out the "blacks:" we have always used a piece of glass. The glass has this advantage, that whilst it stops the access of the blacks, it prevents evaporation, and allows also the top of the Aquavivarium to be used for placing objects which serve for ornament and adornment. Covers made of opaque objects are not desirable, as they prevent the access of light, and thus interfere with the growth of the plants and obscure the view of the objects. Arrangements are often made for allowing the access of air between the cover and the vessel, but this does not appear to be necessary, although there can be little doubt that injury would occur were the vessels hermetically sealed.

The form of the tank will be found very convenient for making other arrangements. We have seen how an Aquavivarium may be introduced into a Ward's case; and by enlarging a tank, and covering it over close, we may convert an Aquavivarium into a Ward's case. If rocks are introduced into the middle, our Aquavivarium may be converted into a miniature lake with an island in it. On the rock may be grown ferns of various kinds, or other plants which love the rocks that are dashed by the spray of water. Such an Aquavivarium should be made of large size; and where a running stream can be introduced through it, such large fish as pike, trout, and tench may be kept.

It will be observed from the last remark, that there are limits within which plants and animals will grow and live in our tanks; the weight of

animal and vegetable life to the weight of water has not yet been determined, but a small gold fish and two small plants have been recommended for a gallon of water. If we suppose the fish to weigh half an ounce, and the plants the same, this would give us about one proportion of organic matter to one hundred and sixty of water. This may seem a small proportion ; but certainly the greatest part of the evil that I have seen occur to the Aquavivarium has resulted from the overcrowding of the plants and animals ; they die as people die in a city, not from treading on each other's heels, but that they consume the air faster than it can be manufactured and conveyed to them. It is on this account that all attempts at keeping large fish fail. According to our calculations, a pike weighing a pound would require a tank containing thirty-two gallons of water, and a forest of weeds to decarbonize and oxygenate the water. This, then, is the reason why, when large fishes are kept in a small quantity of water, it is necessary that it should be constantly renewed.

The vessel having been determined on, whether it be a hand-basin or a tank of the largest size, the next thing to be done is to put some soil at the bottom. This is better done before you add the water ; and therefore a few words about the soil. It should be recollected, to begin with, that to water-plants soil is not a matter of so much importance as to land-plants : with land-plants soil is everything ; but what soil is to land-plants water is to water-plants. Soil is not, however, a matter of utter indifference ; although many water-plants have no roots by which to anchor to the earth, a large number of them have certain peculiarities of structure which fit them for growing better on one kind of bottom than another ; thus

the Grass-wrack (*Zostera marina*) will not grow unless there is mud at the bottom of the vessel. The beautiful Aponogeton, from the Cape, will not grow in a shallow soil. Many of our common ditch plants, whose leaves and flowers float upon or grow above the water, as the Water Plantain (*Alisma Plantago*), the Water Violet (*Hottonia palustris*), the white and yellow Water Lilies (*Nymphaea alba* and *Nuphar luteum*), with many others, require a considerable depth of soil in order to retain them in their positions ; in fact, when plants have a large surface of leaves and flowers, and live in running streams, it is necessary that they should have rope-like roots and deep mooring-grounds. It is yet a question, whether such plants take up much nourishment by their roots, and what it is ; at any rate it is a well-known fact, that many water-plants will continue to grow and increase without their roots being immersed in the soil at all : such plants are the New Water-weed (*Anacharis Alsinastrum*), the Valisneria (*Valisneria spiralis*), the Water Crowfoot (*Ranunculus aquatilis*), the Star-worts (*Callitriche*), the species of *Chara*, and many others. Many of the Confervæ, the species of Duck-weed (*Lemna*), the Water Chestnut (*Trapa natans*), *Pontederia crassipes*, and others, although they have roots, are seldom or never found with them in the soil.

Under these circumstances, it will be found that the nature of the soil is not a matter of much importance to the plant, and therefore the convenience and beauty of the Aquavivarium may be consulted. For cleanliness, and all the purposes of the plants mostly cultivated, a soil composed of well-washed river sand will be found to answer best : this may be put at the bottom of the jar, mixed with a few small pebbles, to the depth of

one, two, three, or more inches, according to its size. The plants which are to be cultivated may then be placed in it, with a pebble or shell here and there to keep them down, as in adding the water they may be washed away. After this is done, the surface may be then covered, according to taste, with pebbles, shells, and pieces of rock. Some regard, however, should be paid to the naturalness of the scene ; large marine shells and lumps of coral are unnatural inhabitants of miniature fresh-water lakes,—they are quite natural in the marine Aquavivarium, but here care should be taken not to overload the bottom of the tank or jar : large masses of such objects are unnatural and inelegant at the best ; arches, and other artificial arrangements, are also to be objected to on the same ground,—they occupy space, and what is wanted to be shown are the plants and animals, and not a miniature city overwhelmed with water, and inhabited by fish and snails.

The objection to all forms of mud and clay, where they can be dispensed with, is the thickening of the water whenever they are disturbed ; this disturbance is sometimes necessary in the removal or addition of plants, but it more frequently arises from the fish, which are in the habit of taking up the loose soil and ejecting it again from their mouths. When sand is employed, it speedily falls to the bottom ; but where chalk or clay is present, it is a long time before it is deposited.

The next thing to be added to our Aquavivarium is water. A little water may be added to the sand before the plants that require it are set : when this is done, the rest of the water may be poured into the vessel. But this requires caution ; if the water is emptied from a spouted mug or can, the chances are, it will wash up the soil and all the plants

arranged in it ; care should be taken to introduce it at the side through a funnel, or what is better, use a water-pot with the rose on. The water is thus gently added, and, what is of advantage, it gets aërated in passing through the atmosphere ; and should you be going to add your animals directly, it will be of service to them. But you should wait a few days before the animals are put in, as by this means the water gets charged with oxygen from the plants.

Now comes the kind of water. Almost any water may be employed for this purpose which is used for drinking. Perhaps of all kinds of water the Thames, as supplied to the houses of London, is the best, as, from containing a dash of sewage without enough to destroy the animals, it affords manure to the plants. Rain-water answers very well, and there is no objection to spring or pump waters, as long as their saline constituents do not make them mineral water. Chalybeate springs are very injurious to vegetation.

In addition to the carbon, oxygen, hydrogen, and nitrogen, which plants obtain from carbonic acid, ammonia, and water, they require certain saline constituents. These they get from the water ; so that, provided they are not in so large quantities as to destroy life, water is the better for containing some of them. It is perhaps questionable if either plants or animals would live and grow in perfectly pure water ; some plants flourish in proportion to the quantities of these saline matters the water contains ; thus the Charas grow best where there are considerable quantities of carbonate of lime ; the Grass-wrack (*Zostera marina*) and a host of other plants grow only in salt-water. Some Con-fervæ grow where the water gives out sulphuretted hydrogen. These, however, are exceptions, and

most of the plants recommended for the Aquavivarium will live in ordinary water.

The water, when the Aquavivarium is well managed, will generally remain clear and bright, and all that will be required will be the addition of fresh water as evaporation diminishes the original stock. Accidents, however, continually happen; the possessor of an Aquavivarium failing to discover the first portentous signs of a coming epidemic amongst his plants and animals, will find them suddenly overwhelmed; the water will become turbid, and smell; myriads of animalcules and locomotive plants will be developed; and the death of all or most of the higher organisms result. Patience will even restore this state of things, for the water is there, and the water itself never decomposes; it may become ice, or vapour, but it never changes its elementary constitution. It is best, however, under these circumstances, to change your water, save what you can from the wreck, clean off the *Confervæ* from the side of your tank and jar with some sand or pumicestone, and begin afresh.

This kind of visitation may be prevented in the same way that cholera and fever are prevented in our towns. In the first place look to your refuse; if your scavengers are not doing their duty, discharge them and get better. Remove the dead,—always have recourse to extramural interment; this applies to dead leaves as well as dead bodies,—these should be all removed. If you feed your animals, take care that the superabundance is not left to rot, as it is sometimes in our markets, to the injury of those who do not want it or cannot get it. If you recollect that decomposing animal and vegetable matter is a source of unmitigated evil everywhere, you will keep a sharp eye on your Aqua-

vivarium, and act upon the hint in the house and town in which you live.

In order to manage the Aquavivarium comfortably, a few simple instruments should be kept at hand. A little hand-net, which you may purchase for sixpence, or make yourself for a penny, will be very convenient; it need not be bigger than a tablespoon, and may be made of brass or iron wire covered with muslin; it is convenient for catching the various creatures, and removing them from one vessel to another: it is also of use in removing dead bodies. Some things, however, cannot be caught in this way, and a pair of long wooden forceps will be found of great service. For removing small creatures a glass tube will be found convenient. Tubes of various sizes may be kept. The way to use these tubes is to take them up with the thumb and second finger, placing the forefinger on the top of the tube. On placing the tube thus in the water, it will be filled with air; but on removing the forefinger, the water rushes in to supply the place of the air, and will carry whatever small object may be near with the water into the tube. Tubes of various sizes will be found useful for different purposes.

A glass siphon, or a tube of gutta percha or India-rubber, will be found very often convenient. Do your best, and you will still occasionally find a dead animal has escaped you, and the water becomes opalescent, abounds in animalcules, gives off smelling gases, and must be drawn off from your tank; this you can do with a siphon.

Another instrument which will be of use is a pair of bellows. Persons are scarcely ever satisfied with the small quantity of animal and vegetable life that serve for a balance; they overload their Aquavivaria with animal life. Under these cir-

cumstances it is essential that fresh oxygen should be supplied, either by fresh water or by passing it through the water. This last may be done by means of a pair of bellows with an India-rubber tube attached to the nozzle. An occasional blow through the bellows will act as pleasantly on the animals as a walk in the parks on the infant population of London, or a visit to the sea-side. In the Dublin Zoological Gardens, an arrangement has been made by which the whole of the Aquavivaria in that establishment are connected by a tube with a single pair of bellows. From this long tube, branches pass off, and open into each tank; and one puff of the bellows supplies air to the whole of the tanks. The passing of the air into the tanks has a very pretty effect, and visitors are so fond of blowing the bellows, that Dr. Ball, who described this arrangement at the last meeting of the British Association at Cheltenham, stated that the authorities of the Gardens had found it entirely unnecessary to employ any of the men in the Gardens to pump in the air.

CHAPTER IV.

PLANTS FOR THE AQUAVIVARIUM.

THE plants to be employed for the Aquavivarium must be all aquatic plants, or those which live with the greater part of their stems and leaves in the water. Others may be employed to ornament any rock-work out of the water, or to ornament the sides of the Aquavivarium; but these, it should be recollected, do not supply oxygen to the water, or take away its carbonic acid.

Many of the great families of plants have representatives that live in the water ; so that it must not be supposed that water-plants belong to a common family. The fact is, they vary as greatly in their structure and habits as do the plants that live on the land.

Botanists divide plants into two great classes,—Flowering plants and Flowerless plants. The flowering plants are again divided into Dicotyledons and Monocotyledons, and each of these great divisions comprehends many forms of plants. We shall follow this division in speaking of the plants for the Aquavivarium ; so that persons may get a little knowledge of Botany whilst attending to their Aquavivarium. In fact, mere amusement is but a poor end to propose to ourselves in any human occupation ; and if people would but exercise their minds a little, they would find that there are really few human occupations that will not afford instruction.

We shall speak first of the Dicotyledonous, then of the Monocotyledonous Flowering plants, and afterwards of the Flowerless plants.

I.—DICOTYLEDONOUS FLOWERING PLANTS.

WATER CROWFOOT (*Ranunculus aquatilis*), Plate IV., Fig. 1. This plant belongs to the Crowfoot family (*Ranunculaceæ*), the same to which Buttercups, Anemones, the Clematises, Monkshood, and Larkspurs, belong. The Water Crowfoot is an interesting plant, and very common in our ponds and ditches, putting forth a beautiful crop of white blossoms in April and May. It has two sorts of leaves : one set are submerged,

and present thread-like divisions, spreading in all directions; another set float on the water, and have three lobes. In this instance we have an arrangement to meet the requirements of the plants: those leaves which are exposed to the air have the ordinary structure of aërial leaves, whilst the others are divided according to the general plan of the leaves of aquatic plants. There are several other species of aquatic Crowfoots, but none of them are so common as the above. Other species of Crowfoots, as *Ranunculus Lingua* and *Ranunculus Flammula*, grow in ditches and lakes, and might doubtless be cultivated successfully in shallow tanks.

WATER LILIES (*Nymphaeaceæ*).—Two Water-lilies, the white (*Nymphæa alba*) and the yellow (*Nuphar luteum*) grow in Great Britain. Either of these are handsome ornaments in an Aquavivarium, but they require a large vessel and a good deal of soil in order to attain perfection. Their leaves are very large, and die down in the winter, and thus produce much refuse. Where tanks of large size can be commanded, not only may these beautiful plants be grown, but their foreign allies, as the species of *Euryale*, and even that queen of the waters, *Victoria regia*, may be attempted where there is heat sufficient.

The **COMMON WATER CRESS** (*Nasturtium officinale*) belongs to a family of plants, the Cross-bearers (*Cruciferae*), many of whose members grow in the water. No one would think of growing water-cresses for breakfast in a drawing-room, although this might most certainly be done; but the water-cress may be cultivated for its use in the Aquavivarium. A few seeds buried in the soil at the beginning of the year soon spring up, and give a very pretty green appearance to the bottom of

the Aquavivarium ; as they grow up, however, they need to be weeded out, and at last, as they are annual, they will need removing.

The AWL-WORT (*Subularia aquatica*), a little plant with awl-shaped leaves and flowers which open under water, has been recommended as a very pretty addition to the Aquavivarian Flora.

There is a little order of plants, called by Dr. Lindley Hippurids (*Haloragaceæ*), all the British species of which grow in water. The most common of these is

The SPIKED WATER MILFOIL (*Myriophyllum spicatum*), Fig. 2. It has flowers, with stamens and pistils, which are arranged in whorls. The stem is slender ; the leaves are also arranged in a whorl around the stem, and are four in number in each whorl. There are several other species, but this is the most common.

MARESTAIL (*Hippuris vulgaris*) is another species of plants belonging to this order. It is easily known by its upright jointed stem, and the leaves being in whorls of about eight round the stem. It flourishes best in deep streams, and requires a good deal of soil in order to prosper.

VILLARSIA is the name given to a beautiful water-plant, in compliment to Madame Villars, author of the "Flora of Dauphiné." This plant, of which there is only one species in Great Britain, belongs to the Gentian family (*Gentianaceæ*). This species is so like the Water Lily that it is sometimes called the little Water Lily ; and its Latin name (*Villarsia nymphæoides*) gives us the expression of White Water-Lily-like Villarsia (Fig. 3). The leaves are roundish, floating on the water ; the flowers are large, and seated on single stalks, and are of a beautiful yellow colour. It is found in the Thames, and in some ponds in

the neighbourhood of London. It is a beautiful plant, and worthy the attention of those who cultivate water-plants.

BUCKBEAN (*Menyanthes trifoliata*) is another plant belonging to the Gentian family that may be cultivated in the Aquavivarium. Whilst it is a useful medicine, on account of its bitter qualities, it has beautiful flowers, covered with soft hairs and large three-lobed leaves. It grows in marshes and by the side of streams rather than in them.

The WATER VIOLET (*Hottonia palustris*), Fig. 13, belongs to the Primrose family (*Primulaceæ*). It has purple and yellow whorled flowers, which open above the water, whilst the comb-shaped leaves, attached to a straight stem, are always below the water. It has a long root, and will not grow well without a considerable depth of soil.

WATER SPEEDWELL (*Veronica Anagallis*) and BROOK-LIME (*Veronica Beccabunga*), Fig. 4, belong to the Figwort family (*Scrophulariaceæ*), and live in water. They are both characterized by having blue flowers. The Water Speedwell has pale blue flowers and an erect stem; the Brooklime has a procumbent stem, and bright blue flowers. These plants, when in flower, make a pretty addition to the Aquavivarium.

Most of the plants we have mentioned need to be rooted to the soil in order to grow well; we have now to speak of one which, although it has delicate roots, thrives very well whilst floating in the water. This is

THE WATER STARWORT (*Callitriche verna*), and is the only genus of the family of Water Starworts (*Callitrichaceæ*) in Great Britain. This pretty plant, which will be found very useful in the Aquavivarium, is very common in stagnant and slowly-running water, all over the country. It

is easily known by its upper leaves floating on the water, and two or three pairs of them forming a little green star—hence its name. This plant forms a pretty object under the microscope, for its leaves and stem are covered with very minute rosette-shaped bodies, which seem to supply the place of hairs in other plants. There are other species of Water Starwort in England, but they are much more rare.

THE HORNWORT (*Ceratophyllum demersum*), Fig. 5, is a floating plant, that will live very well in the Aquavivarium, and be found useful in oxygenating the water. It is not uncommon in slow streams and ditches. Its flowers are inconspicuous, but it has long, slender, filamentous leaves, which are arranged in whorls around the stem, and are forked two or three times. The whole stem looks very feathery and graceful.

II.—MONOCOTYLEDONOUS FLOWERING PLANTS.

VALISNERIA SPIRALIS demands our first notice amongst the Monocotyledonous plants (Fig. 6). Its long leaves with straight veins afford a good example of the nature of the leaves in this class of plants. In Dicotyledonous plants, the veins interlace with each other, forming a net-work. *Valisneria* is named after Antonio Valisneri, an Italian physician, who flourished in the beginning of the last century, and wrote many works on insects and plants. Of all the plants we have mentioned, *Valisneria* is best adapted for growing in the Aquavivarium. It has perennial roots, which do not require any great depth of soil, and its long green leaves absorb rapidly the carbonic acid of the water, and in its stead

give out the pure vivifying oxygen. Although so commonly cultivated in this country, it is a native of the south of Europe, where it flourishes in quick-running streams. It is what botanists call a dioecious plant, that is, its stamens grow on flowers on one plant, whilst its pistils grow on flowers on another plant. Pistilliferous plants are mostly seen in this country. The flowers grow on the summit of a long spiral flower-stalk, which is sometimes several feet in length. The object of this long flower-stalk is very curious: the stamen-bearing flowers, when ripe, break off, and float to the top of the water, and if the pistils had not very long stalks in the deep rivers in which they grow, the fructifying pollen of the stamen would never come in contact with them. No sooner has this process taken place on the surface of the water, than the long spiral stalk contracts, and the newly-formed seeds in the pistil are drawn down into the soil, where they may germinate and produce new plants. The *Valisneria* was first cultivated generally in a domestic manner, in this country, on account of the cellular tissue of which its leaves are composed, exhibiting under the microscope a circulation of their contents. This movement can only be seen by cutting away from the surface of the leaf a portion of the cellular tissue, so as to render the rest more transparent. The same kind of circulation may now be seen in a great number of plants. *Valisneria* belongs to an order of plants called by Lindley Hydrocharads (*Hydrocharidaceæ*), and to this family some other plants belong, which will be found useful in the Aquavivarium.

ANACHARIS ALSINASTRUM, the New Water Weed or Water Thyme, is one of these (Fig. 7). This plant

has a curious history. Up to the year 1842, it had never been noticed in Great Britain ; now it is a common weed in our ponds, ditches, and rivers. The first recorded instance of its being found, was by the late Dr. George Johnston, of Berwick-upon-Tweed, in a pond at Dunse Castle, Berwickshire, in July, 1842. In 1848, he again found the same plant in the river Whiteadder, about five miles from the last locality. In the same year it was discovered in the river Lea, near Nottingham, and since then has been found in various new localities. Dr. Johnston sent some of his specimens to Mr. Babington, at Cambridge, which, thriving in the Botanic Gardens, they were turned out into the Cam, and the plant has become most abundant in that river. From Kew Gardens it has escaped into the Thames, and it may be now regarded as one of our most common and troublesome water-weeds. This plant grows abundantly in North America, where it was described by Nuttall under the name of *Udora canadensis*. The genus had, however, been previously described by Richard under the name of *Anacharis*. Only the pistilliferous plants have been seen in this country. From this and other circumstances, it has been concluded that this plant must have been introduced into this country probably with timber from America. Be this as it may, it is very useful for our Aquavivarium. It grows vigorously, looks very pretty, and is a capital aëerator of the water. Its great fault is, that it grows so very vigorously, that it chokes other plants. It needs, therefore, keeping down. It roots in the soil, but will grow whilst floating. It has drooping stems, which are covered with small oblong-oval leaves, three or four in a

whorl. The cellular tissue of these leaves, like those of *Valisneria*, exhibits a circulation. They are also lined with a siliceous deposit, which render them beautiful objects under the microscope with polarized light.

THE FROG-BIT (*Hydrocharis Morsus-Ranæ*), Fig. 8, is also a British plant, belonging to the family of Hydrocharads, and which may be made use of for the Aquavivarium. It is very commonly found in ditches and ponds all over England. It is a floating plant, with horizontal stems, from which it sends down rootlets into the water, and sends up several long-stalked kidney-shaped leaves, which lie upon the surface of the water. It has large white delicate flowers, which blossom in July and August.

THE WATER SOLDIER (*Stratiotes aloides*), Fig. 9, is another Hydrocharad. It is not uncommon in lakes and ditches in England. It is abundant on Wandsworth Common, also in the fens of Norfolk and Lincolnshire. Whilst growing in the water, it looks very like the top of a pine-apple. It has long sword-shaped leaves, with sharp teeth on their edges,—hence its name of Water Soldier. When young, the leaves are green, and look pretty in the water; but as they grow old they become darker and decay. It does not appear to grow very rapidly; and although it forms a curious variety for the Aquavivarium, it is not advisable to be entirely dependent on it for appearance or the aëration of the water.

THE NAIADS (*Naiadaceæ*) are a submerged or floating family of plants, almost any of the species of which may be cultivated in the Aquavivarium. The great British genus of this family are the Pond-weeds (*Potamogeton*). Upwards of twenty species of Pond-weeds have been described. They

are all characterized by having flowers without stalks seated on spikes, and the parts of the flowers answering to the number four. Thus they have four anthers, four styles, four parted fruits, and so on. They all grow in the water, some being entirely submerged, whilst others have their leaves floating, and project their spikes of flowers into the air. Any of the species may be obtained for the Aquavivarium.

THE OPPOSITE-LEAVED POND-WEED (*Potamogeton densus*) is a very pretty species; the leaves are ovate or lanceolate in shape, without stalks, and are crowded together around the stems. It is found in ditches, and is the only species of Pond-weed that does not possess the little scaly bodies at the base of the leaves, which botanists call stipules.

THE FENNEL-LEAVED POND-WEED (*Potamogeton pectinatus*), Fig. 10, is a pretty grassy-looking plant, and presents an agreeable change in the foliage of the Aquavivarium. It is not a very common plant, but it grows in the neighbourhood of London. It is said to grow in the Serpentine, and I have procured it from the canal in Regent's Park. Another species is—

THE GRASSY POND-WEED (*Potamogeton gramineus*). It has long linear leaves, and, like the last, forms a good contrast with the broader-leaved species.

THE CURLY POND-WEED (*Potamogeton crispus*) is one of the most frequent species, occurring everywhere in ditches and ponds. It is at once distinguished by the waved curly form of its leaves, and may be procured in most running ditches and streams.

THE DUCKWEEDS (*Lemnaceæ*) are a family of plants not to be neglected for the Aquavivarium. They are amongst the simplest of flowering

plants, and are worthy of attention on that account. They consist of three or four little green leaves or fronds, from the under-side of which they send down roots into the water in which they float. If watched in the spring, one of the little leaf-like bodies will be found to contain two stamens and another a pistil. These are the only flowers possessed by the little Duckweeds. In the Aquavivarium they will be found very useful, as affording a screen from the sunlight to the animals below. They also harbour a number of microscopic creatures; and it is amongst the tiny forests which they form on the surface of the water, that the microscopist must hunt for some of his most valued game. There are four species of Duckweed found in our ponds.

THE THREE-LOBED DUCKWEED (*Lemna trisulca*), with pellucid, oblong, lanceolate fronds, and a single root at one end.

THE LITTLE DUCKWEED (*Lemna minor*), with compressed, opaque, and nearly rounded fronds, slightly convex beneath, and single roots.

THE GIBBOUS DUCKWEED (*Lemna gibba*) has fronds of the same shape as the last, but larger, and nearly flat above, but gibbous and spongy beneath, with single roots.

THE MANY-ROOTED DUCKWEED (*Lemna polyrhiza*) is known from the three last by the abundance of its roots. Its fronds are not unlike those of the last species, but are more round. It has not been observed to flower in Great Britain.

There are many other plants belonging to the class of Endogens, which may, with great advantage, be introduced into the Aquavivarium; and probably many like *Valisneria*, which are strangers to Great Britain, may be easily cultivated.

I have grown the *Aponogeton distachyum*, an aquatic plant from the Cape, which has pretty sweet-scented flowers, and which it keeps producing all the year round. This plant grows in great perfection in the open air, in the pond at the Botanic Gardens, Edinburgh, and is also growing in the fresh-water tanks in the Zoological Gardens, Regent's Park, London. The Pistias, Trapas, and Pontederias, are all foreign plants, species of which are to be seen in our hothouses, and some might be tempted to grow in a domestic Aquavivarium.

III.—ACROGENS, OR FLOWERLESS PLANTS.

There are two families of this class of plants, which are entirely aquatic, and from which the Aquavivarium may with advantage be supplied. These families are the Charas, or Stoneworts (*Characeæ*), and Sea-weeds (*Algæ*).

THE CHARACEÆ are represented in Great Britain by two genera, *Nitella* and *Chara*. All the species are easily known in the water by consisting of a central branch, which is composed of elongated cellular tubes, and at the junction of each tube with the other it gives off a series of branches, which surround the primary tube in the form of a whorl. In the axils formed by the branches with the primary stem, the parts which represent the stamens and pistils of the flowering plants are seated. These parts are of two kinds, and are called "nucules" and "globules." The nucules are green, and represent the pistil, whilst the globules are of an orange-colour, and represent the stamens. The globules contain cells, in which are contained small moving, worm-like

bodies, and are interesting objects under the microscope. One of the most remarkable properties of the Charas is the facility with which the movements of the fluids in their cells may be witnessed through the microscope. All that is necessary in order to observe them is to place a portion of the plant on a piece of glass or in an animalcule-cage, and the circulation quickly becomes apparent. This phenomenon is best seen in the species of *Nitella*, as they need no preparation of the branch previous to examination. In *Chara*, it is first necessary to scrape off a layer of cellular matter, which is frequently hard and stony, and which collects on the surface of all their branches. This is the great distinction between the species of *Chara* and *Nitella*. In *Chara* the whole plant is more or less opaque and brittle, and the primary cells are invested with a layer of cells which are arranged in a spiral manner along the primary branches. In *Nitella*, on the contrary, the whole plant is more or less pellucid, and the primary cell-membrane is not covered with any secondary investment.

THE FLEXILE NITELLA (*Nitella flexilis*) is the most common form of *Nitella*, and is not unfrequent in pools, ponds, and lakes. It may be known by the branched character of its stems, and its smooth, glossy, pellucid appearance.

THE COMMON STONEWORT (*Chara vulgaris*), Fig. 11, is the most common species of the family. It is found in ponds, ditches, and slow streams, and may be known by its yellowish-green hue. It has a smooth stem, but it may be easily known from the *Nitellas* by its opaqueness and brittleness, and the spirally-striated markings upon the stem.

The other species of *Nitella* and *Chara* are not so common.

ALGÆ.—The *Algæ* are called Seaweeds, because the great mass of them are found in the sea, but there is a little group of them—sometimes called Crow-silks (*Confervaceæ*)—which are found in fresh water. Some of these are not very ornamental in the Aquavivarium,—in fact they are its weeds, its pests, and will sorely trouble the amateur. He will not be able to pull them up a plant at a time, as he does the chickweed and groundsel in his garden, and they will frequently tax his ingenuity to get rid of them. They are most of them cellular plants without branches, consisting of minute cells which have been laid end to end for several inches in length. Their beauties do not come fully out as they float through the water, but under the microscope many of them are charming. The Yockethreads (*Zygnemata*) present the most elegant markings in their cells, whilst the Quiverworts (*Oscillatorieæ*) attract attention by their never-ceasing movements. Those who have a microscope will do well to keep a vessel especially for these beautiful Algæ, and I promise them a rich harvest of delight in examining their beautiful forms and investigating their functions.

Here, then, we must terminate our account of Plants for the Aquavivarium, not for the want of matter but the want of space. I only hope that what I have said above may tempt the reader to study the Vegetable Kingdom more in detail than can be done by observing the pets of the Aquavivarium.

CHAPTER V.

OF THE ANIMALS TO BE KEPT IN THE
FRESH AQUAVIVARIUM.

THE water having become clear, and the plants beginning to grow, we must now consider what animals we ought to put into our Aquavivarium. I would not recommend persons to be very particular on this point. Some animals are undoubtedly prettier and more curious in their habits than others, but those which can be most easily procured will always be found interesting. I shall therefore refer to the more common forms of British animals, which can be secured for display in the Water-vivary. With the same object in view as when treating of plants, I shall speak of animals according to their natural-history classification. All animals are divided into those with backbones (*Vertebrata*) and those without these organs (*Invertebrata*).

The animals with backbones contain five classes : —Mammals, Birds, Reptiles, Batrachians, and Fishes. With the first three we shall have nothing to do ; for although it is possible to keep seals, porpoises, and even whales in our menageries, few of my readers will attempt experiments on so grand a scale ; nor will they probably try to domesticate young crocodiles or alligators ; so that we have only Batrachians and Fishes among the Vertebrate animals to speak of. The backbone-less animals are very numerous, and are divided into three great groups, all of which we shall find represented in our Aquavivarium.

I.—VERTEBRATE ANIMALS.

1. *Amphibia.*

The Frog, the Toad, and the Newt, belong to the class of animals called Batrachians; they are also called Amphibia, because they lead a part of their lives breathing in water and another part breathing in air. The frogs and toads, when their aquatic respiration ceases, come out of the water, and live on the land; but the newts, after this period of their existence is over, still continue to live in the water. Thus, frogs and toads can only be made to inhabit the Aquavivarium during the period that they possess gills, and breathe in water. In this stage of their growth they are called tadpoles, and very interesting fellows will they be found. The tadpoles of newts, frogs, and toads, are very much alike in the early stage of their existence. The spawn of these creatures may be obtained from any pond or ditch in the early spring. It consists of a transparent gelatinous mass, in which are imbedded a number of dark spherical masses. These black masses increase in size, and at last burst forth from their parent jelly as little creatures, all head and tail. It is interesting to watch the changes they undergo. First the gills appear, and offer a beautiful object under the microscope, as the blood comes through them in the process of aëration; then the legs make their appearance, and as they grow, the gills become less, and the tail shrivels away; at last, the young frog or toad is ready to emerge from its nursery in the water; if kept after this in the Aquavivarium, he dies. Not so with the newts;

their tails continue (Fig. 1), and although they lose their gills, they come to the surface of the water to breathe.



FIG. 1.

We have two kinds of Newts, or Efts, in Great Britain. The COMMON SMOOTH NEWT, EFT, or EVET (*Lissotriton punctatus*), is the most frequent of the two. There is scarcely a pond in Great Britain where they may not be found, and they are everywhere regarded by school-boys as legitimate prey.



FIG. 2.

Although frequently thought to be poisonous, they are perfectly harmless, and may be handled with impunity. The engravings, Figs. 2 and 3, represent the male and female of this species. In the spring



FIG. 3.

of the year the male puts on a brilliant dress and wears a crest upon his back (Fig. 2), which dis-

appears later in the season. These creatures are more intelligent than fishes, and their habits are proportionately more worthy of study:

The other species is the COMMON WATER NEWT, or GREAT WATER NEWT (*Triton cristatus*). It is larger than the last. The male (Fig. 4) is even

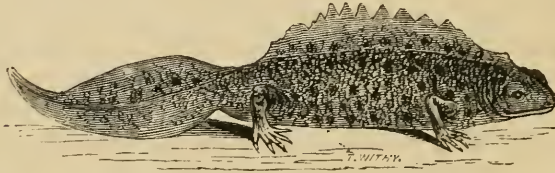


FIG. 4.

more splendid during the breeding season than the preceding species. They are not so numerous as the last, but they are generally to be found in the same places and under the same circumstances. Although generally found in water, being air-breathing animals, they will live out of water, and may be removed and kept out of water without injury. They take in the air necessary to their life at the surface of the water, and for this purpose they come up every few minutes; and this process may be easily perceived through the glass tanks, and gives considerable variety to the living movements of the various creatures.

2. *Fishes.*

Fishes are known from the Amphibia and Reptiles by living entirely in the water, and breathing by means of gills. Fish live in either salt or fresh water, and very few species are capable of enduring an existence in both. Fresh-water fish will be principally alluded to here. It should, however, be recollected, that for the Aquavivarium the smaller

the fishes are, the less trouble will they give. Large fish invariably require extensive arrangements, and entail much labour. The smaller and more common fishes will therefore have our attention.

The STICKLEBACK (*Gasterosteus*). — I mention this little fish first because I think he has claims to the rank of the king of fishes. Whether we regard his high organization, his courageous nature, his domestic habits, his varied instincts, his power of living in all waters at all temperatures, he is fairly entitled to take the first place amongst fishes, and rank high in the animal scale. And where is this wonderful fish to be got? The nearest pool, pond, or ditch that has life in it is sure to have sticklebacks. Take a walk on the nearest road out of any country town, and the chances are that the first boy you meet with a blacking-bottle or a pickle-jar in his hand has got sticklebacks in it. They are the first game of the youthful sportsman all over Great Britain. You need not catch them yourself; a penny will buy a score of them from any of these urchins. But should you wish to catch them for yourself,—always a great pleasure, and an art to be cultivated,—then a hand-net will take them by dozens; but this is a cowardly, wholesale way. If you wish for “sport” at the same time, you will angle for them; not, however, with cruel hooks. The stickleback is much too brave and incautious a fellow to need a hook. A little red worm at the end of a piece of twine is all that is necessary to secure him. Once having seized the worm, he never lets go, though you drag him out of one element into another.

When you have secured your stickleback, you must not inconsiderately place him with other fishes. I have asserted that he is a royal fish, and you will soon discover that he will bear no rivals.

No sooner is he fairly free in your Aquavivarium, than he commences his reign, not always, I must confess, of the mildest sovereignty. The chances are, if you put him with fish of his own size, you will find them all dead in the morning. Sad spectacles!—disembowelled by the use of our pet's spines upon his neighbours' stomachs—their eyes picked out as delicate morsels for his morning's meal. This, therefore, must be a warning to you ; and if you have but one jar, and wish to keep sticklebacks, you will probably not have an opportunity of keeping any other fish, of his own size at least.

But he will repay you for his disposition. He has all the ways of other fishes and many more besides. Look into your tank ; see, there is one larger than the rest : he is clothed in a coat of mail like a knight of old, and it is resplendent with purple and gold. See how his eyes glisten, and with every movement present a new colour. He is a male fish, the king of your little shoal. He has important offices to perform. Presently, in the course of a few days, if you watch him, and are fortunate, you will see this wonderful little fish engaged in the most useful manner in building a nest. He first seizes hold of one little bit of weed, then of another, and carries them all to some safe corner, till at last his nest is built. Having done this, he gently allures his mate to their new-made home. Here she deposits her eggs, and having done this, resigns the care of them to our hero of the purple and gold, who watches over them with an anxiety that no other male in creation but the male stickleback seems to know. He fans and freshens the water with his fins, and at last, when the young are hatched, watches over their attempts at swimming with the greatest anxiety.

Nor is this habit confined to the fresh-water sticklebacks. A lady, writing to me from Aberdeen, and describing her Aquavivarium, says:—"A fifteen-spined stickleback (*Gasterosteus spinachia*) constructed a nest on a piece of rock, which was covered with a fine green seaweed, depositing the spawn first, then covering it with loose seaweed, and lacing all together with a long thread, composed, apparently, of some secretion. The fish afterwards, for about the space of three weeks, watched the nest, never leaving it at all, save for the purpose of driving away the other fish when they approached too near. When a stick was introduced into the vicinity of the nest, the fish would fly, open-mouthed, to attack it, and would bite it with great apparent fury. At the expiration of the above-named time, the young fry made their appearance by hundreds; but I am sorry to say they soon disappeared, being devoured by the other fish, and caught by the tentacles of the sea-anemones. The mother fish continued her attendance at the nest as long as any of the young fry were left."

The stickleback is very tenacious of life, and will live out of water for several hours. I was walking a few mornings since on the sea-shore where some fishermen had left the refuse of their nets the night before; all the animals were dead except a solitary stickleback, who still survived, and on being placed in the sea, scuttled off again as though nothing had happened. The fresh-water species are often taken at sea at the mouths of rivers, and Sir Edward Belcher informs me that he took a specimen whilst dredging at sea during the last Polar voyage.

There are seven British species of the genus *Gasterosteus*, all known by the name of Stickleback. This name has been given them from the sharp spines which, in common with a large section

of fishes (*Acanthopterygii*), they possess on their backs (Fig. 5). They have also other names, as Banstickle, Sharplin, Prickleback, Tittleback, &c.

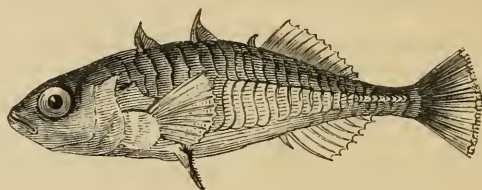


FIG. 5.

The following are the names of the species, which sufficiently characterize their forms :—

1. The Rough-tailed Stickleback (*Gasterosteus trachurus*) (Fig. 5). This is the most common form.
2. The Half-armed Stickleback (*G. semiarmatus*).
3. The Smooth-tailed Stickleback (*G. leiurus*).
4. The Short-spined Stickleback (*G. brachycentrus*).
5. The Four-spined Stickleback (*G. spinulosus*).
6. The Ten-spined Stickleback (*G. pungitius*).
7. The Fifteen-spined Stickleback (*G. spinachia*).

It is rarely, if ever, taken in fresh water.

There are many other sharp-finned (*Acanthopterygii*) fishes found in fresh water, which may be kept in the Aquavivarium.

The PERCH (*Perca fluviatilis*), when it is young, will live very well, and is a very handsome fish.

The MILLER'S THUMB, RIVER BULLHEAD, or TOMMY LOGGE (*Cottus Gobio*), inhabits most of our streams, and will live a long time in confinement. It is known by the peculiar flattened form of its head.

To the soft-finned fishes (*Malacopterygii*) belong the Roach family (*Cyprinidae*). To select from amongst this large family of truly British fishes would appear to be almost invidious. They all live in fresh water. They are all, more or less,

capable of enduring the life of the Aquavivarium. We therefore present first a list of the whole, as given by Mr. Yarrell, in his beautiful work on "British Fishes."

- The Common Carp (*Cyprinus carpio*).
- The Crucian Carp (*C. curassius*).
- The Prussian Carp (*C. gibelio*).
- The Gold Carp (*C. auratus*).
- The Barbel (*Barbus vulgaris*).
- The Gudgeon (*Gobio fluviatilis*).
- The Tench (*Tinca vulgaris*).
- The Bream (*Abramis brama*).
- The White Bream (*A. blicca*).
- The Pomeranian Bream (*A. Buggenhaggi*).
- The Ide (*Leuciscus idus*).
- The Dobule (*L. dobula*).
- The Roach (*L. rutilus*).
- The Dace (*L. vulgaris*).
- The Greening (*L. Lancastrensis*).
- The Chub (*L. cephalus*).
- The Rudd (*L. eryophthalmus*).
- The Azurine (*L. cceruleus*).
- The Bleak (*L. alburnus*).
- The Minnow (*L. phoxinus*).
- The Loach (*Cobitis barbatula*).
- The Spined Loach (*C. taenia*).

Of these, undoubtedly the handsomest and most easy of domestication is the GOLD CARP (*Cyprinus auratus*). Although so common in Great Britain at the present day, it is an introduced fish. It appears to be a native of China, where it was petted long before it became a favourite in Europe. Like all domesticated animals, it presents a great variety of colour and form. Its golden colour is often a dark brown, whilst again it becomes so light that it has been called a silver

fish. They are subject also to great varieties in their fins. Sometimes the dorsal fins are double, and the caudal fins are divided into three parts, so as to give them the appearance of having triple tails. When this latter circumstance occurs, Mr. Yarrell has observed that they are deficient of dorsal fins. In the winter it is well occasionally to feed all fish, as at that season the plants in the Aquavivarium do not grow very fast, and there are few or no animalcules produced. Gold fish may be fed on bread or biscuit. Many of the other fishes will prefer a little piece of raw meat or small worms. The one thing most necessary in feeding fish is to avoid giving them more food than they eat. If too much is supplied, the animal or vegetable matter will easily decompose, and set the contents of the whole jar in a state of fermentation.

Another form of carp, which, although not much known to the angler, has become better known since the introduction of the Aquavivarium, is the Prussian Carp (*Cyprinus gibelio*). This fish is found in ponds in the neighbourhood of London ; and on account of its peculiar habits, and tenacity of life, is well adapted for the Aquavivarium. Although not so bright a fish as the golden carp, the back has a golden metallic lustre, the eye is golden-yellow, the belly is white, and the fins are of an orange-red colour. It is sometimes called the Crucian Carp, but Mr. Yarrell has confined that name to another species (*C. curassius*) which has been much less seen in this country.

The MINNOW, MINCE, or PINK, Fig. 6 (*Leuciscus*



FIG. 6.

phoxinus), is a pretty little sportive fish, which may be easily obtained at the fishing-tackle-sellers', as it is used as a bait for pike. It is very active, and when whisking about in the water with a bright, sun shining on it, forms a most beautiful object. It seldom attains a length of more than three inches. The head and back are of a dusky olive-colour, while the belly is perfectly white, with a shade of pink during the summer season.

The LOACH, LOCHE, or BEARDIE (*Cobitis barbata*), Fig. 7, is a little fish, not uncommon in our

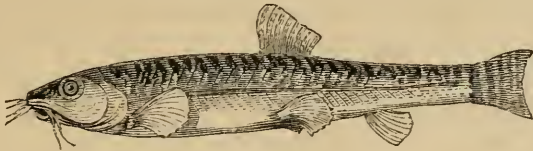


FIG. 7.

rivers and brooks, but which, from its habit of lurking under stones, is not often observed. It will live well in the Aquavivarium. It may be known from the other fish we have mentioned by the little barbules around its mouth. Many other fish have this appendage, and they are said all of them to feed at the bottom of the water. The Loach feeds upon the various kinds of worms, aquatic insects, and the smaller Crustacea. These latter sometimes abound in our ponds; and by fishing with a muslin net may often be obtained in large quantities as food for the fish of an Aquavivarium.

The GUDGEON (*Gobio fluviatilis*), Fig. 8, is another

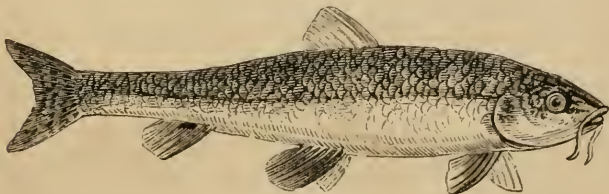


FIG. 8.

barbuled little fish, abundant in the Thames, and a very free biter, so free that he has passed into a proverb ; nevertheless, he lives well in domestication, and not being of large size—never exceeding eight inches in length—is well adapted for our domestic experiments.

Any of the other species of *Cyprinidæ* which have been obtained may be put into the Aquavivarium ; all fish should, however, be carefully watched, lest they should die. When sickening, as may easily be seen by their unsteady gait when swimming, or turning occasionally on to their backs, they should be removed and put into fresh water, and by this means they may be made to revive ; but should they die, and decay in the water with other things, great hazard is run of the loss of the whole of the creatures.

II.—INVERTEBRATE ANIMALS.

1. *Articulata*.

The SPIDERS (*Araneidæ*) take the highest rank amongst invertebrate animals. The different groups of this large family perform a surprising variety of functions. They are adapted for various modes of life, and one group live in the water. The habits of the aquatic species differ ; some live upon the surface of the water, and have their nests at the edges of the pool or pond on which they live ; another species has the power of diving ; it constructs its nest at the bottom of the water, and carries down, by a peculiar arrangement, a sufficient quantity of air to breathe under the water. This is the common Water Spider (*Argyroneta aquatica*),

Fig. 9. This species is very common, and forms an interesting inhabitant in an Aquavivarium.

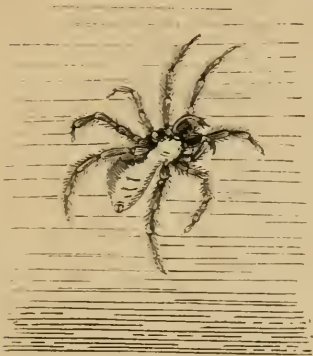


FIG. 9.

Care must be taken, however, not to place it in the same jar with fishes, or other creatures which might make it their prey. The membrane which surrounds the body, and contains the air, is transparent, so that the spider looks in the water as though its body was composed of nothing but a bubble

of air. It is very active, and is a most amusing creature.

The *Crustacea*, the family to which CRABS, LOBSTERS, and SHRIMPS belong, have not so many representatives in fresh as in salt water; at the same time, a large number of species are common enough in our fresh waters. The largest of our fresh-water Crustaceans is the Common River Crayfish (*Astacus fluviatilis*). It is found in almost all the rivers and larger streams of Great Britain, and is brought to London in considerable quantities as an article of food. I have often bought them at the fishmonger's, but must confess to not having succeeded in keeping them alive. My friend Dr. Ball, of Dublin, however, succeeded in keeping one for some time; and Professor Bell, in his classical work on the Stalk-eyed Crustacea of Great Britain, has given the following account of his pet from Dr. Ball. "I once had a domesticated crayfish, which I kept in a glass pan, in water not more than an inch and a half deep; previous experiments

having shown that in deeper water, probably for want of sufficient aëration, the animal would not live long. By degrees my prisoner became very bold ; and when I held my fingers at the edge of the vessel, he assailed them with promptness and energy. About a year after I had him, I perceived, as I thought, a second crayfish with him ; on examination, I found it to be his old coat, which he had left in a most perfect state. My friend had now lost his heroism, and fluttered about in the greatest agitation. He was quite soft, and every time I entered the room during the next two days he exhibited the wildest terror. On the third he appeared to gain confidence, and ventured to use his nippers, though with some timidity, and he was not yet quite so hard as he had been. In about a week, however, he became bolder than ever ; his weapons were sharper, and he appeared stronger, and a nip from him was no joke. He lived in all about two years."

The Entomostracous Crustacea are most of them fresh-water ; they are known from the other Crustacea by their sessile eyes, and the absence of branchiæ, or any organs to supply their place. Dr. Baird's beautiful book on the British forms of these creatures, published by the Ray Society, contain coloured illustrations of every species. They are charming objects under the microscope, as their transparent shells permit the whole of their internal structure to be seen through them. There is one species a great rarity,—the *Cancer stagnalis* of Linnæus, the *Chirocephalus diaphanus* of recent writers. It is a beautiful transparent Crustacean, swimming upon its back, and exhibiting very elegant movements in the water. It is found in abundance on Blackheath Common, and in the ponds by the road-side which are dried up for a great part of the year. It

deposits ova, which live in the mud ; and if a little of this is taken and put into water, the *Chirocephali* will hatch in a few days.

The Water-Flea (*Daphnia pulex*), and a number of other small forms, belong to this family of Crustacea.



FIG. 10.

The INSECTS constitute the largest family of articulate animals. Whole tribes of many of the orders into which they are divided live in the water. No Aquavivarium can be considered perfect without some of the varied forms of aquatic insects. Some are more common and easily caught than others, and to these we will call attention. We shall begin with the BEETLES (*Coleoptera*), as they furnish us in this country with the most conspicuous forms of aquatic insects. The largest of our insects is the great aquatic beetle called *Hydrophilus piceus*. It is the type of the family *Hydrophilidæ*, which although species are found all over the world, none are so large as in our own country. This large beetle (Fig. 10) needs hardly

any description, as it may be known by its size. The female possesses the faculty of spinning a gummy envelope for its eggs, which it attaches to water-plants ; this nest is nearly an inch in breadth, and contains fifty or sixty eggs. The young, when hatched, feed upon small aquatic crustacea and mollusca. When taking their prey, they bend back their heads so far that they make use of their backs as a table to support their food. The larva, when full grown, creeps out of the water, burrows in an adjacent bank,—where it remains for some days as a pupa, and at last comes forth as a perfect beetle.

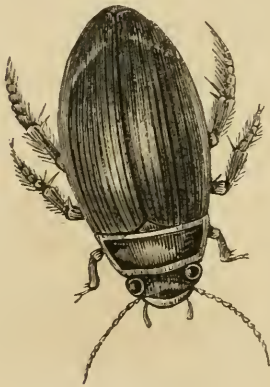


FIG. 11.

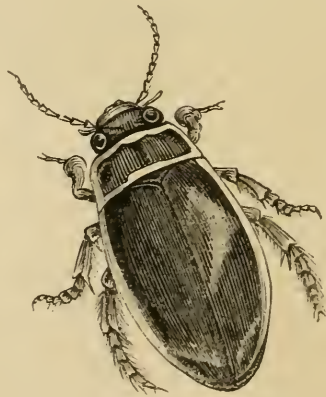


FIG. 12.

Another family of Water Beetles are the *Dytiscidae*. The best-known form of these insects is the *Dytiscus marginalis*. This is much more common than the last beetle, and the male and female may be taken in most of our fresh-water ponds. (Figs. 11 and 12.) Their structure is exceedingly interesting, and those who maintain an Aquavivarium for instruction rather than amusement,

will find in the whole structure of these creatures marvellous adaptations to their position in creation. The *Dyticus* is much more ravenous than the *Hydrophilus*, and everything eatable will suffer more or less from its attacks. Even the stickleback is no match for it, and tadpoles it devours by dozens in the day. It has no hesitation in attacking the *Hydrophilus*, though nearly twice its size. Its larvæ are as destructive and tyrannical as itself, and have got the unenviable title of "Water-Devils." I once put two into a bottle together, and carried them for about an hour in my pocket; on looking at them at the end of that time, I found, in spite of being in the dark and agitated in my pocket, that Cain had slain and eaten his brother Abel. They attack almost everything indiscriminately; the Water-Scorpions (*Nepa*) are often their victims (Fig. 13). Most of the water-beetles fly at night, and if the Aquavivarium is not covered over, they may thus be lost.



FIG. 13.

The genus *Colymbetes* is another member of the family *Dyticidæ*, and embraces species of water-beetles of a smaller size though not less interesting in their habits (Figs. 14 and 15).

The little family of Whirlgigs, also Beetles (*Gyrinidæ*), should not be neglected. They may be easily known by their whirling movements on the

surface of the water, which are one of the earliest harbingers of spring.

Another order of Insects, the *Hemiptera*, may be well represented in the Aquavivarium. Of these insects we have two very common well-marked forms, the Water Scorpion (*Nepa*),

Fig. 13, and the Water Boatmen (*Notonecta*), Figs 16 and 17. Their movements form a pleasing variety in contrast with those of other insects.



FIG. 14.



FIG. 15.



FIG. 16.



FIG. 17.

The larvæ of many of the *Hemiptera* and *Diptera* inhabit fresh water, and may be kept till their last changes are expected. In the spring, the Caddice-worms (Fig. 18), which inhabit little cases of



FIG. 18.

most varied structure, may be collected, and their habits watched. They are the larvæ of various species of *Phryganea*, and representatives of the order *Trichoptera*.

2. *Mollusca*.

The ocean is the great home of the Mollusca, but some of them live on land, as our familiar slugs and snails; and others live in fresh waters. These may be collected for the fresh Aquavivarium. We have before pointed out their office as scavengers, and a few forms will be introduced to the reader. The *Mollusca* are divided into two great families, one generally characterized by having one shell (*Gasteropoda*), the other by having two shells (*Conchifera*). The first produces the most numerous and more common examples. The Coil-Shells (*Planorbis*) are the prettiest and most useful of these animals. The Margined Coil-Shell (*Planorbis marginatus*), Fig. 19, is found very commonly in stagnant waters and slow rivers; and from its habit of eating the Confervæ, and avoiding the higher plants, is one of the most useful of the Mollusca in the Aquavivarium.



FIG. 19.

The Mud-Shells (*Limneus*) are a great contrast in form to the Coil-Shells, and the smaller species, as the Marsh Mud-Shell (*Limneus pereger*), Fig. 20, may be safely introduced into our fresh-water collections. Care must, however, be taken about the large Lake Mud-Shell (*Limneus stagnalis*), Fig. 21, which has an appetite proportionate to its size, and prefers above everything a salad of *Valisneria*. Where the vegetation in a jar or tank is very



FIG. 20.

prolific, one or two of these fellows may be put in to eat it down, but they should be removed before every leaf is cleared off. Another genus which should be represented is that of the Marsh-Shells (*Paludina*). Of these the beautiful Crystalline and Common Marsh-Shells (*P. vivipara*, Fig. 22, and

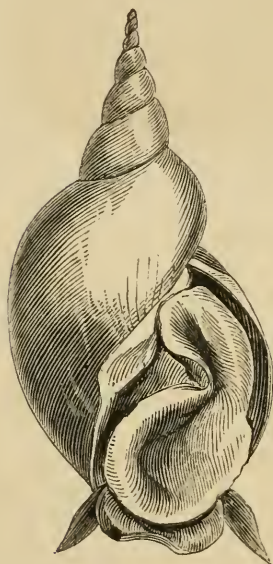


FIG. 21.

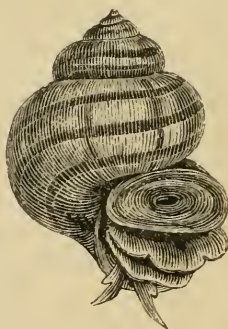


FIG. 22.

P. achatina) should find their way into every collection.

The *Conchifera* have fewer representatives than the *Gasteropoda*. Almost any of them may be introduced into the Aquavivarium. Several of them are of large size; the Swan Fresh-water Mussel (*Anodon Cygneus*) is one of the largest, and is a common inhabitant of ponds. The most interesting of our fresh-water shells is the Pearl Mussel

(*Alasmodon margariferus*), Fig. 23. It is in the shells of this mussel that pearls are most frequently

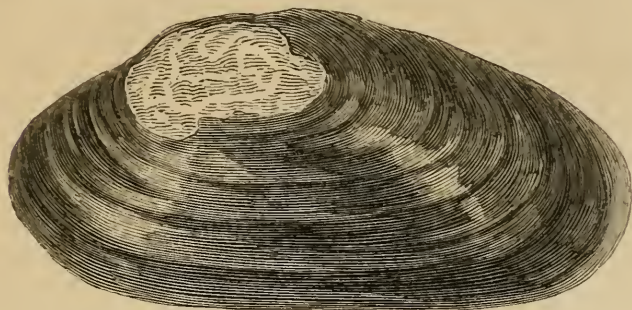


FIG. 23.

found: they occur occasionally in all the larger forms of mussels. In the inside of all shells a beautiful lustrous substance is found, called *nacre*; if this, from any cause, concretes together, it forms a pearl. Pearls may be formed artificially, by introducing some irritating substance between the mantle and shell. Linnæus, the great naturalist, was aware of this, and thought to make his fortune by the discovery. British pearls were known in the time of the Romans, and it is said the reputation of these pearls was one of the minor inducements that brought Cæsar and his soldiers to our shores. They are still procured from the mussel in the river Conway, and although inferior in size and colour to those obtained from the pearl oysters, are introduced into the less-prominent parts of the ornaments which are manufactured from them.

3. *Radiata*.

To this class of animals the various forms of INFUSORIAL ANIMALCULES (*Infusoria*) belong. Under all circumstances they will generally be

found abundant in the Aquavivarium, and will afford constant opportunity for the use of the microscope. With regard to the other forms of Radiata, few of them have representatives in fresh water. The few that exist are of great interest; thus the Fresh-water Hydra represents a very large family, found in great abundance in the sea. These creatures are called zoophytes. A family of these, much higher in organization than the Hydra, exists in our fresh waters, and by some writers are referred to the Mollusca. These animals are called *Polyzoa*.^{*} Although their general structure may be easily recognized by the naked eye, the microscope is required to examine the varied and delicate forms of the polyps of which they are composed.

Another family of the Radiata found in fresh water are the Sponges. The Fresh-water Sponge (*Spongilla fluviatilis*) is not uncommon in the Thames, and the other rivers of England. It would be an elegant addition to the fresh-water vivary, but I have never been able to make it live.

* A monograph of the British Fresh-water Polyzoa, by Professor Allman, of Edinburgh, is announced for publication by the Ray Society.

CHAPTER VI.

ON THE MARINE AQUAVIVARIUM.

MR. GOSSE'S excellent little book on the Salt-water Vivary renders it unnecessary that we should treat at any length on this department of our subject. The principles to be acted on are the same; and those who have carefully read and thought over our remarks up to this point will be already prepared to construct a marine Aquavivarium. There is no doubt that the marine collection is more difficult to manage, and requires a nicer attention to details; at the same time, it is unquestionably more interesting. The sea presents a much greater variety of forms of life than the rivers and fresh waters. These creatures illustrate more fully the great laws that govern the forms of animal life, and no due conception can be formed of the beauty, variety, and unity of design in the structure of the animal kingdom unless they are studied; we recommend, then, most strongly, attempts at the maintenance of a marine Aquavivarium. They may be started and kept going most successfully at the sea-side; but we would warn all our readers of the difficulty of moving them. Sea plants and creatures may, however, be conveniently carried in wide-mouthed jars, such as pickle-jars; and sea water may be carried in stone bottles. It is very much less trouble, and almost less expense, to buy both creatures and sea water at

some of the numerous dealers who live now in all our large towns.

In making arrangements for a marine Aquavivarium, great care is necessary that the plants grow well before the animals are introduced. Sea-weeds are of three kinds, and are coloured olive, green, and red; of these the best are the green, the next are the red. They should be introduced into the water growing upon the stones or rocks to which they are naturally attached. In the course of three or four days they will get well established, then the marine creatures may be introduced. And here let me give one caution,—*beware of overstocking*; overstocking is the ruin of nine out of ten of the collections that are made; it is the child making itself sick with its otherwise wholesome cake; it is the miser forfeiting all the happiness of life for the sake of gold; it is the drunkard killing himself with the beneficial juice of the grape. The apostolic injunction of being temperate in all things is especially necessary here. According to the size of the tank or jar, first one actinia then another, then a starfish, then a fish, may be admitted to the community; but the multiplication of them must be carefully watched, or any morning you may wake up to find corruption and desolation have seized your happy home.

Another rule which I have found of use in marine collections is, not to endeavour to keep creatures whose residence is the deep sea. The creatures that occur between high and low water-mark, or those whose residence is the next zone of depth, are best adapted for the Aquavivarium. In these localities will be found zoophytes, actiniae, starfishes, mollusca, and even fishes sufficient to give great variety to the sea-water vivary. Mr. Lloyd has published a list of upwards of fifty species

of marine animals that he has successfully kept in Aquavivaria.*

One of the most important discoveries in relation

* We subjoin Mr. Lloyd's list:—

SEA-WEEDS.— <i>Green.</i>	Bunodes alba.
Ulva latissima.	„ gemmacea.
„ lactuca.	„ thallia.
Enteromorpha intestinalis.	„ clavata.
„ compressa.	„ crassicornis.
Cladophora arcta.	Actinia mesembryanthe-
„ rupestris.	mum.
Bryopsis plumosa.	Anthea cereus.
<i>Red.</i>	Adamsia palliata.
Iridæa edulis.	Edwardsia sphaeroides.
Griffithsia setacea.	„ vestita.
Delesseria sanguinea.	Corynactis viridis.
„ alata.	—
Corallina officinalis.	NAKED and TUBED
Rhodomela subfusca.	HYDROIDA.
Gracilaria confervoides.	Clava multicornis.
Gelidium corneum.	Hydractinia echinata.
Chondrus crispus.	Coryne pusilla.
Phyllophora rubens.	Tubularia indivisa.
Polyides rotundus.	Sertularia polyzonias.
Ceramium rubrum.	„ abietina.
—	„ filicula.
ZOOPHYTES.— <i>Madrepores.</i>	„ cupressina.
Carophyllia Smithii.	Thuiaria thuia.
Balanophyllia regia.	Antennularia antennina.
<i>Sea Anemones.</i>	Campanularia volubilis.
Sagartia viduata=anguicoma	Laomedea geniculata.
„ troglodytes.	—
„ aurora.	STAR-FISHES and SEA
„ candida.	URCHINS.
„ miniata.	Uraster rubens.
„ rosea.	Asterina gibbosa.
„ nivea.	Goniaster equestris.
„ venusta.	Echinus miliaris.
„ parasitica.	„ sphaera.
„ bellis.	—
„ dianthus.	SEA CUCUMBERS.
„ aurantiaca.	Pentactes pentacta.
„ pulcherrima.	Ocnus brunneus.

to the marine Aquavivarium is, that sea water may be artificially made. I need not trace the history of this discovery; in it the names of Ward, Gosse, and Lloyd honourably appear. The only difference between sea and fresh water is, that the sea contains

TUBE and other WORMS.

Sabellaria alveolata.
 Sabella ventilabrum.
 „ reniformis.
 „ tubularia.
 Serpula contortuplicata.
 „ triquetra.
 Terebella conchilega.
 Pectinaria Belgica.
 Spirorbis communis.
 Spio seticornis.
 Pontobdella muricata.
 Aphrodita aculeata.
 Nereis bilineata.
 „ pelagica.
 Phyllodoce viridis.

CRUSTACEA.

Idotæa appendiculata.
 Palæmon serratus.
 „ Leachii.
 „ squilla.
 Crangon vulgaris.
 Hippolyte Thompsoni.
 Porcellana platycheles.
 Pagurus Bernhardus.
 „ Prideauxii.
 Carcinus Mænas.
 Cancer pagurus.
 Portunus depurator.
 Xantho florida.

BARNACLES.

Balanus balanoides.
 Pyrgoma Anglicum.

POLYZOA.

Bowerbankia imbricata.

Vesicularia spinosa.
 Serialia lendigera.
 Lepralia.
 Membranipora pilosa.

MOLLUSKS.

Nassa reticulata.
 Murex erinaceus.
 Litorina litorea.
 „ rudis.
 Natica monilifera.
 Purpura lapillus.
 Rissoa.
 Trochus cinereus.
 „ ziziphinus.
 Haliotis tuberculata.
 Fissurella reticulata.
 Patella vulgata.
 Dentalium entalis.
 Ostrea edulis.
 Anomia ephippium.
 Doris.
 Ægirus.
 Ancula.
 Tritonia.
 Eolis.
 Aplysia hybrida.
 Pecten maximus.
 „ opercularis.
 „ varius.
 Mytilus edulis.
 Modiola modiolus.
 „ barbata.
 Saxicava rugosa.
 Pholas dactylus.
 Ascidia virginia, &c.
 Cynthia quadrangularis, &c.
 Botryllus polycyclus, &c.

saline matters which have been accurately ascertained by the chemist. These saline matters, of which common salt is the principal, may be added to fresh water, and that transformation is effected by which the great Creator of all maintains the eternal distinctions between the plants and animals of the ocean and the fresh waters of the earth.

The following are the proportions in which the saline constituents of sea water exist in 100 lbs. of water :—

	Oz.	Grs.
Chloride of Sodium - - - - -	43 $\frac{1}{4}$	0
Chloride of Magnesia - - - - -	6	0
Chloride of Calcium - - - - -	1 $\frac{1}{4}$	0
Bromide of Magnesia - - - - -	0	21
Sulphate of Magnesia - - - - -	7 $\frac{1}{2}$	0
Sulphate of Lime - - - - -	2 $\frac{3}{4}$	0
Carbonate of Lime - - - - -	0	21

I now proceed to refer to a few marine creatures, rather as illustrations of the forms of sea life which may be domesticated in the drawing-room than as an account of the numberless animals which may be kept in the Aquavivarium. To begin with the Fishes. Those which inhabit the little pools left by the receding tide on the shores of our oceans, as the Father Lasher (*Cottus bubalis*), and the Water Scorpion (*C. scorpio*), the Blennies (*Blennius*), and the Conger Eel are all adapted for a marine

FISHES.

Gasterosteus spinachia.
 Cottus scorpius.
 „ bubalis.
 „ quadricornis.
 Gobius niger.
 „ unipunctatus.
 „ minutus.
 „ Ruthensparri.

Syngnathus acus.
 „ typhle.
 „ lumbriciformis.
 Murænoides guttata.
 Blennius ocellaris.
 „ pholis.
 Labrus maculatus.
 Crenilabrus cornubicus.

collection ; whilst of those that swim at a little distance from the shore, the Pipe Fishes (*Syngnathus*), the Mulletts, and the Wrasses, have a singular power of maintaining their existence in the Aquavivarium.

The Grey Mullet (*Mugil capito*) is a beautiful fish of our shores, both on the dish and in the tank, and has succeeded better than any other sea fish in the Regent's Park collection.

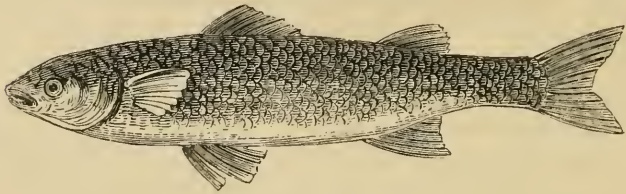


FIG. 24.

The Wrasses are extremely beautiful fish, and may vie in the splendour and beauty of their colouring with even birds and butterflies. The Ballan Wrasse (*Labrus berghylta*), Fig. 25, though

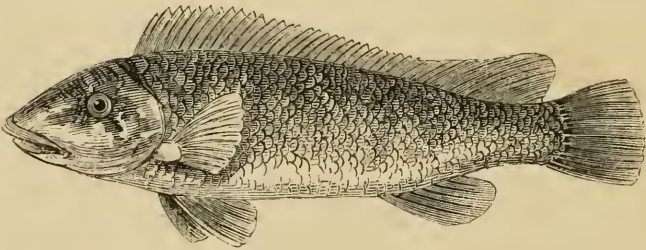


FIG. 25.

not perhaps the handsomest species, is one which lives well, and deserves every encouragement.

The Articulate animals of the sea are very numerous. The larger forms of Crustacea can only be introduced sparingly into the Aquavivarium, as they run over and devour other things. Of the Crabs, the Hermit Crab (*Pagurus Bernhardus*) is

perhaps the most interesting and amusing. He has no hardened shell of his own, and has to seek an empty mollusk-shell in which to reside (Fig. 26),

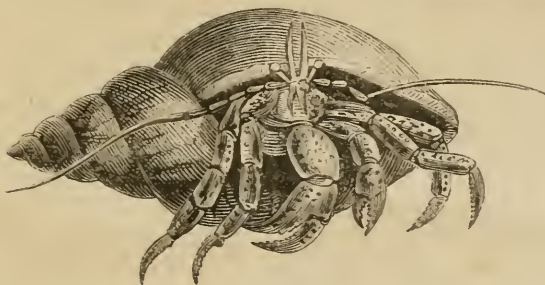


FIG. 26.

He is a troublesome though amusing companion ; he has not the slightest respect for any of your delicate pets, or elegant arrangements, but, like a rude burly fellow with boisterous spirits, upsets everything he comes near, and that with the utmost good-nature.

Lobsters, Shrimps, Spider-Crabs, and all the beautiful things named in Mr. Bell's book on the British Stalk-eyed Crustacea, when caught, may be introduced, and their habits watched ; some, as shrimps, prawns, and spider-crabs, will live only for a few days.

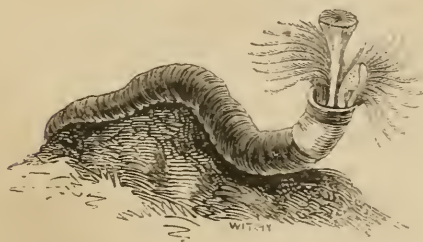


FIG. 27.

The Annelides are a numerous family. At the sea-side their forms may be advantageously studied by the aid of Mr. Gosse's most useful little Marine

Zoology. The one which of all others is best

adapted for the Aquavivarium is the *Serpula contortuplicata* (Fig. 27). This creature is a study of itself: look at that curved case attached to a stone or a rock, an old bottle or a shell. How curiously formed; that tuft of orange-coloured hairs is its gills, and the long red funnel is a sort of stopper with which it corks itself up when it retires into its tube. There are many other Annelides, such as the Sea Mice (*Aphrodite*) and the Nereids, which may be kept and watched with interest.

Four portly volumes in Van Voorst's delightful series of works on British Natural History are devoted by the late Professor Edward Forbes and Mr. Hanley to the subject of the Mollusca of our own islands alone. The majority of these are marine. Every shore abounds with some of them, and everywhere the Periwinkle (*Litorina litorea*), Fig. 28, may be secured as a scavenger for the confervæ, which grow as vigorously in sea as in fresh water. How many of these creatures we cannot even mention the fortunate possessors of Forbes and Hanley's work will see. We give the figure of an Ascidian Mollusk (*Ascidia mentula*), Fig. 29, because of their presenting quite a different type of organization to the other Mollusca we have mentioned. Those two holes are



FIG. 28.

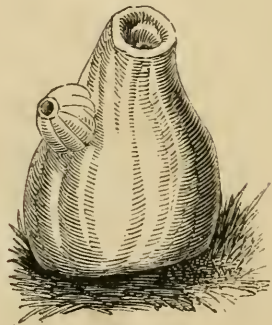


FIG. 29.

orifices through which the water passes, one carrying to the animal inside the water holding food and oxygen, the other allowing the water to escape. The Ascidians are of various sizes and colours, and most of them adapted for the Aquavivarium.

I would also draw the attention of the reader to the beautiful Nudibranchiate Mollusca. They have no shells, and are delicate creatures,—the living pearls, rubies, and garnets of the ocean. Those who wish to know more about them should consult Alder and Hancock's great work devoted to them. This work was published by the Ray Society at a cost of nearly three thousand pounds, and yet those who know these elegant creatures best will say that this money has not been uselessly spent in their illustration.

The Star-fishes, including the Sea-eggs and the Sea-cucumbers (*Echinodermata*), are another family that claim attention. They are not very tenacious of life, but are too interesting to be passed over in our marine collections. The COMMON CROSS-FISH, or FIVE-FINGERS (*Uraster rubens*), is met with on

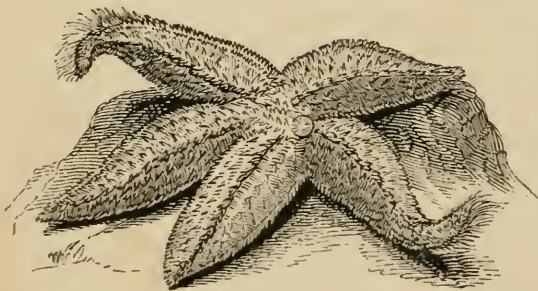


FIG. 30.

every coast. Their spines, their suckers, their beautiful cases, are all worthy of study, and they cannot be better studied than with Edward Forbes's

“History of British Star-fishes” in hand. Those who will not be charmed with both book and fishes had better give up the pursuit of natural history.

We present here the picture of a beautiful orange-red little fellow, who has flourished well in Regent’s Park, and is called the GIBBOUS RAILLET (*Asterias gibbosa*). Fig. 31.

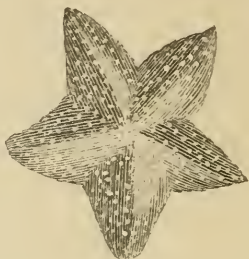


FIG. 31.

We must add one word in favour of Jelly-fishes (*Acalephæ*). These fragile, but beautiful creatures, consist principally of water. They, nevertheless, possess a varied and complicated structure. To the student of the microscope they afford unbounded facilities for study, on account of their transparency. They may be caught by means of a muslin net, which, carried along by a boat, or attached to the end of a rod on the banks of a tidal estuary, will secure, on most parts of our coast, great numbers. These, too, should be studied in the work of Edward Forbes, whose pen and pencil illustrated so wide a range of our native natural history.

The last group of creatures we shall mention before closing are the Sea-anemones—the *Actinice*. These are the glories of the marine Aquavivarium—the sea-flowers that have been grown in marine caves in the Zoological Gardens, for the special behest of those Londoners who never see them at the sea-side. To write all that might be said about them would be to write a larger book than this. Their beauties have been celebrated by Mr. Gosse, Dr. Badham, and Mrs. S. C. Hall, in their writings, and I can only confirm their remarks. If you

want to take them yourself, you must avoid sandy sea-shores, and spend your holidays amongst the rocks. You will find them at Margate and Ramsgate, the Isle of Wight, and Weymouth; in fact, wherever there are rocks covered by the sea. My illustrations extend to three.* First, the beautiful *Anthea cereus*, with its long, dependent, languid-looking filaments, which are never retracted within its body (Fig. 32).



FIG. 32.

Second, the Coriaceous Sea-anemone (*Actinia coriacea*), Fig. 33, the most common form of all the sea-anemones of our coast. It assumes a great variety of colours, from a bright orange to a dark green, and almost perfectly white. They bear almost



FIG. 33.

* For these and some other illustrations, the Author is indebted to Mr. Mitchell, Secretary of the Zoological Society, for permitting his artist to copy from the drawings illustrating the collection in the Aquarium in the gardens in Regent's Park.

any kind of treatment, and live for a great length of time. A friend of mine had some very lively ones which had been brought up from the sea-side in a wine-bottle, which had been emptied of its sea-water, and sent to a neighbouring public-house for beer. The mistake was discovered, and the creatures were transferred to their natural element, where they flourished for many months. There is a large form, called *Actinia crassicornis*, which is probably a variety of the last. Third, the *Actinia Mesembryanthemum*, Fig. 34. Like the last, it is subject to great variety of colour. It is known by the row of beautiful blue tubercles around its mouth. It lives between tide-marks, and entirely incloses its tentacles within its body when out of the water. But for further information on this and the many other interesting species of Actinia, I must refer the reader to Johnston's "History of British Zoophytes," Mr. Gosse's "Aquarium," and Dr. Landsborough's "Zoophytes."

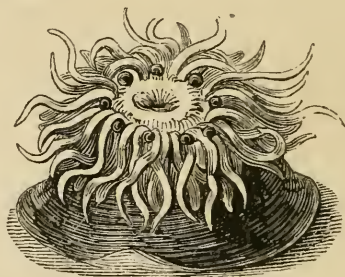


FIG. 34.

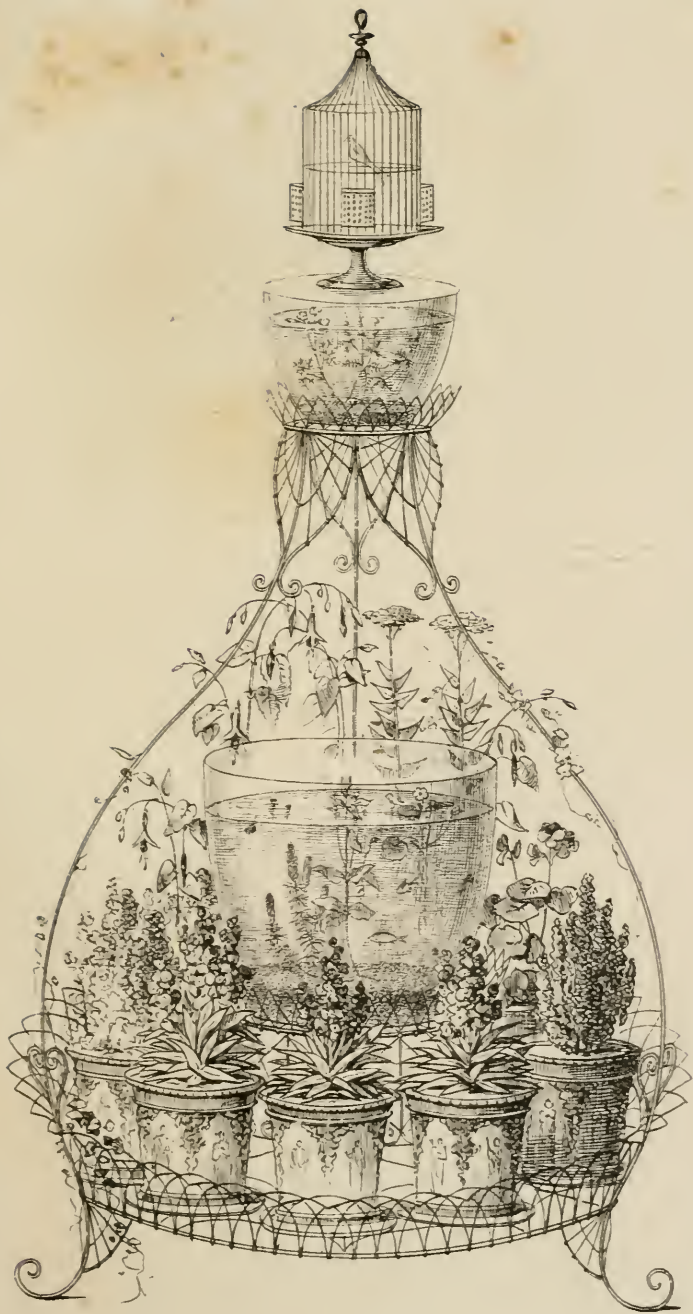
I have now finished my task, and trust this little book will contribute to a taste for the cultivation of natural history pursuits. The Aquavivarium may be made a source of amusement, instruction, and improvement. Those who commence it for amusement will, I trust, not be satisfied with that end,

but make the study of the beautiful objects it contains an introduction to the wider field of nature beyond. Such an exercise of the mind, when properly pursued, must lead to thoughts of the Goodness, Wisdom, and Love of Him—

“That plann’d, and built, and still upholds a world
So clothed with beauty for rebellious man.”

To the thoughtful student, it will soon be apparent, that the life in the glass tank, in its various forms and manifestations, is dependent on laws by which the whole universe is governed. Approached in this spirit, we shall find that our Aquavivarium may not only supply amusement and instruction, but lead the mind to the Giver of all Life and the contemplation of a universe governed by His Wisdom and His Love.





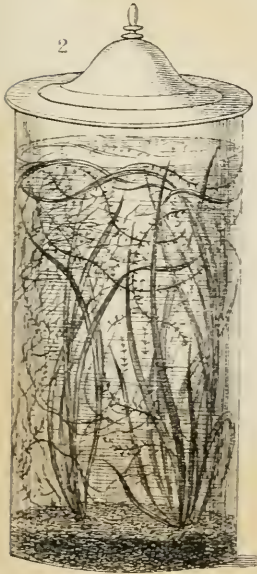
R. Hardwicke 26 Duke St Piccadilly Oct^r 21. 1856.



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