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EVERYDAY BIOLOGY

HODDER & STOUGHTON, LTD., Warwick Square, LONDON, E.C.4
THE
UNDER-WATER
WORLD

BY
E. G. BOULENGER
(Director of the Zoological Society's Aquarium)

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Chapter I  

The Origin of Life

The origin of life is still a matter of conjecture, but science toils slowly, approaching year by year nearer to the answer of a riddle that has disturbed the thinking men for countless generations. There is now little doubt that life—possibly neither animal nor vegetable but still "life"—first saw light in the waters, and there must have been a period when the oceans teemed with creatures imperceptible to the naked eye, ever striving one with another in a world wrapped in awesome silence, only broken by the winds and waves.

* * * * *

A single cell of the most primitive of living matter—"protoplasm"—differs
from a cell of crystalline mineral matter in never being at rest. It must grow or go under, for the reason—as one eminent authority has put it—that "an increase in size results in an increase of independence." Thus we find that as the single-celled animals developed, the most advanced cells not only increased in size but began to multiply and tended to dominate over their fellows.

This restless energy led little by little to the dawn of such microscopic hosts as the Foraminifera—lowly constituted, unicellular creatures that apparently realised in some mysterious way that a protecting skeleton gave them an advantage over their naked fellows. They acquired shells of carbonate of lime, such shells foreshadowing many types of shell to be used by vastly more complex animals—the mollusca—millions of years later in the world's history. Compared to the unprotected Amoebae which are
never the same shape for long, and unhampered by any exoskeleton, surround and absorb the food they come into contact with, the *Foraminifera* are somewhat restricted. Their shells are, however, perforated, and through these perforations the tenant extends filaments which enmesh the edible particles, and draw them towards their interiors. The shells of *Foraminifera* form one-third of the bed of the Atlantic, and are the chief constituents of chalk cliffs, wherever they occur. A single ounce of sand may yield one and a half million of such shells which are being deposited year in, year out, upon most parts of the world's shores, compensating for the ravages of erosion.

When once the single-celled animal contrived to not merely increase in size but to multiply and sub-divide, progress knew no bounds. In the world that was in which the brain had scarcely come
into being, the entire energy of the protoplasmic cell was concentrated upon battling with the mere physical forces that threatened it from all sides. The protoplasm of the primitive animals enjoyed amazing powers of elasticity, reproduction of lost parts, and imperviousness to what we understand as pain. The more complex the individual the greater its brain power and the less its ability to regenerate lost parts or reproduce itself by indirect methods. As we shall see, the life force in every animal works steadily and persistently for something better, compelling it to exert its powers to the utmost and to refuse to remain satisfied with that state of life in which it happens to find itself. Whatever the form taken by any individual, one factor has always to be reckoned with—change—and the creatures that progressed in a world devoid of warm-blooded animals were
those that most readily coped with the exigencies of the moment.

The strong armature of the Foraminifera was presently developed still further by the coral animals. The fortified tower anchored to one spot was well enough, but it left much to be desired. A prolonged siege, whether by animals or the accumulating silt, meant death for the garrison. Therefore at a later period the conception of a fortress which the creature could carry with it wherever it went, opened up a fresh horizon. Such an obvious necessity brought into being the innumerable crustaceans, molluscs, echinoderms and insects that we are all familiar with.

Size counted for more than "brain power" in the world of thirty million years ago. To-day the position is reversed, and the intelligent human dwarf will, every time, rise superior to the nincompoop giant in the struggle for
existence. Amongst what we are pleased to-day to designate as the lower animals—the mammals, birds, reptiles and fishes, the same principle holds good. Bulky and heavily armoured forms must eventually give way to the more intelligent antagonist—however despicable his physical development. It may be therefore argued that in view of the supremacy of brain power over mere size, such creatures as the molluscs and echinoderms should have gone under at an early date, instead of persisting as they do in apparently as great abundance as ever they did when the world was so to speak in the making. But here again the life force has been equal to the occasion, and great as the death rate may be, the birth rate is equal. The more complex the development of the individual, the lower the birth-rate.

The development of armour that could either be worn, as in the lobster, or
The Origin of Life

easily carried, as in the snail, led to the rapid multiplicity of an infinite variety of forms in a comparatively short time. Each as it came into being enjoyed "palmy days"—a halcyon period during which it ruled the world—until a fellow struggler in life's race "went one better"—and, having successfully contrived to meet the demands of a competitive world, thrust a once despotic type into the background. Thus we shall observe in each group of animal forms, reviewed hereafter, how some giant that once dominated the world had to give up its throne to some insignificant usurper. But not always, for sometimes the giant survived—at a price. As in the case of certain monarchs who have retained their regal state by withdrawing from the limelight of publicity, so some animals that at one time towered above all competitors survive as a result of discreet retirement. The regal sea-
lilies (Crinoids) that once formed veritable forests in all the seas now hide in the depths of the ocean. A ten-foot sea-lily, planted in mid-Channel to-day, would be rased to a stump in a few minutes by such modern upstarts as the wrasse. The primitive animal survives to-day in retirement, and is seldom seen save by the deep-sea fishermen. The large King Crab, or Horse-Shoe Crab, is another dethroned monarch, and is generally introduced to the public as a "living fossil." Actually it is an animal that has survived for the strange reason that it has literally no competitors. Secure beneath its roof of armour, the King Crab, in his thousands, ploughs the sands of the Atlantic coast of North America and the Pacific coast of Northeast Asia. He is useless to man and too big or too unpalatable to suit the tastes of most fishes. He is interesting as a survival from the time when arthropods
The Origin of Life

had few rivals. Developing "plastic armour" to the utmost capacity the Crustacea were early represented by the Trilobites, creatures formed to plough up the sand, the front of their carapaces shooting downwards and forewards after the manner of a snow plough. Contemporary with the trilobites were certain huge crustacea (Gigantostraca) of whale-like proportions that rowed themselves through life with broad paddle-shaped limbs. They held sway until the sharks appeared—and then vanished to be remembered only as "fossils."

Amongst the higher forms of life, the lung-fish are an interesting link in the chain of evolution. To-day these fish, in which the air bladder has been converted into a lung, are confined to Tropical Africa, South America and Australia, but in geological times they enjoyed a cosmopolitan distribution. They have survived because of their
retiring habits and great powers of endurance. Thanks to their "lungs" the African and American species are able to survive, buried during the dry season in a cocoon formed in the sun-baked mud at the bottom of a dried-up stream-bed, when all other fish have been stranded and succumbed to a variety of unpleasant deaths. Lung-fishes have been sent to the Zoo Aquarium, walled up in lumps of clay, and been admitted to a watery freedom with a hammer and chisel.

* * * *

Life, as we have seen, originated in the waters and assumed an infinite diversity of forms as time progressed. The waters were inhabited for millions of years before some adventurous creature found that a living could be made on comparatively solid ground.
Chapter II  The Rising Generation

The ocean at large has been justly called the "cradle of life." The term will be found to be specially applicable when we consider that the majority of living aquatic and semi-aquatic animals begin life as free-swimming larvae. Although often destined for a terrestrial career when grown-up, they emerge from the egg specially fitted for a life under water.

Every form of animal life hints in its early stages at the probable appearance of its remote ancestors. Man is no exception to the rule, and however nearly he may approach "perfection" in later life, he makes his début with a form highly suggestive of a simian origin. In the sea the vast galaxy of young pelagic
creatures known collectively as "Plankton" varies greatly in quantity at any given spot, according to the fluctuations of temperature and ocean currents. At one moment the sea surface in a given area may swarm with this floating life, whilst a few hours later scarcely a single individual will fall to the tow net. The direct heat of the sun, the light of the moon, and the tranquillity or turbulence of the water may all have an influence on these delicate organisms. In the tropics the plankton tends to sink below the surface during the heat of the day, whilst at night it swarms at the surface, causing the phosphorescence which may occasionally be observed in home waters. Our west country fishermen at such times speak of seas as "burning" and believe the phosphorescence to be caused by the friction of the minute salt particles. They may then refer to the sea as being "dirty," and, indeed, when plankton is
The Rising Generation

abundant a certain gritty quality in the water is appreciable to the sense of touch. The investigation of plankton ranks amongst the most recent of scientific activities, and in early times the nature of the minute animals swarming at the sea surface was subject matter for the wildest conjecture. Many of the creatures now identified as the young forms of common fish, crustacea, worms and molluscs were given separate names, and were regarded as distinct species far removed from the parent forms. The winkle and the oyster, for instance, commence life as free-swimming animals, encased in delicate glassy shells which they row through the water by means of a number of little hairs or whips that never cease to beat the water. The young of most crustacea resemble minute hob-goblins. They move more spasmodically than do the young of the molluscs and maintain their grotesque bodies in
tolerable equilibrium by means of spines and other prominencies which serve to counterpoise their disproportionate heads and tails. Hundreds of these baby crustaceans have been found in a single cubic centimetre of sea-water. Some of the most arresting examples of dissimilarity between the larvæ and parental forms have been brought to light amongst the great tribe of fishes. The fishes have naturally a large claim upon our attention by reason of their economic importance, and much work is being done in this form of scientific detective work by fishery commissions in all parts of the world. The earliest known fishes were toothless, and provided with mere "key-hole" mouths, fitted for the purpose of obtaining food by suction. In the young of many fishes that, when adult, are provided with powerful jaws of enormous gape, the mouth is but feebly developed, and the tiny creatures
would be unable to hold their own in the crowd of plankton foes through which they make their harassed way, were it not for their almost complete inconspicuousness. These larval fish are frequently all but colourless, and are quite transparent. Colour in such fishes first appears in the form of isolated spots of pigment that multiply and expand over the entire surface until they join up to form a uniform ground colour. A striking example of special protection in the young stages is that of the sun-fish, which in maturity may measure eight feet in length and weigh nearly two tons. As a baby it would fall a prey to innumerable foes but for a covering of enormous spines that make the little creature look like the tip of a giant's club. Another instance of special provision for a life at the sea surface in nursery days is offered by the enormous angler fish which is sometimes known
in the trade under the more aristocratic name of "rock salmon." When adult the angler lives upon the sea-bed, crawling about painfully by means of spade-like breast fins, and relying for sustenance upon the unsuspecting fishes which it lures within reach of its capacious mouth by means of the long flexible ray of its first dorsal fin which terminates in a wormlike expansion and acts as a live bait. In its larval and post-larval stages, however, the head is even more disproportionate than in the adult form, and would drag the little creature to the sea-bed but for an enormous air sac situated over the eyes which makes the immature angler look like a balloon. At this stage its breast fins, shaped like those of a butterfly, are enormous and propel the infant fish through the water at a high speed.

The newly-born eels that are hatched at a great depth in mid-Atlantic are leaf-
like in form and as clear as glass, not developing pigment until they are ready to enter European waters three years later. Apart from their small heads at birth they are not unlike young flat fish in general form. Yet the flat fish in maturity offers an even more amazing contrast to its infant shape than does the eel. On escaping from the egg a plaice or turbot has one eye on either side of its head, and swims in the conventional fish manner with the dorsal fin directed upwards. As it begins to grow, however, a curious twisting of the cranial bones takes place, causing one eye to slowly creep round the head until it lies close to its fellow on the opposite side. At the same time it loses its swimming powers and sinks to the bottom. To maintain the normal attitude would result in the little flat fish enjoying a very one-sided view of life. To obviate this the fish tilts
sideways, developing a more and more pronounced lilt—in some species to starboard, in others to port, as the moving eye continues its march towards the opposite side of the head. By the time the eyes have reached their permanent station the fish itself will be found to be resting completely on one side. The lower part of the body—the "blind side"—remains white and colourless, whilst the upper surface gradually becomes mottled, the colour scheme blending perfectly with the bed on which the fish lies.

The care of the young, and the ensurance of the continuation of every form of life is ever Nature's first care. In the water world elaborate precautions are observed, so that each form of life shall have some chance of holding its own and perpetuating itself in a universe that teems with enemies—both obvious and hidden. As we advance in the scale
of animate nature we find a corresponding increase in parental solicitude, many of the higher vertebrates displaying a care for their young that is only excelled in civilised man. But amongst the more primitive animals there is usually no such forethought. The instinct to mate and procreate the species is unaccompanied by any higher emotions, and the young, whether in the form of eggs, larvae or fully formed individuals, are simply broadcast—flung pell-mell into an unfriendly world on the off-chance of some or even only one of them surviving the countless dangers, and completing the life cycle. This is accomplished frequently with a lavish prodigality. In some instances—the oyster, lobster, salmon, etc.—man has stepped in and by collecting the ova and rearing it artificially, or ensuring its deposit in surroundings that ensure safety, has been able to put some check on this reckless
wastage. It is estimated that in unprotected areas only one oyster out of every two million eggs attains maturity. Fish may contain and lay an enormous number of eggs. Day has estimated that a ling contained 160,000,000, and this was for many years regarded as the piscine record until J. Schmidt, a few years ago, counted 300 million eggs in the ovaries of a large sun-fish. The cod lays over 9,000,000 eggs, the angler fish and plaice 1,000,000. Such figures may well impress one not only with a sense of precautions taken by Nature to ensure the continual existence of these creatures, but also with a realisation of the terrific odds against any individual egg ever hatching, and having hatched, surviving to maturity. It has been calculated that if every oyster born during a period of ten years could be guaranteed to survive all dangers, the river mouths would be choked and the sea-bed piled to a
depth of a hundred feet with their tightly-packed shells.

When, however, a comparatively small number of eggs are laid—a mere hundred or so, for instance—considerable anxiety is often shewn by the parents who may take various ingenious precautionary measures to safeguard their offspring through the earlier pitfalls on the road to maturity. Instances of this "wise parentage" amongst fishes might be cited almost ad infinitum. The "nesting" of the salmon and the lamprey will occur to all, the one fish clearing a space on the gravel reach with its tail, the other moving stone by stone with its suctorial mouth. The American bow-fish and the British lump-sucker both make elaborate nests, whilst the common stickleback—the "tiddler" of the London parks—offers a classic example of a fish raising a structure almost worthy of avian workmanship. The cichlid
perches of tropical countries make deep pits in the sandy streams which are guarded by the parents in turn. The fathers of the Chinese paradise fish and allied forms construct fairy-like bubble nests, in which the eggs are deposited one by one. The nests are formed of a sticky secretion and are blown on the surface of the water. The female of the so-called Nile Mouth-breeder incubates the eggs—about sixty in number—in her mouth, and many other fishes will gather the brood into their cheeks should danger threaten. The male topsail—a marine cat-fish inhabiting the South Atlantic, has a cavernous mouth in which about 100 large eggs are incubated. They are retained in the mouth until the yolk sacs are completely absorbed and the young are able to fend for themselves, a period which may extend over two and a half months. Whilst thus protecting his progeny the father takes no nourishment
with the result that on the completion of his nursing duties he is much emaciated and probably frequently dies of starvation.

In the little bitterling carp of Central Europe we have an example of a fish that foists its eggs upon a foster parent—any fresh-water mussel of large size. Spawning continues intermittently for about two days, the male enticing the lady of his choice towards a mussel. Eventually the bride protrudes a long ovipositor and inserts it in the inhalent siphon tube of the mollusc. If all goes well the baby fish grow fast and leave their strange nursery about a month after spawning when about half an inch in length. The mussel is none the worse for its experience, and in its turn spends an early stage of its life encysted on the sides of the fish.

Parental parasitism of this kind is to be met with in many different types of animals, the parasite merely making use
of its host for the purposes of incubation, whilst drawing its sustenance from some outside source. The crustacea offer numerous examples of this form of parasitism. One small form attaches itself to the tongues of flying-fish. Another lives and hatches its eggs in the gill cavity of a prawn, causing a pronounced swelling, and earning for its host the fisherman’s ribald name of “face-ache” prawn. Yet another crustacean—Sacculina—found attached to the abdomens of crabs is little more than a sackful of eggs, which hatch into free-swimming creatures suggestive of young barnacles. Such parasites are so degenerate that when adult they possess no locomotory organs, showing no indication of the class of animals to which they belong, and their true position in the animal kingdom would have remained unsolved were it not for the clue presented by their newly-born offspring.
The sponge, so familiar to us all since our early childhood, forms a fascinating link in the chain of evolution, standing midway between the simple single-celled animals and the mass of complex forms which by their ever-increasing efficiency culminated in the perfect animal—man. The ancients regarded sponges as being members of the vegetable kingdom, and their generation was, in fact, at one time attributed to a fermentation of the sea scum. As recently as 1785 the great naturalist Linnaeus, failing to appreciate their true position in the system, classified them as plants.

Sponges are hatched from seed-like eggs no larger than pin heads. They develop into free-swimming individuals furnished
with innumerable wavy hairs which violently beat the water, thus propelling the infant sponges from point to point. After a varying period the "spongeling" settles down on a coral reef, on a dock pile, or even on a living crab, and from thence onwards grows by expansion—a slow but steady multiplication of its cells. Many forms build around themselves ramparts composed of millions of minute spicules of carbonate of lime, silica, or horny substance which frequently mimic with wonderful fidelity such human inventions as the barred arrow head and the ship's anchor. The surface of the adult sponge is perforated by innumerable pores through which water enters, conveying the necessary food and oxygen for the purpose of respiration. A large hole at one end of the vase-shaped body serves as an exit for the water current which has been taken in through the myriads of minute
holes and has passed through a labyrinth of canals and chambers formed of soft living flesh. The mass of sponge may be aptly described as an under-water tenement dwelling, and the constant circulation is maintained by each individual inhabitant lashing the water with a very fine hair or "whip." The strong currents produced may be easily seen if a living sponge is placed in a small aquarium, for the scraps of dust and grit will inevitably be drawn in by the animal. Add a minute quantity of red ink, and the indrawn current will be still more apparent. Here we have digestion in its simplest form.

Sponges have no weapons, and once they have attained maturity seek no adventure, the quiet life being all they crave for. They attain their maximum development in the abyssal waters of the mid-Atlantic or Southern Pacific—pits five miles in depth, where such immense
growths as the "Venus Flower Basket" or the "Neptune's Cup" may rise to a height of five feet or more.

The sponges of commerce are the skeletons of forms which build up a network of horny substance that gives easily to the touch and will stand much rough handling. Such sponges are now farmed in all waters warm enough to permit of their culture, although the best still come from the Levant. The sponge gardeners usually perform their duties clad in their heavy diving costumes. They clip their charges, much as they would clip bushes ashore, and the cuttings are placed on suitable and protected portions of the sea-bed. The shape is carefully guarded, as it may mean all the difference between a couple of shillings and a couple of pounds when it comes to handing the finished article over the counter. The sponges, having been collected, are taken ashore and
placed in wire-netting enclosures where they die gradually. Having been dried in the sun and beaten daily for some weeks with the object of liberating the soft, rotting parts, the sponges are ready for exportation. Sponges are sold by the weight, so after the removal of the soft parts the fishermen often fill the skeletons with sand in order to make them heavier and thereby obtain a higher price. The bath sponge, which was an article of commerce in the days of Aristotle, was used by the ancients in their helmets and boots to act as an absorbent. In its living state it presents a blackish mass. It is a very slow grower, a cutting the size of an orange taking about seven years to attain to marketable size.

The fig-sponge of our shores which, as its name implies, assumes a fig-like shape, is addicted to covering the whelk shells tenanted by hermit crabs. In such
situations it fills the dual office of ensuring itself a constant change of locality and, as a result, an increased food supply. The crab bears no ill-will towards its guest, benefiting by the "camouflage" afforded by the co-partnership. When attached to a "hermit's" shell the sponge is often infected by a small crustacean—*Tritæta gibbosa*, which digs a hole in the sponge and there lives a life of idleness entirely at the expense of its host. There is in this case no question of mutual benefit, the crustacean rendering no single service.

Another crab invariably carries a small sponge upon his back, holding it in position with a pair of legs specially adapted for the purpose.

One native boring sponge has the faculty of permeating the substance it elects to grow upon, and does much damage by undermining oyster shells.
As a result of its boring activities the shells become open to inrushes of water and subject to attack from whelks and other enemies. Further, it compels the oyster to so thicken the inside of its shell as to spoil it for presentation to the ultra-fastidious epicure. On oyster farms where this sponge is abundant, the oysters are grown in frames, which are now and then raised and exposed to showers of rain, an exposure fatal to the sponge, but which does no harm to the oyster, who is able to close down.

In the tropics an allied sponge actually eats into stony coral reef, giving the outer surface of the smothered coral the appearance of a vigorous, healthy growth, alive with rose-tinted polyps. But all is rotten within and it crumbles at a touch from the yacht's keel. In some cases this parasitic sponge raises a series of spires several feet in height, resembling miniature cathedral towers.
One of the most spectacular of deep-sea sponges is the Glass Rope Sponge (*Hyalonema*). It is anchored in silt by means of a "root" resembling a horse's tail made of the finest spun glass—very wiry and as strong as a bunch of fine copper wire flex. The almost unbreakable "rope" extends some distance as a spike into the interior of the head of the cup-shaped sponge.

The simple bread-crumble sponge, one of the commonest of British sponges, is subject to great variation of both form and colour. Sometimes it is a mere clump of dull olive, clustered round a branch of sea-weed, whilst at other times it may cover great wall spaces of ocean cavern with blood-red hues. It must have been this sponge that inspired Victor Hugo when, in his "Toilers of the Deep," he wrote of a cave in the Channel Islands "as having the appearance of being splashed with blood,
as though giants had been fighting there."

The Mediterranean sponge *Chondrosia* ends its existence in a peculiarly dramatic manner. It becomes blown out to form a large transparent bag with a gas liberated within its body, and when fully expanded, suddenly bursts into innumerable small pieces, each of which eventually forms a new sponge.
WHILST fully appreciating the immense potentialities of a single cell of protoplasm with its powers of multiplication, and its capacities for assuming a vast variety of shapes, the vast diversity of forms assumed by the Cœlenterata, or animals with a "hollow interior," must strike us with amazement. And yet the plan upon which they are all built is intrinsically the same. The body of life comprised under the title Cœlenterata—the hydroid polyps, the jelly-fishes, the sea-anemones, and the corals—is represented by free-swimming individuals, tree-like growths, and great stony masses big enough to support large houses. But in all cases the animal matter is the same in general form and structure and is
termed a "polyp"—"a creature with many feet." A polyp has a cylindrical body, with one end attached to some solid base—such as a rock, and the other—the upper end, exposed to the world at large. The latter takes the form of a disc surrounded by tentacles, and is often provided with stinging cells. Through the mouth or upper end, which passes direct into the hollow body, all waste matter is ejected after being digested. When a polyp is hungry it expands, and spreading out its tentacles, which may number several thousands, flourishes them in the surrounding water until it finds something which promises a meal. An anemone has not the slightest vestige of a brain. Yet anyone trying to feed the animal with stones will find such fare will be steadily rejected; whilst if it is offered something more appetising—a piece of fish, meat or shrimp—such dainties will be
immediately accepted with enthusiasm. This is clear proof that the nerve cell has come into being. The one-celled animals blindly lash the water, thus creating a current, and must take that which comes their way. The more cultured sea-anemone—deaf, blind and brainless—has begun to develop a capacity for "selection."

The Hydroids are far more suggestive of plants than of animals. They increase by the processes of egg-laying, budding and the "alternation of generations." Budding is effected by a number of cells collecting at one side of the polyp, appearing as a sort of tumour on the parent individual, and detaching themselves.

When eggs are laid these hatch into free-swimming larvae which for some time paddle about by means of whips (flagella) and then settle on some fixed body or parent hydrozoan. In the
method of reproduction known as "alternation of generations," a fixed colony of polyps at certain seasons develops special "buds" which detach themselves from the parent stock and swim away as little bell-shaped jelly-fishes. These lead merry buccaneering lives for a time, and then lay eggs that likewise develop into larvæ, but which, instead of cruising at large, settle down and give rise to a branching colony of polyps. Some of these in their turn produce free-swimming, egg-laying jelly-fish, and so on, until presumably the end of time.

In certain hydroid colonies we find a division of labour. Whilst the majority of polyps are intent on feeding and thus maintaining the general status of the colony, a number of mouthless ones bud off, giving rise to free-swimming medusæ.

The Hydra of our rivers and ditches take the form of blobs of jelly with four
to eight tentacles, capable of enormous extension when searching the water in the immediate vicinity for food. They are a serious menace to larval freshwater fishes, and though extremely voracious cannot apparently be starved into extinction, as they can always obtain enough nourishment to exist from such microscopic creatures as infusoria.

Some beautiful hydroids are found around our coast. The most interesting is the Hedgehog Hydroid (Hydractinia echinata), which forms low scrubby growths on shells and rocks and is covered with spines. The "hedgehog" often affixes itself to old whelk shells, tenanted by hermit crabs, and thus not only enjoys continual change of hunting ground—thanks to the hermit's "wanderlust"—but also occasionally shares in the meals of the crustacean.

Certain hydroids multiply by "alternation of generation," and differ from the
majority in that each polyp is enclosed in a horny cup into which it can be withdrawn when danger threatens or when it is replete and desires an after-dinner nap.

The large jelly-fishes (Scyphozoa) are well known to all and frequently introduce themselves in an unpleasant fashion to the sea-bather. When adult they generally take the form of a large umbrella-shaped disc which may measure five feet across and weigh nearly 100 lbs. Like their close relatives the anemones and corals, many hydroids and jelly-fish menace the smaller inhabitants of the ocean with that most insidious of all weapons—poison. They may not obtrude themselves, yet they are numerous enough, and only their small size prevents our native shores from being as perilous as a tropical jungle. Magnify such creatures fifty diameters and we have monsters that could paralyse the strongest man
by a mere touch, and engulf him entire. A comparatively small jelly-fish or anemone can actually paralyse a fish four times its size, quelling its desperate struggles in a few seconds. How is this accomplished?

In the tentacles of every jelly-fish or anemone are countless capsules containing an acid liquid, and within each such capsule is coiled an infinitely fine hollow thread having at one end several minute anchors. The appliance may be compared to a miniature harpoon and line, the entire mechanism smaller than a pin's head. When touched, the anchors, with line complete, are uncoiled and flung forth with the velocity of a bullet leaving a rifle. The darts pierce the skin or armour-plating as worn by a prawn, and the poisonous fluid is injected. No wonder therefore that small victims collapse into a helpless mass of flesh that is drawn into the poisoner's interior.
The giant jelly-fish are the most formidable poisoners, their murderous weapons being larger than those of the anemones. Certain kinds are dangerous to the human bather, raising blisters similar to those produced by a nettle, though more severe and lasting, whilst certain specimens have been known to cause a fatal cramp. Potent as is the poison injected by our large jelly-fish, it is far more so in the case of a beautiful foreign example—the Portuguese Man-of-War (*Physalia*)—a representative of the *Siphonophora*—a creature characterised by a large float, shaped like a cock's comb, which projects above the surface of the water and acts as a sail. These animals are occasionally drifted to our shores by the winds or Gulf Stream, and as they generally appear in shoals of a thousand or more strong, their efficiency to put a luckless bather out of action may easily be imagined. Their stinging
powers are such that they are more dreaded than the shark by the sponge and coral fishermen. Juvenile "Men-of-War" can sink at will by expelling gas from the float, but lose this power on attaining maturity. Their chief enemy is the turtle, who devours them greedily—always closing its eyes, however, when attacking.

Certain giant species of jelly-fish are popular as shelters for young fishes and crustaceans, who thereby not only enjoy considerable immunity from foes, but obtain a quantity of animals, small creatures paralysed by the stinging cells of the jelly-fish.

At night these and allied creatures may give the most remarkable displays of phosphorescence. Mr. A. C. Hardy, a member of the recent Discovery expedition to the Antarctic, has given a vivid description of phosphorescent Ctenophora, which give out brilliant and
instantaneous flashes. "A marvellous effect was produced by vast numbers over the whole surface of the sea; it was as if we were steaming through shower after shower of submarine rockets which burst just below the surface."

The popular sea anemones and corals are similar to the jelly-fish in structure, the latter being small anemones with the power of obtaining carbonate of lime from the sea water and sometimes forming solid masses. The anemones and soft or flexible corals are represented by numerous forms in British waters and differ from the hydroid polyps, which they often resemble superficially, in the possession of a tube or gullet between the mouth and the body cavity.

The anemones, although mainly sedentary in habit, are capable of gliding slowly over any hard surface. A few are burrowers, anchoring themselves to buried rocks, and withdrawing into the
Cœlenterates

mud or sand when alarmed or "resting" after a heavy meal. Most of the species are extremely voracious and can expand to engulf animals several times their own bulk. Their stinging powers, although not as formidable as those of certain jelly-fish, are considerable, and whilst at once fatal to small animals are quite appreciable to the human touch.

The short, dark-red, yellow-spotted Strawberry Anemone, the Plumose Anemone, which resembles a lady's powder-puff, and the large, solid Dahlia Anemone, so called from its resemblance to that flower, are beautiful forms all well known to all seaside visitors interested in natural history. The Parasitic Anemone is remarkable in being usually associated with hermit crabs, adhering to and often enveloping their shells. Whilst no doubt adding to the hermit's burden, it effectively guards him from many foes. Its formidable tentacles are shot out from
its mouth in the form of long, white stinging threads, and these paralyse any small creature they come into contact with. The anemone shares all the crab's meals, bending down when the latter is feeding, and collecting any fragments that may fall from the hermit's table. One anemone—Discosoma—of the coral reefs of Eastern Asia, grows to two feet in diameter, and is the host of a small fish—Amphiprion—that takes shelter in its gastric cavity. The fish is coloured so as to harmonise with the anemone, and doubtless shares in the meals of the invertebrate besides enjoying its protection.

The soft or flexible corals may assume graceful branching growths, or dense fleshy masses that glow brilliantly when the numerous pink, red or orange polyps are fully expanded.

The mass known as Dead Man's Fingers (Alcyonium) is a common form.
Cœlenterates

The leathery "fingers," which may measure three or four inches in length, are formed of colonies of polyps and are normally pale pink in colour, but becoming dark red as the eggs begin to ripen.

In the bushy, fan-shaped Gorgonia the branching colony presents the form of a tree.

The hard or stony corals are represented in British waters by the Devonshire Cup, which may cover many square feet of sea-bed. The majority of forms, however, hail from warmer seas. The popular red coral which is fashioned into necklaces and all kinds of trinkets is found in the Mediterranean, the Ionian Islands and the shores of Algeria and Tunisia being the head-quarters of the fisheries. Red coral is usually obtained by dragging rope yarn, old nets, etc., over the sea-bed, the nets entangling large branches and tearing them free
from the main stems. When brought ashore the outer crust, or bark, constituting the most recent growth, filled with living polyps, is brushed off, the outer portion of the skeleton filed away, and the inner core polished with oil, and finally with steel. The commercial value varies according to the condition of the growth before being worked, the corals suffering much from boring sponges, worms and molluscs. The world-famed Reef-Building Corals, which form large groups of islands in shallow waters, are the result of long continued budding on the part of the polyps, whose stony castles pile one upon another as each short-lived generation gives place to the new one that follows after. Despite the depredations of burrowing animals, and such fish as the parrot wrasses and coffer fishes that literally browse upon living coral with their chisel-shaped teeth, the polyps multiply so fast as to more than
hold their own. In certain parts of the tropics navigation is in fact rendered hazardous owing to the continually changing contours of the countless reefs. In a few parts of the world coral rocks form a staple building material, and in the Bahamas and Bermudas certain harbour structures are composed entirely of finely ground coral skeletons.
The advent of the Echinodermata or spiny-skinned animals marked an epoch-making step in the course of animal progress. The Foraminifera were armoured and capable of considerable movement, but being incapable of expanding beyond the single cell, remained mere ciphers amongst the more progressive and relatively bulky coelenterates. A few jelly-fishes and anemones grew to a large size, but being on the one hand the sport of wind and current and on the other tied to one spot, suffered in their capacity for expansion. Coral may form vast masses, but the individuals forming such masses are all of negligible size. The Echinoderms have, however, not only combined defensive armour and weapons with great
mobility, but above all, have developed an enormous capacity for growth and expansion. The cells constituting these animals, whilst multiplying apace, appor-
tioned to themselves an immense variety of occupations, some forming armour, others providing motive and feeding powers.

Living Echinoderms are classified as


A number of other divisions flourished in prehistoric times, and are of interest owing to the light they shed upon existing forms.

The Sea Urchins (Echinoidea) are con-
structed on the same plan as are the starfish, but with the rays joined at their tips, and cemented together at their edges. They are generally more or less spherical in shape, but vary from the globular to the discoid. Mouth and vent are always separate, but their positions
vary greatly in different forms. All have a firm calcareous "test" made of numerous plates joined together by elastic tissue, thus giving scope for enlargement by the continuous adding of calcareous matter to the edges of the plates. The majority of forms are provided with numerous spines, fitted to the "shell" by ball and socket joints. These spines are capable of moving in every direction, and not only assist in carrying the urchin from place to place, but also effectively discourage the attacks of enemies. Between them are innumerable rows of pincers, a few of which are provided with poison glands and deal with small creatures that may threaten the delicate tissues between the plates. Certain of these pincers, used for cleaning purposes, have scythe-like blades that shave any dirt from the skin, whilst some have very fine "teeth," which serve to hold minute particles of food. The entire surface of
an urchin is in constant motion, for, besides spines and pincers, there is a regular series of "water feet." A hollow ring running round the inside of the animal gives off five canals set with numerous tubes which can be filled with water, causing them to expand and stretch forwards. One of these tubes or "feet" having taken a firm grip of the ground with its circular tip, presses backwards when another "foot" comes into play. A complex system of canals lined with innumerable hairs perpetually lashes the water and supplies a steady stream to the system of "tube feet." Once these hairs cease to beat, the animal comes to rest. A striking internal feature of the urchin is the mouth with its fine chisel-edged teeth situated on the under surface of the animal.

Urchins reproduce by laying eggs, our commonest form depositing about 20,000,000 in a year, and the egg masses
whilst still attached to the inside of the shell are regarded in Southern Europe as a great delicacy. The eggs liberated in the spring give rise to free-swimming larvae, which presently sink to the bottom and give rise to perfectly formed urchins the size of a pin's head.

Innumerable changes are rung upon the comparatively simple shape of the urchin. Many species have immensely long spines capable of inflicting painful stings and breaking off in the flesh of the aggressor. In some of the tropical forms the spines are as long and thick as large cigars, and these carry the urchin over the sea floor at a considerable speed. Curious are the shield urchins known as "sand dollars" in America, for they are almost as flat as a coin, and by reason of their extreme compression cannot right themselves when placed on their backs as can the more globular and spinose forms. "Sand dollars" are
largely used in the manufacture of an indelible ink.

The Starfishes have the rays free, instead of united, as in the urchins, and so enjoy much greater freedom of movement. Very large specimens may travel at the rate of a quarter of a mile on the flat, and are capable of squeezing into the narrowest rock fissures and crevices. They have yet another great advantage over the urchin. The free rays can be used as arms, and are employed to hug the oyster or other bivalve mollusc in a deadly embrace that ends in forcing the valves asunder. The common starfish, indeed, has cost the oyster farmer countless millions of pounds. Some starfish reach a very large size, a form common on our west coast attaining a span of two feet, whilst a Papuan species exceeds a yard across the arms. Whereas a fairly heavy blow ends the sea urchin's career for good, the starfish is almost
indestructible by mere mutilation, for, if torn limb from limb, each ray will reproduce yet another ray. The larval starfish is very unstarlike in farm, being little more than a grotesque stomach surrounded by hairs which slowly propel it over the waves. In a very short time, however, the upper and lower halves of the star form about the stomach and the creature sinks to the bottom ready to face life. The so-called Cushion Stars recall certain fossil forms that stand midway between the starfishes and the urchins, their rays being so short and thick as to admit of little exploration of rock crannies.

In the Brittle Stars (Ophiuroidea), which have a world-wide distribution, the arms are sharply defined from the central disc, and each limb is supported by a series of plates that work one upon the other like vertebrae, by means of very powerful muscles. Whereas ordinary
starfish creep, brittle stars stride over the sea floor in a very purposeful manner. The popular name is derived from the readiness to discard limbs, not merely upon injury, but upon the slightest touch.

Allied to the brittle stars are the basket starfish, in which the five rays divide and subdivide until the central disc is lost in a maze of gracefully intertwining tendrils. A basket star when young resembles an ordinary brittle star, but on gaining maturity has developed over eighty thousand branches. The creature walks on the tips of these branches with the body raised above the sea floor, the many serpentine arms enclosing fishes as in a net.

The Crinoids or Sea Lilies known to-day are but scattered survivors of a race that must have covered much of the sea-bed in times past. A sea lily may be compared to a brittle star mounted
on a stalk, the mouth pointing for ever upwards, and the arms branched.

The beautiful pink Rosy Feather Star, the only British Crinoid is, in its early stages, planted on a calcareous stalk, anchored to weeds, corallines, etc., but late in life the feather star breaks away from the stalk and lives on the sea floor amongst dense vegetation.

The Holothuria or Sea Cucumbers, so called from their superficial resemblance to that vegetable, are more uniform in shape than the urchins and sea stars. The body is always elongate and is sparsely armoured, the tough skin carrying a number of scattered spines instead of plates. A number of branched tentacles surround the mouth. Some sea cucumbers attain a very large size, a North Atlantic species exceeding a length of two feet and a diameter of a foot. A common form just below tide limit on
our coasts is the Sea Gherkin (*Cucumaria saxicola*), which is greyish-white in colour, with violet tentacles. It lies prone on the sea-bed or, by means of its suckered tube feet, perches vertically against rocks, and in such situations one may watch its ten tufted arms, like ten grotesque hands, snatching invisible tit-bits from the surrounding water, and methodically placing them in the circular mouth. In our largest native species—the Cotton Spinner (*Cucumaria niger*)—which frequents deep water, the tentacles that can be completely withdrawn are covered with a roll of tough skin. When molested it throws out masses of white threads, which swell on contact with the water, and like the threads thrown out by certain anemones, entangle all kinds of creatures, even quite large fish, that may come into contact with them. The cotton spinner, like all the members of the order to which it belongs, is capable
in case of injury of growing new parts, including internal organs. Certain kinds of sea cucumbers—"Trepang"—being specially rich in gelatine are regarded as great delicacies in the East. The principal fishery is on the Barrier Reef, and gives a turnover of some millions of pounds annually. The cucumber having been split, cleaned and dried in "smoke houses" where they shrink to about one-third their natural size, resembling charred sausages, are shipped to every quarter of the globe where orientals congregate.

One species of sea cucumber makes a habit of harbouring within its body slender fish half a foot in length. A number of fish may inhabit the same cucumber, and in the aquarium at Naples as many as seven have been recorded as passing into the echinoderm one after the other. The entrance of the fish is obtained at the time when its host is
obliged to dilate its anal aperture for the purpose of the expiration of water. The fish is of more or less nocturnal habits, resting within the body cavity of the cucumber during the daytime, only leaving its host at night in order to embark on a foraging expedition.
Chapter VI

Worms

Under the title of *Vermes*, zoologists have gathered together a heterogeneous collection of animals, popularly known as Worms. The great majority are aquatic, and some directly affect man in a variety of ways. Many impress themselves upon us as dreaded parasites; quite a number form the staple diet of edible fishes, whilst one species at least is a popular human food in the Far East.

Of the Annelids or Ringed worms many are abundant in home waters. Most forms have a long cylindrical body made up of a series of rings, and a head with a comparatively well-developed brain, eyes, feelers, and a retractile proboscis. Each segment is provided with a pair of two-lobed feet, furnished with bristles and
hairs, and which serve for walking, swimming, and in a few forms, for breathing. The powers of regeneration which these worms possess are very remarkable. If cut in half the head grows a new "tail-end," and the hinder portion a new head. Some, if split longitudinally, still go marching on, the lost side being grown again in a comparatively short time, material for the purpose being taken from the original side, the entire worm losing in length as it gains in thickness.

One of our best known members of the group is the Sea Mouse (*Aphrodite aculeata*), a stoutly-built creature covered with prismatic bristles measuring nearly half a foot in length. It is a favourite item in the diet of many bottom-feeding fish. Nearly allied is the common Rag Worm (*Nereis diversicolor*), and the Hermit Crab Worm (*Nereis fucata*) that foists itself upon the crustacean, sharing
its borrowed shell—and its meals. The big Lug Worm (*Arenicola marina*)—the popular bait—is a burrower, and makes the well-known worm castings seen on all sandy shores at low tide, and which, like the castings of our common or garden worm, are simply composed of waste matter passed through the creature's lengthy alimentary system. Whilst the lug worm is content merely to hide itself in the sand, many worms mingle the sand with carbonate of lime obtained from the sea-water, converting the resulting mixture into serviceable dwellings. In a few cases the tubes are formed of sand saturated with a glutinous secretion. The so-called Sand Mason (*Terebella conchilega*) forms the stubble-like stalks often seen protruding from the sand at low tide, whilst the Comb Worm (*Pectinaria koreni*) makes a long thin tube as straight and rigid as a pencil. All protrude tufts which are
often gorgeously coloured, the tube with the gill plumes fully extended resembling some long-stalked delicate flower.

The resplendent Peacock Tube Worm (*Sabella pavonina*) which protrudes long green and purple gill-filaments, erects stout sandy turrets of such strength and profusion as to form wave-resisting reefs on certain parts of our south-west coast.

The Leeches are familiar members of the annelid tribe, one species being still used in medicine, for which purpose it is extensively bred on the Continent. They have powerful basal suckers, and circular mouths rimmed with saw-edged teeth, by means of which they attach themselves to their prey. Only one species is marine.

The Nemertines or Ribbon Worms have long, unsegmented ribbon-like bodies capable of great expansion. The group’s most striking characteristic is the proboscis, which is retracted into a
sheath extending through the head and body. When in action this organ is shot forth, and its sucker-like tip fixes upon the prey with a tenacious grip. A striking example found on our shores is Lineus marinus, the Boot Lace Worm or Fishing Line Worm. The creature, which may reach to a length of ninety feet when fully extended, lives upon small fish which it "plays" until exhaustion renders the quarry quiet enough to be swallowed. When replete and resting the worm is very unlike a bootlace, in appearance resembling a mass of ox liver.

Allied to the worms are the Rotifers or Wheeled Animalcules which, owing to the incessant motion of the hairs on the front of their bodies, give the appearance of minute rapidly rotating wheels. Although very unwormlike in shape it is believed that they are descended from ancestors resembling the larvae of true
worms. There are fixed and free-swimming forms, all of which are visible to the naked eye. The fixed species are encased in gelatinous sheaths which become covered with debris, or are deliberately reinforced with a stony wall, built up "brick by brick," each "brick" being set neatly in position. The tower is, in fact, built up in courses with almost human precision.

The position of the Polyzoa or Moss Animals in the scale of life appears to be doubtful but they are generally regarded by modern zoologists as not very distantly related from the worms. Moss Animals live together in great masses, though each minute individual is encased in a separate chamber of horny or calcareous substance. The colonies often bear a strong superficial resemblance to corals but are much more highly organised, each individual animal possessing an alimentary canal, mouth and vent.
The bright orange or pink *Lepralia* or Ross is very abundant on our west coast and forms huge stony masses six feet or more in diameter. Certain modified individuals of this group occurring on polyzoan colonies and termed *Avicularia*, bear organs which have much the same functions as the pincers of Echinoderms. They bear a grotesque resemblance to the skulls of birds of prey, the "skulls" being mounted upon perpetually swaying necks.
Chapter VII  Crustaceans

Both as regards number of species and individuals the Crustacea exceed most other groups of animal life. A lobster and a wood-louse have little in common at first glance, yet these two creatures, like all the members of the order to which they belong, are built upon much the same plan. In all crustaceans the body is divided into segments, each bearing a pair of limbs which may serve such a variety of purposes as walking, swimming, fighting, feeding and digging the home burrow. A few crustaceans are terrestrial, but even amongst these their infancy with a few exceptions is spent in the water. The great majority are aquatic, "peopling" every pond and stream with unseen millions, the forms
visible to the naked eye being comparatively few and far between.

Crustaceans are enclosed in a crust or shell composed of a tough elastic substance allied to horn and often strengthened by carbonate of lime. It does not grow with the animal and has consequently to be cast periodically—at frequent intervals in infancy and more rarely as maturity approaches. When a lobster moults, the fleshy parts of the animal are withdrawn through a crack in the middle of the carapace. The operation is a lengthy and tiresome one, since the large claws, the head including the eyes, the body and even the lining of the stomach must all be drawn out of their cases. The new "shell," which is always in the process of forming beneath the suit actually in use, hardens after about a week’s exposure to the water. The power of regeneration of lost parts is common to all crustaceans, damaged
limbs being discarded and renewed after the next moult. Propagation in these animals is always effected by means of eggs which usually hatch into larvæ quite unlike the parent form.

A number of the animals included in this group are familiar owing to their large size and economic value. The crustacea differ from the insects and arachnids in having two pairs of antennæ in front of the mouth; in the possession of three or more pairs of jaws behind the mouth, in the peculiar disposition of the "walking legs," and, with very few exceptions, in breathing by means of gills. The Macrura, or long-tailed crustaceans, includes the prawns, shrimps, lobsters and crayfishes. These, together with the hermit crabs and true crabs, are known as the Decapod or ten-footed crustaceans, having five pairs of legs, the first being often developed to form pincers which may, as in certain lobsters
and crabs, almost equal in bulk the rest of the animal.

The common lobster, which may attain a weight of 16 lb., breeds between July and October, and the eggs—usually about five thousand in number—are carried by the female attached to her abdomen. The young on hatching, unlike its fresh-water relations the crayfish, bear no resemblance to the parent form and lead a free, independent existence. The growth of the animal is very slow, from ten to twelve years being required for a lobster to attain to a length of a foot, and during this period it will have passed through at least twenty-five moults.

Lobsters are frequently sent to the Zoo aquarium packed in damp seaweed. Now if such animals immediately after a long journey were put direct into the tanks they would drown, their enfeebled bodies having become filled with air en route. To bring them round
they are therefore, on arrival, laid upon their backs in quite shallow receptacles filled with just enough water to partially cover them. In these they remain for one or more hours bubbling out the air inhaled on the journey. When the gill chambers become once more filled with sea water the patients are able to turn over without assistance, and are then considered to have recovered sufficiently to appear before the public.

The handsome reddish-brown rock lobster—the *langouste* of the French—may measure two feet from head to tail. The antennæ, which are nearly half as long again, are responsible for certain musical sounds which are produced by rubbing the basal joints against the sides of the beak. The "music" produced has been compared to a beginner's effort on the double bass. The antennæ serve also as a form of wireless apparatus, being fringed with hairs provided with nerves
which are directly connected with the creature's brain. These are supposed to transmit and pick up the vibrating messages in the surrounding water.

One other British crustacean produces loud sounds under water. This is the little ruby-tinted "snap" lobster (Alpheus rubra), common on the south-western coast in deep water. The "finger" of the big claw of the creature works on a trigger principle and snaps with sufficient force to be audible at a distance of several yards.

Amongst the most entertaining inhabitants of the under-water world are those hermit crabs who spend the greater part of their lives in one long struggle to cope with the housing problem. The true hermits have the abdomen free but devoid of armour, and to remedy this defect they hide in empty shells or beneath the shelter of sea anemones. The size of a hermit is dictated by the
shells in its immediate vicinity, and consequently the largest forms are found in the tropics. All are crabs of great energy and enterprise and are, when not occupied in house-hunting, engaged in foraging, feeding and open conflict. Every time the animal moults he increases in size and is then forced to search for a new home. Large numbers of possible residences are examined before the hermit settles down in what in his view constitutes the ideal home. If a suitable empty shell is not available he may attempt to eject the sitting tenant, with the result that a fight to death ensues, the victor being rewarded with a meal as well as a home.

These crabs are expert climbers, scaling steep rock faces with ease. On Cocos Island giant hermit crabs, hampered with shells weighing a pound or more, make nightly inland journeys for the purpose of raiding birds' nests twenty
or more feet from the ground. Early explorers were puzzled by the presence of large marine shells high up on the mountain sides, until it was discovered that they had been carried there on the backs of the crabs that had died—possibly from a too long absence from the sea. In many hermits the gill-chambers are so constructed that the animal can spend considerable periods out of water. This is very marked in the robber crab of Christmas Island which lives in burrows lined with the fibre torn from the coconuts. It lives largely upon fallen nuts, but will on occasions climb up a forty-foot palm tree to obtain fresh fruit. Having gathered the nuts it breaks in the eyelet holes with its immense pincers and feasts on the kernel. But the robber crab is not confined to a fruit diet, for like most crabs he is a scavenger. He closes the door of the burrow with one big claw
just as our native hermit crabs close their doorways of their borrowed shells. The rat investigating a robber crab's retreat usually meets with an untimely end, its body being neatly disposed of by the robber. Matrimonially intent robber crabs make annual pilgrimages to the sea, where the eggs are laid and the young pass their childhood.

A large number of relations of the true hermit crabs are inhabitants of very deep waters. It may here be as well, therefore, to refer to some of the leading characteristics of the deep sea crustacea. At a depth of several miles the floor is apparently composed largely of ooze into which the normal weighty animal would sink. Deep-sea crabs, lobsters and prawns are, however, notable for the immense length of their limbs which may measure twenty times the breadth of their bodies. Thus, like some herdsmen in the swampy plains of Hungary, they
walk poised upon stilts. Other notable features of these crustacea are the enormous size of their eyes and their luminosity. One deep-sea prawn at least can pour out from glands at the base of its antennae rolling clouds of a ghostly pale blue light that can illuminate surrounding objects. Others are lit up by special organs—"photophores"—upon their bodies or heads. The light may serve a variety of purposes. It may attract prey, light up hunting grounds, or help to keep the shoal together.

The short-tailed crustacea or crabs are derived from lobster-like animals that by a constant "tucking-in" of the tail, the better to burrow or hide in rock fissures, have reduced that organ until it serves merely to support the ova. No crab can use its tail to project itself forcibly through the water in the manner of a shrimp or lobster. The diversity of form amongst crabs is remarkable. Some
have the limbs attenuated as to resemble weeds, others have them developed into flattened paddles with which they take swallow-like flights through the water. The circular, bashful crab of our coasts has the limbs so flattened that the animal, when they are tightly folded under the body, resembles a smooth boulder and can submit to being rolled about by the waves on a rough bottom without sustaining injury. Although chiefly inhabitants of salt water, crabs are nevertheless occasionally found high up in mountain streams, and in the tropics are often abundant inland, where they may do serious injury to the crops. One form from the Barrier Reef measures just over a foot across the shell. It has a claw six times as large as that of the biggest lobster, and such monsters may be responsible for the ghastly stories told of shipwrecked mariners being eaten alive on Crab Island in the Pacific.
The widely distributed, triangular-shaped, small-clawed spider crabs deck themselves with various articles such as seaweed, pebbles and shells, relying for safety upon their powers of camouflage. In some species the shell has a smooth surface that offers good anchorage to such growths as sponges, but more often one beset with hooks and bristles that serve to retain seaweeds. These the crab deliberately plants in position, first chewing the roots to render them frayed and more adhesive. Unlike most crabs the members of the spider family are so jointed that they can reach backwards and so touch any parts of the carapace. The common British species labours unceasingly in bedecking itself and if stripped of its covering will at once set about its toilet in order to re-acquire a camouflage suit. The largest spider crab, a native of Japanese seas, covers eighteen square feet of floor space. This
giant, much dreaded by the pearl divers, is regarded as a delicacy. It is common at a depth of 600 feet or more, but at certain seasons enters shallow creeks and inlets when it is caught in traps. When captured a dozen or more men unite in pinioning the creature and lash it to a bamboo frame like the spoke of a wheel. A limb is tied to each spoke and the crab is then sold "per joint."

The crustaceans belonging to the order Stomatopoda have long bodies and scythe-like fore limbs which recall those of that terrestrial insect hypoint, the praying mantis. With these limbs they catch fish, shrimps and other prey, and can inflict painful wounds on the incautious hand. The common European species (Squilla mantis) drives long, tortuous burrows in gravel or sand just beyond the low-tide limit, and comes forth to feed only at night. The mother squilla lays several thousands of eggs,
which she rolls into a ball and carries between her mouth parts until the young hatch out—a period of two to three months. The larvæ pass through many grotesque stages and attain a larger size than the parent form. Squillas are regarded as a delicacy in many parts of the world. In Italy, where they are usually fried in oil, they are served in the restaurants under the name of "scampi."

Certain minute crustacea, abundant in fresh-water and brine pools, are of special interest. They are built on a primitive plan and approximate to what geologists believe to be the ancestral form. Closely allied is the transparent fresh-water "flea" *Daphnia*, which is sometimes so abundant as to tint pools and sluggish streams a dull red. The carapace is in the form of two flattened valves, and the long antennæ are employed in swimming with a peculiar jerky motion. *Daphnia* may be recommended for microscopic
study since its extreme transparency permits a clear view of all its internal organs. Apart from the zoologist few appreciate the fact that the familiar barnacle is a close relation of the crabs and lobsters. Up till the early nineteenth century, when the larval stages were first made known, it was classed as a mollusc. We now know that the newly-born barnacle is a free swimming animal with a typical crustacean physiognomy, with three pairs of legs and a conspicuous third or median eye. After a time it attaches itself by the head end—provided for the purpose with a special cement—to a rock or other solid object and acquires the stout armour characteristic of the adult. Certain species attach themselves to living crabs or lobsters, others to molluscan shells, and a few even to living whales and turtles.

The Goose Barnacles, so-called from the ancient belief that they turned into
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ageese, retain the head portion in the form of a tough, leathery stalk, six to ten inches in length, which attaches them to some solid matter—usually floating timber.

The sea-lice force themselves on our notice in different ways. Some are parasitic upon fishes, whilst others do immense damage to timber. One form (Limnoria), which resembles a miniature wood-louse, has proved a regular scourge to man, especially in the old days before the general use of iron and concrete. It rendered our large ships unseaworthy, driving deep tunnels one-tenth of an inch in diameter into the solid oak, whilst in recent years it has been found boring into the insulated coverings of submarine cables at a depth of nearly 300 fathoms. The creature swallows and digests the wood which it gnaws, but it is not known whether it ever partakes of any other form of food.
Chapter VIII Aquatic Insects

When one considers how insects, as far as numbers are concerned, have dominated the land it is rather surprising that more have not invaded the waters. Insects have shown themselves to be capable of great adaptability since their advancement from the primitive stock, and one would have expected that this faculty would have been instanced in the invasion of the waters to a much greater degree than is actually the case. For various reasons, not to be gone into here, insects have never exceeded a length of eighteen inches, and it is possible that size limit may be partially responsible for this lack of enterprise. Again, although terrestrial insects are preyed upon to a considerable degree by
the other inhabitants, their enemies are small in numbers when compared with the aquatic animals seeking to devour such feebly armoured creatures. Insects undoubtedly first appeared on land and their breathing apparatus has had to undergo special modifications before it could extract the necessary oxygen from the water. The theory that insects were primarily land forms is justified, not by fossil remains, at the best fragmentary, but by the universality of the land type of breathing apparatus, which obtains also among the semi-aquatic species. These latter are much less numerous than the former and in their turn outnumber those purely aquatic.

All insects obtain oxygen by means of external valves, known as spiracles, leading to an internal system of air tubes. These spiracles are, in the case of terrestrial insects, distributed along
the sides of the body. Many aquatic insects, however, have all the spiracles closed with the exception of one pair at the head end and one pair at the apex of the abdomen. More commonly, only the terminal abdominal spiracles are functionable. This adaptation of the breathing apparatus obtains in most of the mature aquatic insects and in some of the larvæ. Other kinds of aquatic larvæ have no functionable spiracles, but are provided in their stead with a varying number of lateral or terminal processes known as tracheal gills. Many of the adult aquatic insects obtain their supply of oxygen direct from the air by rising to the surface of the water and bringing the tip of the abdomen into contact with the air. Various methods are employed to retain on some part of their body a supply of air so that some time may pass before it is necessary for the insect to rise again to the surface.
Insects associated with water may roughly be divided into three classes. First, there are those that live in the water during both their early and mature stages; second, are those that are aquatic only during the earlier or larval stage, and third, there are the inhabitants of the surface that do not penetrate into the depths.

In speaking of the members of the first group, as wholly aquatic, it does not necessarily mean that they are unable to leave the water for varying periods; many of the beetles and water-bugs fly at night from pond to pond in search of fresh food supplies or when hunting for mates during the breeding season.

Many of the orders and several of the families into which the great class, Insecta, is divided have representatives that can be placed in one of the above-mentioned groups. There are families
all the members of which are aquatic and others, very great in numbers, that have only a few aquatic species, the majority being terrestrial.

Contained in the first group, the so-called wholly aquatic insects, are many interesting forms and of these some of the beetles (Coleoptera) are specially worthy of mention.

There is one found commonly in ponds in this country. It is quite a large insect, being a little over an inch in length. Carnivorous in habit and known scientifically as Dytiscus marginalis and popularly as the "Voracious Water Beetle," it justifies the latter name by catching and devouring many of the smaller and less well protected denizens of the pond. Dytiscus is a strong swimmer, the hind pair of legs being especially adapted for the purpose and are used together after the manner of oars. The females have the wing-cases
grooved, while those of the male are smooth. The feet on the forelegs of the male are expanded to form discs that act as adhesive suckers; these sucker feet are used as grasper and are brought into play during the breeding activities. The female deposits her eggs in the stems of aquatic plants and the young larvæ, after hatching, lead an existence as active and voracious as that of the parents. Both larva and adult require to rise to the surface for air and a supply is carried down, in the case of the adult, in a cavity under the wing covers and by absorption into the system through the terminal air passages in the case of the larva. When feeding is in progress the juices of the victim are sucked through channels in the larva's jaws, the skin being cast aside when empty. The fully-grown larva, when about to pupate, makes its way into the soil at the side of the pond and there
fashions a cell in which it may undergo the transformation with some degree of safety.

Another beetle, somewhat larger than Dytiscus and of different habit, is one (Hydrophilus piceus), known, sometimes as the "Great Water Beetle" and sometimes as the "Silver Water Beetle"; this latter name has been gained by the beetle's method of carrying its air supply underneath the body where it is displayed as a beautiful silvery covering. The way in which this air supply is obtained is very remarkable. The apical joints of the antennae act by means of an arrangement of hairs as a sort of scoop which, when thrust above the surface of the water, retain and transfer to the underside of the abdomen a bubble of air. Good architectural powers are possessed by this beetle. The female constructs, with some gum-like material she secretes, a little flask-shaped cocoon
in which her eggs are deposited and kept free from harm until the larvae hatch. This cocoon is usually attached to the floating leaf of some pond weed and has at one end a neck protruding above the surface, admitting air to the interior. The case, which may well be called a cradle, is quite waterproof. The young larvae, on hatching, make their way out through the bottom. The adult beetle, unlike Dytiscus, is usually herbivorous, only turning its attention to a meat diet during the breeding season: the larvae, however, prey upon various forms of pond life. When about to pupate the larva forms a cell in the soil of the pond side and there undergoes the wonderful transformation. Hydrophilus is not nearly such a strong swimmer as Dytiscus, for the legs work alternately and are not so well adapted for swimming. Once common in this country, this species is now somewhat rare; but on
the Continent it is still to be found in numbers.

Some species of the large family of leaf-eating beetles (*Chrysomelidae*) have larvae that are aquatic. The forms belonging to the genus *Donacia* frequent the surface plants of ponds and streams and lay their eggs on the leaves. The resulting larvae, which are grub-like in form, fall to the bottom and feed on the roots of such plants as water-lilies, broad-leaved pond weed, etc. They obtain their air supply, by means of two abdominal spines furnished with spiracles, direct from the plant roots. A cocoon is formed on the roots and the pupa inside is also able to tap the plant for its air supply.

Turning to the order *Hemiptera* that contains many and very varied forms of bugs, one finds such thoroughly aquatic insects as the Boatman and the Water
Scorpions which are to be met with in almost every pond.

The Boatman (*Notonecta glauca*) is a very active inhabitant of most ponds in this country and other members of the family are widely spread throughout the world. The habit of swimming on the back with the aid of the hind legs moving exactly like a pair of oars has earned for these insects their popular name. The supply of air is carried beneath the wings. Eggs are laid in the stems of aquatic plants and the young larvæ are small editions of their parents; but possess only very rudimentary wings. Boatmen are very predaceous. If kept in a small aquarium they will attack the other inmates, be they small fish, tadpoles or insect larvæ, and obtain their nourishment by sucking the juices of the victim through a large proboscis. If handled carelessly the Boatmen are capable of
piercing the skin of one's hand in a very painful manner.

Closely allied to the Boatmen is another family (*Corixidae*). These insects do not swim upside down, but in shape and general appearance resemble their cousins. The eggs are attached to aquatic weeds by means of a glutinous substance and are sometimes in such numbers as to form quite a large mass. In Mexico the Indians consider the eggs a great delicacy, and to obtain them they place in the water bundles of reeds and later collect the egg-masses that have been deposited on them. It is said that in Egypt and Mexico the adult insects also are eaten.

The *Belostomidae* is a family containing the largest known water insects, *Belostoma indica*. It measures nearly five inches in length and is heavily built. There are no British representatives of this family, which occurs in India, South Africa and
North America. All are very predaceous; *Belostoma indica* seizes an Indian toad by the underside and sucks steadily until it has exhausted the juices of its unfortunate victim; fish also are attacked. A puncture from the proboscis of Belostoma is extremely painful and is said to be poisonous. In some species of this family the eggs, until hatched, are carried on the back of the male. The eggs of *Belostoma indica* are laid in clusters on the stems of plants growing at the water's edge, the young insects falling into the water on hatching. The young are small editions of their parents; but lack wings and wing-covers, which gradually appear as maturity is reached.

The Water Scorpions (*Nepidae*) are remarkable insects. They are sluggish creatures, lying half buried in the mud or crawling slowly about the weeds. There are two main types, one of which
our *Nepa cinerea* is a good example. It is broad and extremely flat, somewhat leaf-like in appearance. There is an appendage at the apex of the abdomen consisting of two bristles that, together, form a tube through which air can pass. The front legs are especially adapted for the capture of the prey, for, like the Boatmen, the Water Scorpions are carnivorous. It is owing to these modified front legs bearing a supposed resemblance to those of a true scorpion that the popular name has been bestowed. The other type, of which a good instance is the Long Water Scorpion (*Ranatra linearis*), instead of being broad and flat, is long and thin, measuring over three inches to the end of the tail-like breathing apparatus. It frequents weeds, and when at rest is difficult to detect owing to its stick-like form. The eggs of *Nepa cinerea* are laid in the tissues of plants;
they have at one end seven short filaments that are supposed to function respiratorily. Ranatra's eggs possess only two of these filaments and are laid on the plants.

Coming now to the second class—that is, the insects that are aquatic only during the earlier stages—we find many very interesting forms. There are, for instance, the May-flies—the insects of a day. They are, as is well known, eagerly devoured by fishes, and the artificial flies known as "duns," "spinners, "drakes,"

etc., used by fishermen are supposed to be copies of certain May-flies. The larvae live in ponds, lakes and streams, both fast-running and slow. They vary in detail but are all more or less alike in general form, possessing tracheal gills arranged along the sides of the body. The eggs are sometimes dropped or deposited on the surface of the water or are concealed beneath stones at the
bottom, the May-fly submerging herself for the purpose. The larvæ are herbivorous, feeding upon algæ and other plant tissues. Some species burrow in the mud, while others creep about among the weeds. When the time is due for the adult May-fly to appear the larva rises to the surface and there rests; the skin of the back splits and the winged insect makes its way out and takes flight. This winged stage is not the true adult, but is what is known as the subimago, for another casting of the skin has to take place before the final stage is reached. May-flies are noted for the shortness of their lives in the winged state; some live only a few hours, while others may endure for twenty-four or, in a few instances, a little more than a day. The aquatic life of the larva is as relatively long as that of the adult is short, for certain species spend three years in the water before reaching maturity.
Caddis-worms are well known to all who investigate the mysteries of the pond. They, the larvae of the Caddis-flies, are experts in the art of house construction and camouflage. The eggs of Caddis-flies are laid in the water or on vegetation overhanging. Once hatched, the young larvae commence to construct each a home for itself, a travelling house, so that they are free to move about in search of food and at the same time have protection from the many creatures lying in wait to secure such tender morsels. The larva makes its protective case of little bits of stick, leaves, small shells, gravel or sand, etc., according to the traditions of its species. The foundation of the case is a silken substance secreted by the larva and is tubular in shape; whatever other building material is selected is fastened to the outside of this tube. The case usually tapers slightly toward the hind end,
which is more or less closed, the front end being left open to allow the larva to protrude its head and legs. Hooks are present on the end of the abdomen, enabling the larva to anchor itself safely in its case. The abdomen is very soft, but the head and thoracic segments have a harder covering, better able to resist attack. As the larva grows and so becomes too large for its home it adds to the front end of its case, and cuts off a piece at the back; in fact, it makes its home grow with it—a very accommodating proceeding. Some of the leaf-built cases are very difficult to detect when the owners are crawling among the water-weeds. There are a few species that do not construct these travelling houses, but in their stead spin a silken web among the weeds somewhat resembling that of certain spiders. Lurking within this contrivance, which serves both as a means of protection and a
snare, the larva waits until some small creature becomes entangled in the mesh, whereupon it dashes forth and seizes it, for the snare-building species are carnivorous, not herbivorous like the great majority of the caddis-worms. When the time for pupation arrives the end of the case is sealed and the change takes place within. In due time the perfect insect is ready for emergence and the pupa, forcing its way through the sealed entrance of the case, rises to the surface of the water. In some species the pupa manages to propel its way to some floating leaf or other support before the skin splits and the imago frees itself; but in other species the emergence is effected direct from the surface of the water. Along each side of the larva's abdomen are a series of filamentous processes acting as tracheal gills, absorbing the oxygen in the water. By an undulating movement of the body
the larva maintains a current of water through its case. There are a great many species of caddis-flies, occurring in all parts of the world in various situations, some few even living in very brackish water. A marine species in New Zealand forms its case of coralline seaweeds.

Some of the universally admired dragon-flies are among the largest of known insects, and fossil remains indicate the former existence of a species measuring eighteen inches in length. They are found all over the world, and their larvæ inhabit ponds and streams, leading a purely aquatic existence. Dragon-fly eggs are in some instances dropped freely into the water, and in others are attached to the stems of aquatic plants. Some species insert the eggs in the plant tissues. There are two kinds of larvæ, one kind being the offspring of the big type of dragon-fly so
often seen hawking swiftly over some pond or length of stream, and the other kind belonging to the much smaller and comparatively feebly flying type known as the "demoiselle." Both kinds are carnivorous, the large one particularly so. Certain of the mouth-parts are fused to form a prehensile organ capable of being shot rapidly forward in order to seize the prey; this apparatus is known as the "mask," as when not in use it conceals the other mouth-parts. Small fish, other insect larvae, tadpoles, etc., all are prey to these fierce larvae. Some species crawl about on the muddy bottom of ponds or climb among the weeds. When the full larval size is reached and the adult insect is ready for emergence the larva climbs up a reed stem until above the water level, and there rests until the skin is dry; a fissure then appears along the back, and through the opening the perfect insect makes its way. The
method of emergence is peculiar and suggests a gymnastic display. These larvae do not possess lateral tracheal gills, but have terminal respiratory organs that vary in the two types. Dragon-flies are feared as well as admired, for some country people firmly believe that they can sting; in some districts, in fact, they are known as "horse-stingers." This belief is entirely erroneous, as these beautiful insects are quite incapable of inflicting injury.

Among the true flies (Diptera) are several interesting species that have aquatic larvae. Pre-eminent among these are the members of the mosquito and gnat tribe. Many of these are too well known to need much description, as they have forced themselves on man's notice in a very unpleasant manner. The eggs of mosquitoes are in some cases laid on the surface of the water, either singly or in masses known as egg-rafts, or are
deposited singly on some nearby situation. The larvae lead an active existence. They are legless, but are able to move rapidly by a series of lashing movements of the body. On the eighth segment of the abdomen is a breathing-tube, or siphon, and when the larva rises to the surface for air the tip of this siphon breaks through the surface-film. The majority of mosquito larvae hang head downwards when at rest, but those of the genus *Anopheles*, to which the malaria mosquito belongs, rest parallel with the surface. The pupa also is active, being able to descend rapidly from the surface if disturbed. It floats head upwards, the breathing apparatus, in the form of a pair of horn-like processes, being situated on the top of the thorax. The adult insect emerges direct from the floating pupa, using the empty skin as a raft. There is one remarkable form in this country that obtains its oxygen
direct from the stems of certain water plants, which it pierces with an especially contrived siphon. The food taken by the larvæ consists usually of various minute algæ, although there are a few forms known to be carnivorous. The small particles of food are wafted into the mouth by the aid of two thick tufts of hair situated on each side of the head. The complete life-history is gone through in a very short time, varying from ten to twenty days according to species and circumstances. One of the factors that have made mosquitoes such a menace to man is that the larvæ do not necessarily require a large sheet of water in which to live. The larvæ of the dreaded mosquito (Aedes argenteus) that acts as the carrier of yellow fever occur in any small quantity of water, holes in tree trunks, old tins, broken jars, etc., frequently being selected.

There is a small and harmless gnat
(Corethra) that has a very interesting larva. Known as the "Phantom Larva," this species well justifies its name by being of glass-like transparency. It resembles in some respects the mosquito larva, but has no specialised breathing organs. Darting with great rapidity through the water, it seems to vanish and reappear in a decidedly phantom-like manner. It is carnivorous and catches various minute creatures.

In the mud at the bottom of small ponds are to be found red worm-like creatures. These so-called "Blood-Worms" are the larvæ of another gnat (Chironomus). Sometimes these blood-worms leave the mud and crawl about quite actively. This gnat lays its eggs in a mass of jelly which is usually attached to a stone or leaf.

The larva of the Chameleon Fly (Stratiomys) is another water dweller. It is very unlike any of the foregoing
forms, being long, somewhat flattened and having no legs. It is a very sluggish creature, passing most of its time at the surface where it hangs head downwards. At the apex of the abdomen is a rosette of bristle-like filaments which, in conjunction with two spiracles, acts as the breathing organ. When fully grown the larva sometimes burrows into the bank and sometimes floats at the top of the water. Pupation takes place within the larval skin.

There is a large fly known as the "Drone Fly" (Eristalis) that has an aquatic larva commonly called the "Rat-tailed Maggot." This larva, a somewhat repulsive-looking creature, lives in putrid water where it feeds upon the accumulated filth. The body, which is certainly maggot-like, is furnished with a telescopic tail composed of three parts capable of sliding one within the other. This remarkable tail can be extended to
a length of over four inches and acts as the breathing apparatus, being provided at the extremity with a rosette of filaments. The pupa is enveloped by the larval skin, the larva when fully grown leaving the water and burying itself in the soil. The adult fly is very bee-like in appearance.

One does not usually associate the moths with an aquatic existence, but there are a few species whose larvæ feed on the leaves of water plants, protecting their weakling bodies by means of cases or sheaths formed of small pieces of plant tissue and silk; these cases much resemble those of the caddis-worms. The moths known in this country as the "China Marks" have this habit.

The important order, Hymenoptera, containing the bees, wasps, ants, etc., has a few aquatic representatives. These belong to the parasitic group. They include the extremely small "Fairy Flies,"
which do not exceed half a millimetre in length. They possess wings fringed with hair and are able to descend into the water in search of the eggs of the “boat-men” and dragon-flies in which to lay their own eggs. They are, in fact, egg parasites. The very minute larva, on hatching, proceeds to devour the contents of its host egg and then pupates within it.

There is another and somewhat larger parasite that selects the caddis-fly larva as its host. The adult insect crawls down some plant stem into the water and having found an unsuspecting caddis-worm lays an egg upon it. The parasitic larva feeds on its host, but is careful not to injure the vital organs until it itself is ready to pupate, which it does within the caddis’s case.

The exploiters of the surface are not nearly as numerous in species as the under-water dwellers; but they are none
the less interesting. The Water Spring-tails (*Podura*) are sometimes present in such numbers as to form black masses on the surface of ponds. If these minute creatures are disturbed the mass breaks up, each individual leaping away to safety; but the mass is quickly reformed as soon as the danger is past. The bodies of these insects, and others of the surface-film fauna, are covered with very short and closely-set hairs that prevent the body from becoming wet. A spring-like apparatus on the underside of the body of *Podura* enables it to leap actively.

The Skaters (*Hydrometridae*) are well known as they are to be seen during the spring and summer months disporting themselves very actively on ponds and, in some cases, on quite swiftly flowing streams. There are several forms, for the most part small insects. The food is mainly dead insects found floating on the surface of the water.
Aquatic Insects

Some delightful beetles known as the "Whirligigs" (Gyrinidae) spend the summer days making endless figures of eight at dizzy speed upon the surface-film; they also are carnivorous. The eggs are laid in rows on aquatic plants and the larvae are provided with a series of beautifully plumed tracheal gills on the sides of the abdomen.

Although the very great majority of aquatic insects only frequent fresh water, there are some related to the Skaters that inhabit the tropical seas and are to be found many hundreds of miles from land. They have been observed on calm days skating over the surface of the ocean feeding on dead, floating marine animals.

As well as the insects that can be termed truly aquatic either as larvae or adults are many to which the term "half-way" insects may be well applied. They are dwellers in mud and dwellers
in marsh mosses; others again inhabit the sea-shore and are covered by each tide. The "half-way" insects belong to many widely different families; springtails, flies, beetles, etc., are to be found, all leading a life from which it is but an easy step to a pure aquatic existence.

Although the Water Spider is not strictly an insect, but belongs to the class Arachnida, it seems not out of place to include it in this chapter as it is so frequently found associated with aquatic insects. It is a great favourite with those who keep small aquaria. *Argyroneta aquatica* is a moderate-sized spider of about half an inch in length, and lives in ponds and ditches. The abdomen is very thickly covered with short hair. This hair coat retains a covering of air after the spider has visited the surface of the water and gives the body the silvery appearance that is
so much admired. A silken nest is constructed among the weeds under water; it is thimble-shaped and is very carefully contrived. It serves the purpose of a diving bell and is stored with air, liberated bubble by bubble from the air covering on the spider's body. When building this nest the spider has frequently to rise to the surface for a fresh air supply. The egg-cocoon is deposited in the nest and the young spiders, as soon as hatched, lead an independent existence and go out into the world to build similar fairy-like domains of their own.
Molluscs abound in all latitudes, save in the Arctic and Antarctic circles, invading the land, and all waters, fresh and salt. They are soft-bodied invertebrate creatures, provided with gills and, in most cases, an external shell. The shell is secreted by a soft fold of the body called the mantle and consists largely of carbonate of lime taken from the soil or water. The richer the supply of lime, the stronger the shell. Fresh-water molluscs have much weaker shells than those of marine species, and the reason for this is that in fresh water there are usually no great waves or other disturbances liable to break the shell.

Though of lowly status in the scale of life the Mollusca are of great economic
importance, many being of value as food, ornament and building material. A few play an important part in the religious life of certain oriental races.

Molluscs are divided into a number of groups which include such different forms as the snails, limpets, whelks, oysters, slugs and octopods. Those bearing external shells are divided into the univalves and the bivalves, the shell in the former being made in one piece, as in the snail, and the latter in two united by a hinge as in the oyster.

In the univalve molluscs the animal is provided with a large fleshy "foot" by means of which it can crawl and climb, and a long, ribbon-shaped tongue bearing sharp-edged "teeth" numbering sometimes several thousands. The nervous system is well developed but not concentrated as in the higher molluscs—the Octopods and Cuttle-fish—to form a brain-like mass.
One of the commonest of univalves in this country is the familiar Limpet, whose shell attains great solidity, especially on rugged coasts where it is exposed to violent seas. The animal holds to the rocks with proverbial tenacity and a pressure which has been calculated at over 60 lbs. The limpet is further remarkable for its homing instinct. When covered at high water it will sally forth in search of adventure and vegetable food, returning always to exactly the same spot, at low tide. Its home is a quite deep pit, formed in the rock with the aid of the sharp edges of its almost circular shell and an acid secretion. The tongue of the limpet, which exceeds the shell in length, is coiled like a watch-spring, and when protruded makes a distinct scratching sound, audible through the thick glass of an aquarium.

Nearly allied to the limpets are the
beautiful Ormers or Ear-Shells. These are fished for in all the warmer seas where their flesh is highly esteemed. The "mother-o'-pearl" of the inside of their shells is used for various decorative purposes.

The Top Shells (Trochidae and Turboni- dae) introduce a feature characteristic of many univalves. This is the "operculum," a usually spherical cap of horny material often reinforced with a layer of carbonate of lime and which acts as a door. This part of the mollusc may weigh several pounds and present gorgeous colourings. In fact, the "cat's eye" brooch, so popular in Victorian days, was manufactured from the opercula of a species inhabiting the Indo-Pacific Ocean.

The River Snails (Vivipara), abundantly represented in the Thames, are interesting in that the young are hatched within the parent shell. The closely
allied Apple Snails of tropical swamps contrive to breathe whilst buried in the mud through a long tube, the "siphon"—seen to advantage also in the common whelk. These snails lay eggs in large clusters on weeds high above water-mark and the young, unlike those of many univalves, pass through no larval stage, but emerge complete replicas of their mother, provided with minute shells.

The Cone Shells, represented in British waters by only two species, abound in most tropical seas where, often very large, vividly-marked and highly polished, they touch the high-water mark of the shell collector's ambition. Fantastic prices have been paid for some of these shells, especially for examples of the famous "Glory of the Sea" (*Conus gloria-maris*). In the year 1850 it was believed that only two specimens of this shell were in existence. It so happened that one specimen was in the hands of a Dutch
diamond merchant—and shell collector. If one may believe the chroniclers this "conchologist" chanced to see the other specimen put up for auction, and after a tense fight with a rival enthusiast purchased the shell at a staggering figure. On being handed over the prize he crushed it beneath his feet, exclaiming: "Now I possess the only specimen on earth!" The thirty specimens which are in existence at the present day were all obtained from a reef off the Philippine Islands which has recently subsided. No fresh specimens are therefore likely to be obtained.

In certain cone-shells the tongue is developed into a hollow fang which communicates with a poison duct, and the venom when injected acts on the central nervous system. As a result accidents from incautious handling of these much sought after shells are quite frequent, and consequently natives often
refuse to touch them when the animal is known to be alive.

The Violet Snails, occasionally brought to our shores by the Gulf Stream, are unique in spending their lives floating in mid-ocean. The eggs are arranged upon the underside of a raft of foam-bubbles united by a sticky secretion, a nest recalling that of certain tropical fresh-water fish. Certain close relations of the violet snails which live ensconced in dainty shells, delicate as bubbles and no larger than a pin’s head, take up their abode amongst the spines of starfishes and sea-urchins.

In the true Whelks, of which the common British species (*Buccinum undatum*), which grows to a length of over half a foot, is a familiar example, the siphon pipe may be protruded to a length equalling that of the animal’s spiral shell. The shapeless lumps of egg-capsules of the common whelk are known
to all, being cast ashore by every landward gale. The remarkable Worm Shells that inhabit the coral reefs are allied to the whelks. Sooner or later the shell of this animal becomes hemmed in by ever growing coral. What is to happen? To prevent being walled up by the more active organism the worm shell has obviously to take drastic action to meet the situation. It does so by ever increasing the mouth of the shell until it becomes prolonged into a twisted tube. Always taking the line of least resistance, the worm shell fashions its dwelling to coincide with every vagary of coral growth—the result, a Gordian Knot.

Judging by the records of the rocks the univalves are immeasurably older than the bivalves. The exact origin of the bivalve is a matter for conjecture, but geological investigation justifies us in assuming that lethargic univalves took
to lying upon their backs until the more progressive members took action to remedy the various disadvantages inseparable from the supine status. The mantle of the whelk or snail is a clearly visible sheet of fleshy substance for ever exuding a form of mortar which on exposure hardens into carbonate of lime.

Many bivalves are sedentary or at best hampered by very limited powers of movement. Their bodies are well developed whilst the muscles which keep the shell open or shut at the tenant's will are very powerful. The "foot" which can enable a big snail to travel at the speed of a quarter of a mile per hour may, in the bivalves, be turned into a plough for furrowing mud, drilling rock, or spinning a number of "anchor ropes." There are, however, many sedentary forms, the majority of which, owing to the loss of the tough locomotory foot, are edible.
The first of these to claim our attention is the oyster. The Common Oyster such as is cultivated at Whitstable needs no introduction. Many weighty scientific volumes, miles of government reports and cartloads of light literature have been turned out in honour of the "succulent bivalve." The oyster during the summer months produces a couple of million eggs which are kept within the shell until they hatch, when the larvae or "spat" are shot out with considerable force. The baby oyster, represented as a gelatinous mass encased between two transparent shells, travels along the surface of the ocean, progressing by means of a number of protruding hairs which whip the water and carry it upon a very insecure journey. Should the infant oyster escape the attention of its many enemies and survive a couple of days he sinks to the bottom and cements himself to the ocean bed. He grows very slowly
at the rate of not much more than half an inch in diameter a year. Five years or more may therefore elapse from the date of its birth before it becomes an oyster worthy of the attention of the epicure. A French variety of the common oyster known as the “huître de Marenne” is remarkable for its bright green colour, which is due, not to copper as has been sometimes erroneously stated, but to a greenish-blue diatom which lives in the oyster ponds at Marenne. Green oysters never occur in the open sea, and the “Marennes” only acquire their characteristic tint in the parks in which they are placed for fattening.

Our native oyster is peculiar in continually changing its sex, it having been recently established at the Marine Biological Association’s Station at Plymouth that the creature may change from male to female as many as four times in the year.
The elongate Portuguese Oyster and the American Oysters, which differ specifically from the British, French and Dutch specimens, do not change sex, remaining either male or female for the whole of their lives.

The Pearl Oyster has ever been popular, not only for the marketable pearls that about one oyster in twenty contains, but also, in the case of those inhabiting the Australian seas, for the "mother-of-pearl" lining of the shells. The genuine "oriental pearls" are formed of successive layers of nacre, produced by the mantle and wrapped round some foreign substance which has intruded itself. Millions of pounds have been invested annually in order to cope with the demand for real "pearls." Some years ago an enterprising Japanese brought many of the pearl gamblers to earth by realising the obvious, namely, that pearls could be cultured without
much difficulty. This prince of commerce dredged his pearl oyster beds and deliberately placed glass beads in all his young healthy specimens, which were replanted on special beds free from starfish, crabs and other marauders. Three years sufficed to cover the bead with a rich layer of nacre and, as a result, pearls purchased to-day command a much lower price than they did twenty years ago.

The tropical "Thorny Oyster"—a "bivalvular hedgehog"—ranks amongst the gems of the ocean. Unlike the pearl oyster its beauties are all exterior. The upper valve is covered with spines of delicate sculpture, whilst the whole mollusc is aflame with wonderful orange, gold and scarlet tints that blend perfectly with the various coral animals amongst which it lives.

The Mangrove Oysters attach themselves to branches that are submerged
during the rainy season. When the drought comes the mangrove branches, coated with oysters, hang five feet above the water level. Each shell is attached by its lower or deeper valve which contains enough moisture to keep the mollusc alive until the waters rise again and cover it in about six months' time.

Related to the oysters are the Mussels which clot every rock and harbour pile and attach themselves by means of long tough threads which they secrete. In Pinna, a fan-mussel of our shores, these anchor ropes are enormously elongated, forming huge tufts of silky fibre several feet in length from which gloves, socks, scarves, etc., have been woven. Pearls occur in certain kinds of oriental mussels and the Chinese introduce little lead images of Buddha between the shell and the mantle of a common fresh-water form. In due season these images be-
come covered with mother-of-pearl, and so cunningly are they insinuated that shells only four inches long present twenty or more of these, neatly arranged in rows—a wonderful example of manual dexterity inspired by an almost fanatical religious faith.

A vast galaxy of animal life flourishes in any neglected water supply, and in 1912 nearly 100 tons of a fresh-water mussel (*Dreissenoia*) were removed from a water-pipe at Hampton-on-Thames, the shells reducing a 36-inch bore to a mere 9-inch. Mussels are not the only animals to inhabit water-pipes. First there may appear microscopic sponge pores and polyzoa, and the branching growths therefrom may soon create a jungle giving sanctuary to worms, crustaceans and especially molluscs of all kinds. Even eels and flounder may join these strange colonies which, adapting themselves to altered conditions, prosper
in a vitiated atmosphere and complete darkness.

The largest bivalve known is the Giant Clam (*Tridacna gigas*) of the Barrier Reef, which may measure over two feet in length and weigh 500 lb. This mollusc is a veritable man-trap and the diver putting his foot in the gap between each valve is usually doomed. Not long ago a native was caught by a baby giant clam at low tide. Attempts to hack the shell to pieces would have resulted in the mollusc bringing the valves together with such force as to crush the man’s limb to a pulp. Therefore to save his foot a block of the coral, about three feet square, to which the clam was attached, was cut away and the native with the block complete was placed on a stretcher. The coral mass was then placed beside a fire. Gradually the heat caused the shell to open of its own accord and the victim was liberated. This tendency on
the part of a bivalve to close on being alarmed has been the undoing of many a crow and water-rat, our native fresh-water mussel being responsible for the capture of many a small bird and mammal.

Many bivalves, by reason of their limited powers of locomotion, are usually condemned to lead sedentary lives. But in some the development of the "foot" offers the possessor considerable change of habitation. Cockles are notorious nomads, ploughing through the sand at the rate of a hundred yards per hour. The bivalve foot can not only plough the sand, but delve deep into it. The more muscular the foot the deeper are the digging capacities of the animal, and the more specialised its breathing apparatus. Bivalves penetrating several feet beneath the surface have the siphon pipes protected by a lengthy covering and elongated to reach the surface. The
shell is wedge-shaped the better to penetrate sand and gravel, being prolonged into a tube made in two longitudinally divided pieces united by a hinge in the case of the razor shell.

In the wood-and stone-boring bivalves, which present a problem as yet unsolved, the delicate shell is file-like, the "foot" is short and muscular, whilst certain acids are brought to bear upon the substance penetrated. The animal will drive forward blindly through the hardest stone other than marble and granite, and if it comes into contact with another borer tunnelling at right angles to its road, burrows through its fellow-mollusc into the rock or wood on the other side. In the old days of "wooden walls" terrible havoc was wrought by the "ship worm," a bivalve that as it tunnels lines the burrow with carbonate of lime, and in the early eighteenth century the coast of Holland was threatened with inundation
by the damage done by this mollusc to the wooden piles supporting the dykes. Despite all kinds of up-to-date precautions the "ship worm" continues to undermine harbour piles, breakwaters, etc.

A number of strange molluscs have the shell reduced to a mere horny disc covered by the mantle, which is divided into two flaps. Some, such as the "Sea Hare"—which, when irritated, exudes a purple dye—are of large size, certain tropic species measuring nearly two feet in length. The group includes the Pteropods—the "Sea Butterflies"—in which the "foot," developed into a pair of side fins, flaps through the water with a hurried action suggestive of a moth. They swarm in the Arctic and Antarctic regions, forming one of the chief items in the whale's diet. Many of these naked molluscs are amongst the most beautiful of aquatic animals. When
disturbed or at rest they resolve themselves into mere blobs of jelly, but when foraging for food and fully expanded they resemble a garden slug ornamented with candles, antlers and flowers—a wonderful medley of bizarre forms. The gills are frequently modified to harmonise with the animal’s surroundings. Thus the Sea Lemon has the gills so coloured and arranged that they blend with the creature’s favourite food, the “bread-crumb” sponge, whilst those of the Grey Sea Slug of our shores are indistinguishable when amongst the waving tentacles the sea-anemones upon which it feeds.

The Octopus, Cuttle-fish and their allies belong to a highly organised group of molluscs—the Cephalopods—the members of which, known in popular language as devil-fish, have made the public flesh creep from the earliest times. Although many authors have drawn upon their
vivid imaginations in their descriptions of these animals, more than a single octopus washed up from the ocean depths has been found to measure nearly forty feet across the arms, and therefore quite capable of overpowering a human being. Victor Hugo's blood-curdling account of a man-versus-octopus fight in his "Toilers of the Sea" may therefore not be so very far from the truth. The cuttle-fish likewise attain to vast proportions, the tentacles of a giant specimen that was landed a few years ago off Milford Haven measuring twenty-four feet in length.

The Cephalopods are not only the largest but the most remarkable of molluscs, and to the casual observer have little in common with their relatives the Winkle, snail and oyster. They are provided with remarkably well-developed brains enclosed in cartilaginous skulls, and eyes larger in proportion to the size
of their bodies than those of almost any other animal. The molluscan foot, used by the snail to crawl, and by the cockle to jump, is split into eight or ten arms each beset with several hundred suckers. Each sucker is rimmed with a horny ring and can exert a pull with a pressure of anything up to 30 lb., according to the size of the animal. It must therefore be admitted that a creature furnished with nearly 3,000 such suckers can be no mean antagonist. If we add to this a marvellous capacity for changing colour, enormous energy, with great tenacity of life and the power to cover a retreat by means of a smoke-screen, it will not come as a surprise to learn that the Cephalopods have survived in large numbers from an early age. The octopus and cuttle-fish are hatched from eggs known to fishermen as sea-grapes, and these are usually attached to weeds. Unlike most mollusca, the young pass
through no larval stage, emerging perfect little replicas of their evil-looking parents.

There is enormous variation of the accepted cuttle-fish form to meet special conditions. Some have the web uniting the arms so exaggerated as to form an umbrella, whilst many deep-sea species have the eyes mounted on stalks, and are furnished with luminous organs. The tribe is divided into ten-armed and eight-armed members, the former being the more numerous. One species, the Pearly Nautilus, has ninety arms. All save the eight-armed octopods are provided with a shell—generally internal—and by the study of fossil forms we can trace its development from the earliest types known. Cephalopods, though abundant to-day, must have been much more numerous "when the world was young." Certain strata, such as the lias of Dorset, are largely built up of
their shells. Single fossil shells nearly two feet across are commonly used as doorsteps and garden decorations, and it is probable that at one time the seas flowing where Dorset stands to-day swarmed with countless myriads of nautilus-like animals. The living Nautilus and Argonaut are both inhabitants of tropical seas. In the former both sexes are encumbered with massive shells, but in the latter the shell is a female possession only and is used as a receptacle for the eggs. Two of the animal's ten arms are tipped with large spherical lobes that serve the purpose of the ordinary molluscan mantle, and by collecting carbonate of lime from the water build up this delicate mid-ocean cradle. The poets of old insisted that the argonaut spread its arms to catch the wind—a charming conceit, but inaccurate in the light of recent research.

The cuttle-fish whose "bones" are
found washed up on every sandy beach are largely used for bait and in many countries for human food. The "shell," finely powdered, forms an important ingredient in many medicines, tooth-powders and ointments, whilst the artist's sepia is obtained from a species common in Italian waters. Though so formidable, cuttle-fish have many foes besides man. Fish and sea birds attack them, and even the giant specimens of the North Atlantic fall victims to whales, the Cachalot being especially appreciative of such a diet. Whales are frequently captured with wounds inflicted by the suckers of giant cuttle-fish—evidence of terrific conflicts in some ocean waste. Ambergris, that waxy compound, so valued in the manufacture of perfumes, commanding as much as four pounds per ounce, consists largely of cuttle-fish beaks, and is the outcome of cetacean digestion. The majority of cuttle-fish live upon fish,
which they capture in a very ingenious manner. Two of the tentacles or arms are from three to twenty times the length of the others and they are kept tucked away in a pair of special pockets, one on either side of the creature's head. When a fish is "sighted" these arms are run out at lightning speed. The club-shaped tips, covered with suckers, attach themselves to the quarry and the fish is drawn towards the mouth, which is situated in the centre of the ten arms. This mouth is the counterpart of the snail's ribbon-like tongue and is in the form of a parrot's beak, consisting of two horny interlocking structures with razor-like edges. All the cuttles provided with large side fins can progress forwards by gentle winnowing motions of these organs, and one species at least can leap clear of the water, and thus sometimes comes to grief by landing on board ship. When in haste, cuttle-fish and octopods rely
on their siphon, which is situated just beneath the head and exhale water previously drawn in to supply the gills with oxygen. By exhaling with extra force the animals can drive themselves backwards through the water at a very high velocity, swimming simply by a process of "hurried breathing." The octopus of our shores is not dangerous. Not only is it a comparatively small animal, its body measuring seldom more than eight inches and the span of arms two to three feet, but it is further rarely in an aggressive mood. It lives entirely on shell-fish and is the arch-enemy of all crab, lobster and oyster dealers. A fair-sized British octopus will capture twenty crabs at a sitting, storing them away amongst its ample folds until needed. When hungry it simply disarticulates the crab, having previously injected it with a poisonous secretion, and a heap of crab shells often marks the entrance to its
abode. An octopus will wrestle for hours with a large oyster, until it succeeds in forcing the valves apart. It is such an intriguing animal that imagination may very easily give it more than its due as regards intelligence. A Channel Island naturalist was accustomed to keep octopods in wire "chicken runs" sunk in deep rock gullies, and these runs were so arranged that small crabs could enter but the octopus could not escape. It was found that the "devil-fish" remained hidden in a rock crevice until a crab came within range, when he simply unrolled an arm and gently flicked the unsuspecting crustacean with the tip between the eyes. The crabs appeared to become hypnotised by this treatment, and allowed themselves to be drawn into the ogre's lair. It is alleged that the animal will sometimes kill a small fish and so dispose of it as a bait for crabs. To ensure a feast the octopus will wait
for hours beside a bivalve, slipping a stone between the shells just as they begin to open. The octopus, though given to making a rock fissure its home for months on end, is essentially a wanderer, ever seeking fresh adventures, and its restlessness may lead to embarrassing situations in the aquarium. At Brighton, for instance, an octopus once pulled up the waste plug of its tank at closing time and condemned itself and its tank-mates to spend fourteen hours out of water. As a result the majority of the inhabitants of the tank were found dead in the morning. In the same aquarium an octopus some years ago climbed up the front of a tank, escaped through a ventilator and landed upon a lady visitor in the corridor below. In most aquaria the octopus tanks are generally roofed over with netting or wire. Not long ago in a Continental aquarium, where no such provision was
made to incarcerate the specimens, an octopus gained access to a collection of lobsters in an adjoining tank. One was speedily rendered clawless and retired into a corner of the ring, but a giant specimen weighing 8 lb. put up a splendid fight. Hour after hour mollusc and crustacean circled round each other, the former always seeking to make a rear attack upon his adversary. The fight was allowed to continue to the great excitement of the spectators, who eventually grew weary and retired. The following morning there was displayed a heap of lobster shell, and a complacent octopus tucked snugly in his flower-pot kennel digesting the spoils of victory.

All Cephalopods have the power to rapidly change colour, adapting themselves to their environment. Full-fed and contented, an octopus is often white on one side and brown on the other, the meeting-point being sharply defined.
When threatened with danger it turns ashen grey.

The octopus like the cuttle-fish is the possessor of a peculiar gland secreting an inky fluid which is stored in a special bag and expelled through the funnel. The "sepia" is used with considerable strategy, for as soon as the black fluid, which hangs in the water in the form of a dense cloud, is ejected it completely envelops the pursuer. The octopus is thus enabled to confound its enemy and make good its escape.
Chapter X  Odd Fish

The average normal fish is a vertebrate creature of torpedo shape specially adapted for living in water, and to this end its form is embellished with fins which act partly as oars and partly as balancing organs in an ever shifting environment. It is further provided with gills enabling it to extract the life-giving oxygen from the water. Almost anyone can name at random at least a score of examples of the ordinary common type of fish, and we therefore propose to confine ourselves in this chapter to those lesser known types that, owing to their peculiar form or habits, are worthy of being designated as abnormal or odd.

Perhaps no class of fishes deviates from
the normal so dramatically as the massive angler fish. They spend their life on the ocean floor, luring other fishes into their ever-smiling jaws by means of fin-rays situated immediately over the head, and which act as living rods and lines with bait complete. A fish is attracted to the waving flap of skin on the tip of one of these living rods and seizures it. Instantly the rod dips so that it overhangs the enormous mouth—a sudden snap, and the catch is bagged. Such are the methods of the common angler fish of our coast. But anglers are found in all parts of the world, and in all depths of water, and each form is specially adapted to its environment. Some inhabiting the ocean depths have the tips of their rods illuminated by comparatively large bulbs of phosphorescent light. In some of these deep-sea forms the rod is developed into a whip lash ten times the length of the fish itself, whilst a few carry
voluminous flaps of skin beneath the chin, forming a tangle that sweeps the bottom and probably enmeshes the animals that evade the seduction of the phosphorescent lure. A very queer angler indeed is one emanating from the North Atlantic, for in this type the male is minute and parasitic upon the lumpish female. The inconspicuous husband, in fact, becomes literally grafted to his bulky bride, whose blood supply he actually shares.

The little viviparous Sword-tail fish of the rivers of Mexico deserve mention whilst still upon the theme of marital relationship. For some reason, as yet imperfectly understood, the females, having delivered themselves of their third brood, sometimes change sex, developing the exaggerated sword-shaped tail denoting that "Mrs." has become "Mr." It has been suggested that this is merely Nature's way of equalising the
sexes, the males usually outnumbering the females.

The life-history of the greatly compressed flat-fish—the soles, flounders, dabs, plaice, turbot, etc., may be designated as odd, inasmuch as at birth they do not differ in structure from most normal fish and swim in a vertical position. When a few days old, however, an amazing transformation takes place. The infant flat-fish sinks to the sea-bed, losing its swimming powers, the body tilts to one side, and the skull changes its shape, bringing one eye over to the same side as its fellow. Thus is a flat-fish created from quite an ordinary fish within the course of a few hours.

The normal fish engulfs any prey that may come its way, but at least one species obtains its meals in a much more sporting manner. This piscatorial sportsman—the Archer fish of the streams of the Malay Archipelago—has very pointed
jaws which form a spout and with these he shoots a stream of water at insects clinging to the waterside foliage. The Malays keep the creature in bowls covered with a bamboo lattice on which insects are placed, and bet on the result of the fish's marksmanship. The Madeira puffer fish, which is able to blow itself out with air until almost spherical in shape, has also been known to shoot water from its jaws. A pair of these fish living in the Zoo Aquarium developed this remarkable habit soon after their arrival at Regent's Park, filling their mouths with water and spitting the contents at their keepers and those privileged to be escorted "behind the scenes" of the Aquarium. It is not the habit of the marine puffer fish to secure its meals in this manner, and there appears to be no excuse for its rude if entertaining behaviour. The skin in certain species of puffer fish is armoured with spines
and tubercles which lie flat when the animal is at peace with the world, but stand at right angles like the quills of a porcupine when the animal becomes inflated with fear or anger. Dr. Allan, of Forres, has stated that large sharks sometimes swallow these porcupine fish, and that he has found them floating alive and distended in the stomachs of sharks. The fish have a very powerful dentition, and he relates how on one occasion one of these comparatively small creatures ate its way out of its living prison by biting through not only the stomach but also the thick walls of the body. The shark it was that died. When brought ashore in nets these fish are nearly always spherical in shape, and in this form are used as footballs by the juvenile natives in many parts of Eastern Asia. Allied to the puffer fish are the tropical and sub-tropical trigger fishes, so called from their dorsal fin ray which
can be suddenly erected and locked by special trigger-like muscular attachments.

Of ways of catching prey there is no end. A number of widely diverse types of fish employ that very up-to-date weapon, electricity, which may be generated by special nerves, glands or muscles. In the electric eel of the shallows of the rivers Orinoco and Amazon the electric organs, which extend in two series on either side of the fish's tail, are capable of producing a shock the equivalent of nearly 400 volts. Like all other electric fish the "eel" cannot give shocks indefinitely, for there comes a time when it must rest for a period to recuperate the electrical energy expended, and there is a story told by Humboldt of South American natives deliberately driving horses into a stream infested by electric eels in order to incite the fish to exhaust themselves. When "played-out" and
harmless the fish, we are told, were dispatched with spears.

The electric ray or torpedo, a fish tolerably common off our southern coast, gives a powerful shock when touched. As late as Elizabeth's reign it was recommended as a certain cure for rheumatism, the patient being stood bare-footed upon a ray.

A number of fish are supplied with a gill chamber that retains a supply of water and thus enables them to wander about on land.

The little oriental walking or jumping fish will not only snap at luckless insects that chance to fall upon the surface of the water, but will stealthily shuffle ashore to obtain his meals. Lying prone upon the mud bank he will patiently wait until some unsuspecting fly comes within range. The mud-skipper, as the fish is sometimes called, is a grotesque creature with breast fins that are nearly
developed into legs and enormous bulging eyes situated on the top of the head. The latter, like those of the chameleon, can be turned in all directions, and thus, whilst one eye is watching the prey, the other is on the look out for an approaching enemy. By curling its very muscular tail forwards and then suddenly straightening it out the fish, when pursued, is capable of making tremendous jumps, covering a distance of four times its own length.

The climbing perch of India is another fish that is not seriously inaccommodated when finding itself on "terra firma," and during the dry season has been observed to travel long distances in search of water. When threatened with drought it has, in fact, been known to climb palm trees with a view to discovering water in the cavities of the branches, such a climbing feat being made possible by the fact that its gill covers are armed with
sharp spines which act as climbing irons. It is noteworthy that climbing perch are wanderers by necessity rather than by inclination, those at the Zoo Aquarium, though provided with tempting tree trunks, never evincing the slightest desire to leave the peace and plenty of the waters.

Eels are given to "walking," or rather wriggling, and the fact that they are found in Swiss lakes thousands of feet above sea-level, implies that they possess very considerable powers of endurance out of water.

A number of fishes which cannot be altogether classed as parasites obtain their food by acting as hangers on or camp followers to more active forms. A case in point is that of the Remora or Shark-sucker, which carries a large oval sucking plate on its head. By means of this disc it attaches itself to the under surfaces of sharks and turtles, sharing in
their meals and enjoying the benefit of a constant change of hunting grounds without itself being put to the slightest exertion. On occasions it may elect to attach itself to the upper surface of its host, in which case the remora is obliged to travel on its back. The power of this sucking disc is very considerable, being capable of exerting a pressure of twenty-five pounds. In certain parts of the West Indies to this day the fish is made to do a day's work, being tethered to a rope and employed in the capture of large fish and turtles.

When Christopher Columbus discovered Cuba he found that the remora was employed by the natives for catching fish and turtles. The following account is found in the life of the great explorer by his son Ferdinand: "In one of the channels they spied a canoe of Indian fishermen who very quietly, without the least concern awaited the boat
which was making towards them, and being come near made a sign to them in it to attend till they had done fishing. Their manner of fishing was so strange and new to our men that they were willing to comply with them. It was thus: they had tied some small fishes they call Reverso by the tail, which run themselves against other fish, and with a certain roughness they have from the head to the middle of the back they stick fast to the next fish they meet; and when the Indians perceive it, drawing their line they hand them both in together. And it was a tortoise our men saw so taken by these fishermen, that fish clinging about the neck of it, where they generally fasten, being by that means safe from other fish biting them; and we have seen them fasten upon vast sharks."

Fish of all kinds, as is only too well known, tend to become highly luminous
if sufficiently defunct, but a large number are brilliantly illuminated during life. The majority of these are fishes living in very deep water. Their "photophores" or light organs take an infinity of shapes, some being arranged in rows along the sides of the body, whilst others are carried on the ends of specially adapted filaments and fin rays. In certain forms the whole of the undersurface may be an unbroken sheet of bluish light, illuminating the ocean floor for some distance round, the lights serving the dual purpose of attracting the prey and enabling their owner to see his way in the inky blackness of the abyss.

In a deep sea fish (Gigantura) the eyes are telescopic, whilst each jaw is furnished with a pair of formidable canine teeth directed forwards. In the stomach of an 80 mm. long specimen recently examined by Mr. Tate Regan at the Natural History Museum, was found
another deep-sea fish (*Chauliodus*) 140 mm. in length. This apparently impossible swallowing feat is explained by Regan as follows: "The Chauliodus was seized by the middle and was swallowed double until it reached the posterior end of the stomach, when the head and tail still protruded from the mouth of the captor. These were then taken in and bent back until the whole fish, now doubly folded, was in the stomach of the Gigantura. Digestion affected the part first swallowed where the flesh had quite disappeared, exposing the vertebral column for a length of 18 mm.

Most of these deep-sea fish have the eyes enormously developed, but others, like certain burrowing mammals and reptiles have paid the penalty of neglecting to use their eyes by all but losing them. Again, in certain fish inhabiting dark caves, the eyes are almost or even entirely absent. The underground
waters of such harbour fish with the eyes completely hidden beneath their skin. Nature, however, attempts to compensate all blind creatures by greatly augmenting certain other senses, and in these animals a number of papillæ, which are situated on the head are extremely sensitive organs that serve to help the fish in probing the darkness. It has been ascertained in the case of blind cave fish, that it is only in the adult that the fish is sightless, being in infancy provided with a quite serviceable pair of eyes.

Every portion of a fish’s anatomy is open to enormous modification to meet the exigencies of environment. This applies to the eyes as much as to any other organ. A small fresh-water fish inhabiting the rivers of tropical America, the so-called four-eyed fish, has each of its very prominent eyes divided into two portions, the upper half being for use
above water and the lower for use under water, the iris being so formed that two distinct pupils are present. The fish swims at the surface, with its four eyes sweeping air and water at the same moment.

A few deep-sea fish when very young have the eyes mounted upon stalks, and the ingenious oriental breeders of gold-fish have produced varieties in which the eyes bulge to an extent that is unpleasantly suggestive of a disease. The gold-fish, indeed, has shown itself to be extraordinarily plastic and "fancy cultures" have been produced from very early times in both China and Japan. Some of these varieties, the "veil-tail" for instance, move as if encumbered by a long skirt. Other "triumphs" of the breeders' art may have the fins either entirely absent or so badly proportioned that the unfortunate fish is condemned to spend the greater part of its life in turning somersaults.
Fish may be met with in both very hot and very cold waters. The common carp, for instance, will survive for months walled up in a block of ice, whilst at the other end of the scale is the little Central Arabian desert minnow that flourishes in hot springs over four hundred miles away from the nearest open water. It has been suggested that the eggs have been carried to these isolated springs in weeds adhering to the claws of birds, and that thus a race of fishes has been evolved which can enjoy life in water at a temperature of 110° F.

All fish may in a sense be regarded as poisonous, since their teeth and spines having once punctured the skin are liable to cause wounds, which, if neglected, become septic. A few, however, are provided with a genuine poison apparatus analogous to that of our native adder. The best known examples are the weever fish, abundant all on sandy coasts. The
hollow spines of the first back fin, and those on the gill covers are in these fish connected with glands which secrete a highly venomous fluid. They cause intensely painful wounds, very easily acquired since the fishes usually lie half-buried in the sand, with the result that the spines come into contact with the naked feet of shrimpers and children paddling. The fish itself is quite excellent eating, and on the Dutch coasts immense numbers are sold both fresh and smoked. In France, where the fish is likewise regarded as a delicacy, a special law provides that the poison spines must be removed before the fish is exposed for sale. Serious accidents caused by weever stings are not by any means uncommon in this country. The warning "ware weevers" exhibited on some of our piers leaves something to be desired, since the form of this very abundant fish is none too well known to
the public, and common sense suggests that a pictorial representation of the fish be appended beneath such well-meant but ambiguous warnings. Two species of weever are found off the English coast, a large form, and a small form, the venom of the latter, curiously enough, being the more potent.

The richly marbled Morays or Spotted Ells, abundant in tropical and subtropical seas are sometimes poisonous. One species found favour with the ancient Romans who, money being no object, cut off sheltered coves and even whole bays as fattening ponds for the fish. It is recorded that 6,000 of these eels, averaging five feet in length, were dished up at one famous banquet, and according to Gibbon and other historians, slaves were sometimes used as food for the creatures since it was believed that human flesh enhanced their flavour. The Murænas poison is remarkable in that
instead of finding access to the wound through special channels in the teeth, it is broadcasted over the whole mouth diffusing itself amongst the lacerated tissues of the victim.

Many of the numerous species of cat-fish are poisonous, the front of their dorsal fin being in some forms armed with a spine connected with a poison gland. The spine is raised suddenly by special trigger-like muscles, and does execution in the most approved stage-assassin manner.

A few fish are able to make themselves heard, producing various loud sounds. Thus the gurnards and puffer fish, when taken out of the water, make pig-like grunting noises, whilst an East Indian gurami is said to emit a feeble bark. The fish belonging to the family Sciaenidae, represented off our shores by the Meagre, produce melodious drumming sounds. According to Kyle "the drummers occur
mainly in sub-tropical waters from America, Mediterranean, and the waters of Asia, and some of the romance of a tropical evening often enters into the descriptions of narrators. Bending low over the side of a boat, or better still with an ear to the water, one can hear from the depths the songs of sirens, rising sometimes into the tones of an organ or sinking to the low melody of a harp; at other times the sound has been compared to the ringing of bells or the continuous roll of drums. In the Mediterranean the fishermen are guided to the whereabouts of the Meagre by the drumming it produces in the water. The mechanism employed in producing the sounds is naturally various; a smacking noise by the lips, a rasping sound by the rubbing of the spines together or in their sockets. The drumming noises, however, mostly come from the air-bladder or the muscles connected with it.
Sciaenoids the air-bladder is developed to an extraordinary extent, and with the movement of the gases inside from one compartment to another, it is thought that the wall of the bladder is set in motion. The muscles surrounding the compartments may contribute to the vibration by rapidly extending and contracting."

In a previous chapter mention has been made of certain young fish that live under the protection of a jellyfish. Still more remarkable is the case of the golden and light blue coral fish of the Dutch East Indies, *Amphiprion percula*, which spends the greater part of its life within the body cavity of an anemone. The anemone receives compensation for the shelter that it affords by receiving a food supply from the fish, living upon the waste matter that is ejected by its paying guest. These fish are frequent boarders at the Zoo Aquarium, but, unlike
the majority of the exhibits in that institution, are not caught by means of a net. They are obtained through the agency of native divers, who bring up anemones from the depths, inside each of which one of these fish is usually to be found.
The romance and high adventure suggested by the title "Giant Fish" may possibly be counterbalanced by a certain amount of pardonable incredulity. It may therefore be worth mentioning that such weights and measures as are here recorded have been subjected to scientific investigation.

Almost every family of fishes has its giants, although in some cases they may measure but a few inches in length. When, however, a fish exceeds a weight of 100 lbs. it is entitled, no matter what its scientific interest, to command public respect.

The piscine giants par excellence are found amongst the most primitive forms—the sharks, skates, rays, monkfish, and
sawfish, and the vast size of some of these fish may be explained by the fact that the race came into being and held its own at the tail end of the fearsome age of reptiles. Sharks and rays were in existence when the Dinosaurs haunted the creeks, when the giant Mosasours (so called from the Latin name of the river Meuse, on the banks of which its remains were first discovered) ranged the ocean, and the Pterodactyls or "flying dragons" were a menace to all surface swimming creatures.

Only very big fish could have coped with such odds. The largest extinct shark (*Carcharodon*) had a gape of mouth in which a full grown man could recline at ease, whilst the biggest living shark can boast of a mouth only a very little smaller.

The largest known shark, the whale-shark, measures nearly 100 feet in length, has a "waist line" of forty feet, and
Giant Fish

weighs five tons. Although the possessor of close on ten thousand teeth, it is not the bloodthirsty monster that many suppose it to be. On the contrary, it is quite harmless, never having been known to make a meal off a luckless bather, its menu being restricted to quite small cuttlefish. Quite a number of sharks, however, can be really dangerous. The notorious tiger shark, for instance, accounts for hundreds of casualties every year, and many Australian bathing beaches are patrolled by specially appointed boatmen, whose duty is to give due warning when the fateful triangular fin shows above the water line. Five tiger fish, each seven feet long, have been known to dispose of a six-foot tarpon in as many minutes. At the close of the meal an eighth "tiger" joined the party, and his brothers, their appetite still unsatisfied, disposed of him as a final bonne bouche. Most dreaded of all the shark
tribe is the extraordinary "hammerhead." This big fish has its eyes set on stalks running at right angles to the head, a strange setting believed to give the fish command of an unusually wide field of vision. The hammerhead begins life looking much like an ordinary British dogfish, and it is not until it approaches maturity in its third year that the two "hammers" are developed. The white shark, which reaches forty feet in length, hails from most warm seas, and has a deservedly bad reputation. It will eat anything it can swallow, and a school of half a dozen can dispose of a dead horse flung overboard in six sharp snaps—one to each shark.

Amongst anglers the shark is classed as "vermin," and is fished for when better game is scarce. A typical giant shark "patternoster" consists of four hooks and chains each weighing twenty or more pounds, with a ten-pound stone
attached to each hook to prevent it fouling its fellows. A fifty-gallon oil drum does duty as a float and each hook is baited with eighty pounds of fish. Such tackle has been known to land a 2,000 lb. tiger shark, a 2,000 lb. shovel-nose shark, a two-ton sawfish and a bunch of sand sharks averaging 800 lbs. each. The commercial shark fisher uses the harpoon. One company in Australia lands a quarter of a million sharks annually, converting the catch into such a variety of commodities as oil, leather, fertilisers, medicines, wax, soups and soaps.

The ray or skate is virtually a shark “rolled flat.” Its side fins are certainly produced into immense “wings,” but its general make up is identical with that of a shark. Rays of ten feet across the “wings” are not unknown in the North, while in tropical waters monsters averaging forty-five feet in width abound in huge schools. Specimens have in fact
been recorded weighing 4,000 lbs. In Florida a popular sport consists in harpoonning one of these large rays and hanging on until the fish runs itself aground, for curiously enough a big ray when hard pressed will almost invariably head shorewards. Eight or nine boats crews may participate in the chase, each attaching itself to the harpoon line by a discreet rope's length, until weight tells and the fish is exhausted. The sting ray, which often exceeds twenty feet across the wings, may be designated to the "sporting" class, as when struck it can cover some 150 yards of sea-surface in a few seconds by means of a series of ricochets. Sting rays are justly dreaded, as the fifteen foot tail bears a horny shaft some eighteen inches long, closely set with finely serrated "teeth." When this weapon is brought suddenly to bear upon the naked flesh the consequences are disastrous, as the wounds invariably
prove septic. The fish is known in many parts of the world as the "mantle fish," it having the reputation of enveloping divers and other victims in its "wings" as in a mantle. The stories told of its powers of enveloping its prey are open to grave doubt, but there is no question of the damage that it can inflict when descending from a ten-foot leap into a frail row-boat.

Though apparently monarchs of all they survey, giant sharks and rays have their enemies. The former are liable to be attacked by their own brothers and sisters, whilst all kinds of fish nibble at the wings of the latter as they lie in the sand. Sharks are further often much hampered by the remoras or sucking fish, which may attach themselves in companies of twenty or thirty by means of large oval sucking plates situated on their heads, causing the unwilling host to leap out of the water in a vain effort to get rid of the pests.
Sawfishes are sharks having the snout prolonged into a seven-foot beak set with large tooth-like structures on either side. Many a sensational story has been recounted of the uses to which the beak has been put, but the unromantic scientist avers that the weapon merely serves as a plough and is employed to dig up sand and dislodge the shellfish on which the creature feeds. It is known, however, that on occasions the saw has been used to rip open a large fish, dislodging the interior and providing an unappetising meal for the owner of the saw. It is noteworthy that the sawfish does not lay eggs, but is viviparous, and that the infantile saws are protected by parchment-like sheaths which prevent the keen-edged weapons from puncturing the maternal interior.

Very superior to the sharks and rays as regards sport is that giant member of the herring tribe—the tarpon, which may
Giant Fish

attain a length of eight feet and a weight of 240 lbs. The fish will often fight for six hours, and in its frantic efforts to escape may leap ten feet clear of the water, sometimes descending upon the boat. Add to this the fact that tarpon fishing is to be had at its best by moonlight, and one can readily imagine the delights of this form of "herring fishing."

The largest fish to inhabit European waters is the tunny, a member of the mackerel family, which frequently exceeds 1,000 lbs. in weight.

The giant amongst modern fishes—as distinguished from the primitive sharks and rays—are the sword-fish, surface swimming monsters likewise related to the mackerel. They abound in tropical and sub-tropical waters, and add a peculiar thrill to their pursuit with rod and line by their ability to "ram" the fishing boat with the long needle-pointed
development of the upper jaw. Swordfish measuring fifteen feet have frequently been caught, such specimens carrying a sword of three feet or more in length. The fish are very pugnacious and are said to attack whales with their formidable weapons. Several instances are recorded of their piercing ships' plank, and there is in fact at the present moment an exhibit in the galleries of the Natural History Museum at South Kensington, of the remnants of a whale-boat rammed by a sword-fish, to a depth of nearly two feet.
Chapter XII  

Fish Migration

The movements of fish, like those of most other animals, including Man, are dictated principally by the food supply. The lower an animal's status in the scale of life the less is it the master of its fate, and the movements of the vast fish shoals present little analogy to those of the ship-loads of human migrants or even to the extensive wanderings of a herd of antelope. The most independent of fish are largely the helpless sport of tide and wind. The movements of the great ocean currents are principally responsible for the migrations of fish as at present understood—and that is very imperfectly. Prior to the systematic study of oceanography, a science still in its infancy, the appearance of fish shoals
was accounted for in all kinds of fantastic ways. Many were supposed to have had their origin in slime and mud. The observations of fish migrations were also exploited profitably by the augurs of all countries.

Fishes abound principally in shallow waters, or those of middle depth. From a depth of 400 fathoms downwards, fish life becomes increasingly scarce. On the other hand, from 400 fathoms and upwards, it is within easy reach of the shore, and subject to the continual fluctuations of the tide, which may rise and fall but a few feet as in the Mediterranean, or retreat for several miles as off the coast of Brittany.

The appearance or otherwise of fishes depends primarily upon the disposition of the egg. Fish eggs may be roughly divided into two classes, the free swimming and the anchored. Sea water tends to be more saline in mid-ocean than close
in shore, hence many floating eggs laid in the less saline water are provided with oil globules to ensure their buoyancy. A few like those of the angler are held together in gelatinous masses covering several square yards, whilst others like those of the garfish are linked together with a textile film. There is a general tendency for currents at or near the surface to move the floating eggs in a series of ellipses. Whilst travelling the eggs hatch, so that series of more or less connected shoals of fry, varying much in size and age, cover large tracks of the ocean. This is known as "passive migration," the young fish having to attain some strength and resistive power in order to direct their course. The well-known shoal formation in which most migrant fish travel has many advantages, offering greater resistance to divergent currents and ensuring more immunity from enemies.
Some fish, like the wolf fish, migrate annually in the winter months to deeper water for breeding, returning to the shallows in the spring. Others such as the smaller blennies come in-shore to breed, where they are possibly less troubled by larger fish.

In-shore fishes are less given to wide migration than those affecting the open seas. The sea horse and pipe fish, for instance, despite their feeble swimming powers, literally hug the coast contending against adverse currents by anchoring themselves to fixed objects by means of their prehensile tails. The huge sunfish exhibits the opposite extreme, for its immense balloon-like body is drifted about the seas of the world. The common sun fish has in fact been taken at such widely separate localities as Lowestoft, Bombay and Sydney.

Comparatively recently the food fishes of the northern hemisphere were made
the occasion for endless strife. Sanguinary battles by sea and land have been waged by nations, not least our own, jealous to monopolise them. Today the fishery boards of the world more or less co-operate in attempting to unravel the mysteries of fish migration and development.

No fish are more purely pelagic than the mackerels, a tribe whose graceful forms include such valuable food fish as the tunney and bonito. Spawning takes place in the summer about twenty miles from the shore where the female lays about half a million eggs which drift a little below the surface and hatch in five or six days. Mackerel were believed to retire to the Arctic for the winter, as the herring is still supposed to do by some authorities, and up to the time of Cuvier, it was popularly held that they hibernated by burying their heads in the mud and there rested with the tail
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elevated skywards. It is now generally agreed that mackerel winter near the sea floor in a quiescent state, moving from the coast to deep water and vice versa as weather dictates.

The cod, second only to the herring in economic value, lays its eggs in deep water where they slowly sink as they become heavier in development. The eggs of the herring, on the other hand, are laid on the sea bed attached to stones. The herring was formerly only supposed to spend the summer in Arctic waters, migrating south in vast shoals as the year declined. Recent researches, however, disprove this, and it is probable that the shoals tracking south along our easterly coast are composed of individuals born in widely different areas of the North Atlantic. Their movements after they reach our south coast remain a mystery.

Few fish have a more romantic history than that great traveller, the eel. In
olden times the sudden appearance of eels in lakes and ponds far inland led to the belief that they were generated from horsehair soaked in water. Not until comparatively recently was the mystery of the eel's origin ascertained, when Schmidt, a Norwegian investigator, tracked the fish to its breeding ground in mid-Atlantic. It is now known that the European and also the American eels share a joint breeding ground off the Bahamas. The eggs are probably laid on the sea floor, but the actual period of incubation is unknown. Once hatched, the young, which are leaf-like and transparent and measure only a few millimetres in length, commence to forge their way either to the shores of Europe or America according to the species. The journey to Europe takes about three years, during which time the young rise higher and higher in the water and as they progress undergo various changes,
such as the loss of teeth and the acquisition of a barrel-shaped instead of a leaf-like form. The glass elvers, as they are then called, enter most of the great tidal rivers in immense numbers during their third spring, at which time huge quantities are netted for food. At first relying on microscopic food, the growing eels soon acquire a taste for almost anything they can swallow. Fish of all kinds, crayfish, and even water rats and aquatic birds, all find acceptance by a hungry eel. The fish penetrate to the sources of almost every river. Their gill chambers can retain sufficient water to permit them living ashore for long periods, and this combined with great muscular strength helps them to make lengthy trips overland, travelling as far as some of the Swiss lakes, situated several thousand feet above sea level. After some years in fresh water the eel returns to its birthplace in the sea, covering the
thousands of miles without taking a single meal on the journey.

The salmon is the most spectacular of migrating fish, for to ensure the continuance of its race, it must ascend its native river, and with its goal in sight surmount obstacles that might daunt the strongest of men. A salmon will leap eight foot boulders or tire itself to death in the attempt. But no amount of courage can avail against the insidious river-side factory. In this country the only encouragement given to the king of sporting fish is a half-hearted regulation restricting dye-works and a mesh of stake nets. In the United States the salmon nets are laid down by the fishery boards in restricted areas, and such animals as may harm the fry are carefully weeded. In California there is a law which ordains that every fisherman shall release four young fish for every adult individual caught.
The river offers obvious advantages as a spawning ground compared to the sea, being immune from many foes that haunt the oceans, and it is evident that most of our river fish are derived from marine forms that have migrated to spawn farther and farther from the perils of salt water. Such forms as the miller's thumb, stickleback and burbot are scarcely distinguishable from their marine relatives.

Fish migration is no mere theme for the dryasdust type of scientist, for it affects the man in the street to an extent which few realise. Human agencies have aggravated what is at best an exceedingly difficult problem. Possible breeding grounds of food fishes are given little rest, for day and night the steam trawlers of Europe furrow the sea bed from Falmouth to the west of Scotland, and from Grimsby to the Dogger Bank. The White Sea as far as the North Cape and
even Greenland is now "nibbled" by ambitious steam trawlers. Add to this the pollution of our rivers and it will be seen that man is his own worst enemy as regards his fish supply. Legislation has in recent years been brought to bear on stream pollution, and in some cases the mischief is not beyond all undoing. Trout and many other food fishes have been farmed very successfully in America under government supervision. The Californian Fishery authorities, for instance, have enormously increased the numbers of shad, a close cousin of the herring. In 1871, 12,000 fry about eight days old were transported from the Hudson River to the Sacramento. To-day shad of remarkable size have spread themselves along 3,000 miles of coast from California to Alaska, and over 60,000,000 shad fry are annually transferred from the Hudson to the Sacramento by a fishery board that really deserves to be called
progressive. In Great Britain similar experiments have been made with plaice in Loch Fyne, but these being of a semi-private venture have remained at the experimental stage. It was found that young plaice liberated in the Loch Fyne area, immune from the enemies that continually attack such fish in the sea, showed a comparatively small mortality.

Whilst few practical steps have been taken in this country to protect fish which might be turned into a regular food supply, efforts have been made to follow the movements of our food fish by the system known as "marking." The idea is not new, for Izaak Walton, in 1653, wrote: "Much has been observed by tying a ribbon on the tail of some young salmon which have been taken in weirs as they have swummed towards the salt water, and then by taking a part of them again by the low mark at the same place as they returned
to the sea, which is usually about six months after." A very good effort in days before steam or petrol were dreamed of, and any avowed naturalist was regarded with suspicion. To-day fish are marked with discs of vulcanite attached near the dorsal fin, both above and below, with silver wire, which disc bears cryptic numbers and letters referring to longitude, latitude, date, depth and temperature of water. The actual marking occupies a few seconds only and entails no bloodshed. The specimens, with their passports, are kept in tanks aboard the ships of the fishery board until they have recovered from the shock of being caught up and are fit for return to the sea. Much valuable data has thereby been obtained. It is known that a plaice lives to fifty years of age and that only three per cent. of these fish caught by trawlers are of marketable size. A vigorous flat-fish, striking bad
feeding-ground, may push forward and travel from Dover to Ostend within a year, whilst on the other hand, one put overboard on good ground may wander very little and be picked up, as has actually happened, three times in as many days by various trawlers. A plaice returned to the sea by one of our inspectors of fisheries off the coast of Yorkshire was recaptured twenty miles east of Aberdeen two and a half years later. It had travelled over 150 miles during the period in question and grown eight inches in length.
Chapter XIII  

Aquatic Amphibians

The Amphibians—the frogs, toads, newts and salamanders—occupy an intermediate position between the Fish and the Reptiles. With very few exceptions all are very fishlike in their infancy, when they are dependent upon water, taking in the necessary oxygen by means of gills. Once past the gill stage the majority may be relied upon to find a living ashore. The group is of little economic importance, but its members engage in a ceaseless warfare against insects, thus playing a part in the balance of Nature.

Amphibian tadpoles may be found in mountain streams, rivers, ponds, and subterranean pools, and may come into the world from gelatinous strings, floating
masses of eggs, or from single eggs. The number of eggs laid and the size of the tadpoles stand in no relation to the size of the parents. A tadpole, known as the Paradoxical Frog of Brazil, actually exceeds in length as well as bulk the adult, and the ancient writers, in fact, described the creature as an animal which began life as a frog but which eventually turned into a fish.

In most cases the eggs and tadpoles of frogs and toads, having been deposited in the water, are left to look after themselves. In some cases, however, they are protected by the parent and the means taken to ensure their safety are as diverse as the forms of their protectors. They may be nursed in enclosures or holes in the water, in nests overhanging the water in which the larvae drop at a certain stage of their development, or in transparent gelatinous bags also in the water.

The large Brazilian tree frog (*Hyla*
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*faber*, known as the "Ferreiro" or "Smith" from its voice which sounds like a mallet beating upon a metal plate, protects its offspring by building basin-shaped receptacles of mud about a foot in diameter on the borders of ponds. The mud is scooped out by the mother to a depth of four inches and with the material thus removed she forms a circular wall which emerges just above the surface of the water. The larvae are thus guarded from foes and are liberated about a fortnight later when the walls fall in. When this happens they are old enough to be able to look after themselves.

The parents of a Japanese tree frog (*Rhacophorus*) construct subterranean chambers in the moist earth on the edge of ponds. The building operation completed, the mother produces a secretion which she beats up with her feet, thus forming a frothy mass into which the
eggs are deposited. The parents then quit the burrow, not by the way they entered, but by a tunnel which they construct after the eggs have been laid, and which leads obliquely to the water. By means of this exit the tadpoles, when the nest collapses, find their way by the liquefaction of the froth to the pond in which they complete their metamorphosis. The eggs, if taken from the nest and put in water, die immediately.

In an Australian toad the eggs are laid in a dried-up pool, but do not hatch until the rain has again filled the pool.

In other tree frogs (Phyllomedusa and Chiromantis) of South America, India and tropical Africa, the eggs are attached to the leaves of trees overhanging the water. The larvæ, after a few days, drop into the pools below where they complete their infancy. In certain other tree frogs the spawn is deposited against the walls of wells into which the larvæ
likewise drop when they have become proficient swimmers and are old enough to procure food.

A small frog (*Phrynixalus*) spends its nursery days enclosed in a transparent sausage-shaped membrane which is abandoned in mountain streams.

In *Dendrobates*, a small South American frog living in districts where the pools may dry up in a few days, the parents carry the tadpoles on their backs, the offspring adhering by their large sucker-like lips. The young are thus carried from one pool to another.

The more animal food the tadpoles obtain the quicker they develop. The tadpole stage may persist in fact in most frogs and toads for nine months or more if the animals are fed on vegetable matter only. Experiments have proved that if tadpoles are kept under water continuously by placing a sheet of perforated zinc between them and the surface of
the water they may remain in a larval stage indefinitely, provided they are given sufficient vegetable food to support life.

Certain frogs, *Xenopus* of Tropical and South Africa, *Hymenochirus* of Tropical Africa, and *Pipa* of Tropical America, are purely aquatic and never leave the water. In conformation with their aquatic life, the eyelids are absent, the nostrils and eyes are situated on the top of the head and the toes are very broadly webbed. So broadly webbed, in fact, are the toes in the African Clawed Frog (*Xenopus*) that when expanded they resemble half-opened umbrellas. The tadpoles of this creature are remarkable in possessing large tentacles—balancing organs—situated on either side of the head and which, when fully developed, obtain a length equal to that of the head and body.

It would be reasonable to suppose that
the young of the flat, triangular-headed *Pipa* should be hatched in the form of tadpoles. Not so, however. The eggs, up to 100 in number, are deposited with the help of the male upon the back of the female where they sink into the skin, which during breeding season becomes spongy and yielding. The cavities so formed become covered after a few days with a horny lid. Nearly three months later the young ones lift up the lids and emerge as perfect little toads, having spent their entire tadpolehood in the holes of the maternal bagatelle-board. The following account of the breeding of specimens in our Zoological Gardens has been given by Bartlett: "About April 25, the males became very lively, and were constantly heard uttering their most remarkable metallic call-notes. On the following morning, Tennant, the keeper, arrived in time to witness the mode in which the eggs were deposited.
The oviduct of the female protruded from her body more than an inch in length, and the bladder-like protrusion, being retroverted, passed under the belly of the male on to her own back. The male appeared to press lightly upon this protrusion and to squeeze it from side to side, apparently pressing the eggs forward, one by one, to the back of the female. By this movement the eggs were spread with almost uniform smoothness over the whole of the surface of the back of the female, to which they became firmly adherent. On the operation being completed the males left their places on the females and the enlarged and projected oviduct gradually disappeared."

The tailed amphibians, represented in England by three species of newts, are provided with two pairs of limbs, exceptionally, however, only one pair. The body is always elongate, almost eel-shaped in certain forms where the limbs
are small or rudimentary. The eggs of these amphibians are usually laid singly, sometimes in small batches attached to submerged weeds, the egg-laying showing little of the adaptability observable in the frogs and toads. The larvæ bear large external gills, but as they grow up these disappear, and the animal is obliged to rise to the surface at intervals for a breather. The frogs show their kinship with the higher vertebrates not only by their general structure, but also by their vocal powers. The newts and salamanders, however, are always silent. Courtship is achieved in a fish-like manner, and consists of violent gyrations and manoeuvres until the lady says "Yes." Often the males develop a nuptial suit of many startling colours, and developments of the tail and crest, ornamentations which can be seen to advantage in the spring in the British Crested Newt.
Among some tailed Amphibians the external gills are retained throughout life. The Axolotl of Mexico is perhaps the most interesting example. The creature, which occurs in the lakes of certain districts of Mexico, where it is farmed for food purposes, retains the larval form with large branching external gills for the whole of its existence, breeding in the imperfect condition. In other parts of Mexico and North America it transforms when a few months old into a black and yellow salamander. In 1863 a number of Axolotls that had been imported to Europe from Mexico bred in the Jardin des Plantes in Paris, where the young were successfully reared. It was naturally surmised that these animals, having bred in the branchiate condition, must be perfect aquatic animals. Two years later, however, some individuals of the second generation lost their gills and the fins on the back and
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tail, developed eyelids and yellow markings on the skin, and eventually took to land, transformed into the common North American salamander *Amblystoma*. It has since been ascertained that the Axolotl can be forced by drought to take to a terrestrial life and adopt a slow-going, sheltered existence on terra firma. In recent years, it has also been found that this Peter Pan of the Animal World can be induced to grow up by inducing it to take a single meal of thyroid or pituatory gland.

The largest living Amphibian is the Giant Salamander (*Megalobatrachus maximus*) of Japan. The creature, which suggests a huge flattened-out lizard, attains a length of over six feet and lives concealed in dark crevices where it leads a solitary life. Its skin is brown, spotted with black, and is very tubercular. Its eyes are minute and are scarcely to be distinguished from the tubercles on the
The animal, which is closely related to a fossil form, was originally described as a fossil man, its discoverer and describer ending his account of the animal with the words—"Homo diluvii testis." The eggs of the Giant Salamander form a rosary, each egg being connected with the next by a small string. Their care devolves on the father, who continually gets under them and lifts them up for the purpose of providing aeration.

Another Giant Salamander (Megalobatrachus sligoi) was discovered in 1924 in Hong-Kong, and the only existing specimen now resides in the Zoological Society's aquarium. The creature, which measures four feet in length, was captured in the Botanical Gardens after a storm, emerging from a broken drainpipe. The Giant Salamanders are known to live to a very old age, and the Zoo specimens are expected to outlive all the
human members of the staff. Its only competitors in Regent's Park are certain inhabitants of the Tortoise House.

The aquatic Salamander (*Cryptobranchus*) of North America, attains a length of eighteen inches. Its eggs, likewise laid in a rosary-like string, are protected by the male, who guards them against their cannibalistic mother.

*Amphiuma*, an eel-shaped relative of the Giant Salamander, is a native of the rivers and swamps of the South-Eastern United States, and obtains a length of over three feet. The eggs are deposited in clumps. In this case the nursing duties devolve upon the mother, who coils herself round them until they hatch, a period sometimes exceeding twelve weeks.

The cave-dwelling Proteus or Olm of the East Coast of the Adriatic, lives in complete darkness. It is quite blind, for its eyes, in accordance with the cave life
which it leads, are hidden under the skin. Its elongate body, provided with small, widely serrated limbs, is pale flesh colour, whilst its large external gills are blood red, forming a striking contrast. The flesh-coloured skin is as sensitive to light as a photographic plate, becoming jet black if exposed to the rays of the sun. It has been shown in recent years that these salamanders, which at an embryonic stage only have well-developed eyes, can be forced to regain their eyesight, a certain Viennese biologist having succeeded in developing the rudimentary visual organ into a full-sized functional eye by subjecting the animals to red illumination for five years from birth. In its native state this enigmatic creature feeds almost exclusively on various kinds of small crustacea. In captivity it has been known to thrive for over three years without taking any form of nourishment.
Aquatic Reptiles at one time dominated the rivers, lakes and seas and attained huge proportions. To-day, they are represented only by a few species of turtle and small sea snakes. All are confined to the tropical seas, though occasionally the Gulf Stream brings a turtle to our own chilly shores. The Green Turtle which is cosmopolitan in the warmer waters is omnivorous, feeding on all kinds of fresh seaweeds and living animals. The females only come to land to lay. Choosing usually a moonlight night, the mother turtle comes ashore, selecting a sandy beach, and makes a bee-line inland until she reaches an area a few hundred yards above high-tide mark, where she digs shallow
pits and deposits her eggs, covering them with sand before returning to the sea. This return to the sea provides the hunters' harvest. The ponderous reptiles, foraging their way painfully seawards, are "turned turtle" by means of crowbars and left there to be collected, and shipped to various parts of the world. The Green Turtle, so called from the colour of its fat, from which the famous soups are made, shares its popularity with the Hawksbill, which provides most of the tortoiseshell of commerce. The latter turtle is more predacious than the partly vegetarian Green Turtle, and feeds largely on swimming crabs and pelagic fishes.

There are many ways of catching turtles. Waylaying at the nesting season is the most profitable, but they can also be taken "on the fin." Their capture is frequently effected by the harpoon or by a diver jumping over-
board and grappling with the beast, and towing it in the usual "life-saving" manner to the boat. The use of the Remora sucking fish has already been mentioned.

The Leathery Turtle is the largest of living turtles, attaining a length of eight feet and a weight of over 1,500 lbs. The creature, a connecting link with the past, differs from all other tortoises and turtles in its vertebrae and ribs being entirely free and not fused to the carapace. The shell is not made up of a series of immovable plates, but consists of a sort of leather waistcoat, reinforced with innumerable plates of bone. It has a world-wide distribution, occurring in all tropical seas and occasionally reaching our south coast.

Sea Snakes are confined, with one exception, to the Eastern Hemisphere, and are descended from terrestrial ancestors. They show peculiar modifications for a life on the ocean wave,
the body being encased in scales of more or less uniform size, suggestive of fish, the eyes being situated on the top of the head, and the tail being compressed to form a paddle. All are highly poisonous and bear living young. The colouring of most species is usually of the "dazzle" pattern, the design being cunningly tinted and arranged to blend with the restless waves and seaweeds, thus rendering the beast more or less invisible. Sea snakes are wholly pelagic, chasing fish and crabs in the surface waters and only swimming inshore for breeding purposes. The female anchors, by means of her pliant tail, to corals and seaweeds during the mating season, but at other times keeps to the open sea.

No dissertation upon aquatic reptiles is complete without some reference to the giant "sea serpent," although one does so with apologies, for all accounts of the beast to date are at the best
unconvincing. Many explanations for its appearance have been offered—floating rope, seaweeds, the tentacles of a giant squid, or a school of dolphins swimming in single file. All these very natural phenomena might, at a distance, well suggest a giant snake to the super-imaginative or intoxicated. Before dismissing the "sea serpent" to its proper place—Fleet Street—a few of the more entertaining accounts of the monster may be quoted.

Archbishop Magnus, a naturalist living in the year 1555, who recorded all natural and unnatural phenomena that came his way without asking inconvenient questions, tells us that: "They who sail along the shores of Norway relate with convincing evidence that particularly admirable story, namely, that a very large serpent of 200 feet in length and 20 feet in diameter lives in rocks and holes near the shores of Bergen."
It comes out of its caverns only on summer nights, to wander on shore to devour calves, lambs and hogs, or goes into the sea to eat cuttles and all kinds of fish. It has a row of hairs of two feet in length, hanging from the neck, sharp scales of a dark colour and brilliant flaming eyes. It attacks boats and snatches away the men."

A host of other early writers have copied this good prelate's story with such embellishments as occurred to them at the time. One can easily forgive this sort of thing amongst fifteenth century writers, but when one finds that such romances are still "going strong" right up to the opening of the present century, a lurking suspicion of an ulterior motive not unnaturally obtrudes itself.

In 1845, a certain Dr. Albert Koch, not only claimed to have seen the serpent, but actually exhibited a 140-foot long specimen on Broadway. His
Hydrachus drew an excellent gate for some time until some German naturalists exposed the hoax. The "serpent" was found to consist of the remains of several specimens of a fossil whale.

About the same time all kinds of master mariners and others testified on oath to the presence of marine monsters, ornamented with horns, spines and other appendages, and such accounts were hailed with delight by the pressmen of all nations.

Since the advent of the camera and the increased duty upon alcohol, however, the sea serpent appears to have become unusually shy.
The aquatic mammals are not as numerous as they were when the world was young. They have proved far too useful to man to be allowed to live in comparative peace, the depredations in their ranks made by climate and natural enemies being as nothing compared with the havoc wrought amongst them in the name of commerce. Efforts are now being made—possibly too late—to conserve a few survivors.

Aquatic mammals must have been in existence for at least two million years, and it is a matter for congratulation that we are at last lavishing money on their conservation and study. Recently the survey ship the Discovery weighed anchor in the Thames giving visitors an oppor-
tunity to see the latest efforts made in whale preservation. It was part of the Expedition's work to harpoon whales with harmless silver darts, each dart being stamped with records of longitude, latitude, date of firing, etc., and many such darts are doubtless now being carried about the high seas embedded in the sensitive skins of living whales which, when captured, will furnish valuable information as to the little known habits of these animals. The position of shooting is recorded in a log against the number of the dart fired, and a reward offered by posters at all the whaling stations of the world for the return of darts and certain data.

According to Dr. Stanley Kemp, the chief of the scientific staff of the *Discovery*, the intensive whaling now going on in the South Seas, unless decisively checked, will before long reduce the animal almost to the point of
extinction as has, as a matter of fact, happened in the North. The fishery still requires from those who follow it qualities of great daring, but the latest modern developments have threatened its survival. It could hold its own in the neighbourhood of the ice floes when the fishermen entered the seas in sailing ships, armed with such a primitive weapon as the hand-propelled harpoon, and on sighting a whale rode after it in small boats. The steamboats and the harpoon, fired from a gun, bearing in its head a time fuse that explodes like a bomb, are too great a handicap for the animal. Once the stock of whales has been depleted, their recovery will probably never be effected. There is consequently a grave risk that an important source of wealth is being destroyed. In the South whale food appeared to consist almost exclusively of a single species of crustacean
(Euphausia), and a study of that species was one of the subjects to which the Expedition devoted attention. Dr. J. L. Suarez, of Buenos Aires, has estimated the number of whales left in the Antarctic as between 10,000 and 12,000, of which not fewer than 1,500 are slaughtered every year. Dr. Suarez has given particulars of the enormous profits made by the whaling companies. The annual profit of one Norwegian firm is roughly £165,000, and this company paid its shareholders a dividend of over fifty per cent. on its capital.

The whale, like most aquatic animals, is outlined like a submarine, a shape best suited to cleave the water when travelling at high speed. The animal is so rich in fat, or blubber, that it may cover large specimens to a depth of several feet. The fat being a mass of tissue impregnated with oil protects the whale from extreme cold, and ensures
buoyancy. In semi-aquatic animals, such as the hippopotamus, the nostrils are set as high up in the nasal region as possible—in fact, on the top of the head—but in the whales, which live almost entirely under water, they are literally disposed between the eyes. The hot breath from these nostrils condenses in cold air, hence the spouting, a whale's breath looking like a jet of steam suddenly erupting from a geyser. If a little sea water gets in the way of this vapour a waterspout is formed. Whales are the largest animals known, some measuring over 100 feet in length, and only some of the extinct Dinosaurs exceed them in length. They, however, hold their own in bodily bulk.

The Whalebone Whales, once so much in demand for corsets, frequent the Arctic Circle, the "bone" being merely a curious development of the palate that acts as a "soup strainer," the "soup"
in this case being floods of sea water filled with countless myriads of tiny crustaceans and molluscs. Not all whales are such harmless monsters as the species supplying the whalebone. The Cachalot, or Killer, is amongst the most dangerous of sea beasts. In olden times when whalers set off in a small boat to chase the Cachalot the whale often turned the tables on his tormentors. When the rowing boat approached and the harpooner, standing in the bows, lodged his spear in the quarry, the boat was not infrequently capsized by a blow from the animal's tail. The whale, in its death agonies, might even leap clear out of the water and fall back upon the boat.

Certain authorities point out that if there is any truth in the ancient narrative of Jonah and the whale the large "fish" in question must be the Sperm Whale or Cachalot.
Many a fish story has weathered the cold incredulity of the scientist and the jeers of the man in the street. The biggest of all big fish stories—the story of Jonah—is still, however, a matter for serious controversy. Although the acrimonious prophet's remarkable experience is usually treated as a myth, many are content to accept it as it stands, regarding the performance as a miracle enacted under divine interposition.

Mr. Ambrose John Wilson, of Queen's College, Oxford, is the latest to champion the veracity of the ancient narrative, and in a contribution to the Princeton Theological Review, attempts to prove its truth by subjecting it to scientific and historical tests. Mr. Wilson points out that the "fish" in question would be the Sperm Whale or Cachalot, a species measuring up to eighty feet and inhabiting the waters where Jonah was a voyager. He compares the interior of
such a creature to a house room in which at least twenty Jonahs could stand upright. The impossibility of the performance has been urged on the ground that the whale’s gullet is too small. Although certain species of whales have comparatively small throats, the gullet of the Sperm Whale is not only large but distensible, and this, as the author points out, is a question not of calculated possibilities but of recorded facts. The Sperm Whale may subsist on octopuses, the bodies of which, often far larger than that of a man, have been frequently found whole in its stomach. There is also a well established record of the skeleton of a shark sixteen feet long being found inside a Sperm Whale. Therefore, while one may reasonably question the prophet’s survival after being swallowed, there is no shadow of doubt that certain whales could swallow a human being with the greatest ease.
Can a man live inside a whale for more than a very short time is the next point to be considered. According to Mr. Wilson the answer is in the affirmative. He reasons "there will be air to breathe, of a sort, the air necessary to enable the fish to float. The heat would be oppressive, but not more than 104° to 106° F. in the opinion of an expert, a provision maintained by his blanket of blubber often many feet in thickness. This temperature, though fever heat to a human being, would not necessarily be fatal to human life. Again, the gastric juice would be extremely unpleasant, but not deadly. It cannot digest living matter, otherwise it would digest the walls of its own stomach."

The author further attempts to strengthen his case by quoting an account of the Jonah-like experience of one James Bartley, which took place as recently as the year 1891, and was investigated and
confirmed not only by Sir Francis Fox, but by a committee of French scientists, one of whom was the late M. de Parville, the scientific editor of the *Journal des Debats*, of Paris. According to Sir Francis Fox's account, in the February of 1891, the whaling ship *Star of the East* operating near the Falkland Islands, launched two boats to deal with a big bull cachalot. One of these was upset by a blow from the whale's tale, and a member of the crew, one Bartley, disappeared. The whale was subsequently killed and the work of dismembering commenced. The crew were busy with axes and spades removing the blubber and worked all day and part of the following night. Next morning they attached some tackle to various parts including the stomach, which was hoisted on deck. The stomach attracted special attention by its strange internal contortions. On opening it there was revealed James Bartley, A.B., alive
but with his skin bleached to a deadly whiteness that remained throughout his life. For fourteen days afterwards this man was a jibbering maniac, after which period he regained the normal. This remarkable story which was accepted by the special committee presided over by Sir Francis Fox has, however, been described as "moonshine" by the captain of Star of the East, and therefore very much reliance cannot be placed on its veracity.

Sir John Bland-Sutton has given an account of a man being taken into the mouth of a whale very many years ago. In this instance, a U.S.A. vessel sent out a small boat to chase a cachalot. The boat was bitten in two, as frequently occurred in the days before the gun harpoon was invented, and one Marshall Jenkins, of the crew, went down with the whale, as the beast sank in its death agonies. It came up for the last breather
and, as often happens in such cases, vomited. Together with the remains of its last peaceful meal—cuttlefish and worse, it brought up Mr. Jenkins, depositing the whole amongst the wreckage of the broken boat.

It is very evident that we need to learn more before finally turning down the uncomfortable experience of the late Jonah as an entertaining but incredible "fisherman's tale." But, to put it mildly, the physiological side of the story, however, presents many a moot point. How long, for instance, can a man stand a temperature of about 105°F. without water, even assuming that the air was fit to breathe? No animal tamer who has placed his head inside the mouths of lions and other wild animals for only a few seconds at a stretch, at a high consideration, would admit the possibility of the atmosphere inside a wild animal being supportable for long, and even
assuming that the whale’s belly contained sufficient oxygen to keep a man alive for three days, it is hard to believe that the gastric juices would be innoxious. As it is, one can only say that James Bartley had the “luck of the navy” to come through his ordeal. Jonah was still more fortunate, as from all accounts he did not suffer from premature whitening of the skin, or even temporary mental derangement.

The Killer Whale is a cosmopolitan frequenting all seas, and has actually been stranded as far up the Thames as Chiswick. The “Gladiator,” as the animal is sometimes called, engulfs huge quantities of herrings and fearlessly attacks giant cuttlefish. In the northern part of its distribution it harasses the Whalebone Whale, attacking in large schools and tearing strips of flesh from its victims. In the Antarctic it also does great execution amongst the penguins. The pen-
The Under-Water World

guins so grotesquely helpless ashore can swim at a high speed below water. When pursued by the Killer they make a dash for the nearest ice floe and leaping clear of the water often land six or twelve feet above the surface. The Killer, however, swims beneath the floe and humping its back endeavours, often successfully, to bump the penguin back into the water.

The Narwhal, or Sea Unicorn, of Arctic Seas, is remarkable for the development of the two upper incisor teeth. In the female these teeth remain concealed, but in the male the left and sometimes the right attain a great length—five to seven feet. When both tusks are developed they are twisted spirally in the same direction in marked contrast to the spiral horns of antelopes, in which one always turns to the left the other to the right. The tusks were once much in demand by apothecaries, being supposed
to possess all kinds of medicinal virtues, sharing the rhinoceros' horns reputation as a detector of poison. These large whales, which are on the verge of extinction, were once so common that their tusks were used by Icelanders as scaffolding poles for their huts.

The poverty of our knowledge as regards the distribution of whales was well illustrated in December, 1927, when a shoal of 120 False Killers were stranded off the coast of Ross-shire, as the result of severe gales. The bodies were roughly skeletonised and together with the heads conveyed to the Natural History Museum at South Kensington, at a cost of about £500. The heads were immortalised in plaster casts and with the skeletons belonging to them distributed amongst the museums of the world. The False Killer (*Pseudorca crassidens*), which was first made known to science by the discovery of a skull dug up in the Lincolnshire Fens,
appears to have enjoyed a wide distribution in prehistoric times, and in recent years chance specimens have been met with off the coasts of Denmark and Tasmania. Prior to the appearance of the Ross-shire school, only some half dozen preserved specimens were in existence in widely separated museums. The great majority of whales seen in our museums are stranded specimens, and this for a curious reason. A whale once aground cannot, like a reptile or fish, turn in its own length, or even three times its length. The backbone is singularly inflexible, indeed many of the vertebrae of the neck are fused together to form one, rendering any side movement of the head impossible, and the head of some species is quite a third of the entire length. The tail also is set horizontally, not vertically as in a fish, making it impossible to use this appendage as a lever. For this reason all whales swim with an up and
down motion and not from side to side in the manner adopted by the majority of fishes. Almost the entire motive power is supplied by the tail, the flippers though huge enough being generally small in proportion and serviceable merely for turning. A ten-foot whale probably describes a circle of nearly 100 feet in order to reach its starting point. This inability to turn may in some measure account for the immense distances covered by schools of whales. Fish, having struck a good feeding ground, can turn and turn again until the food supply is exhausted. A whale, on the other hand, forges blindly forward and having taken what it can of such food as crosses its path must plod ahead until another chance of a passing snack offers itself.

Porpoises are merely whales in miniature. The oil they yield is not sufficient to tempt the money-maker, whilst their hide is as thin as notepaper, and cannot
be used for commercial purposes—Porpoise hide as advertised being really White Whale skin. They are lively beasts, their gambols in midsummer always delighting the seaside visitor, and one recalls Mr. Punch's picture of the seaside pierrot whose audience suddenly about turned and feasted its eyes on a school of these entertaining animals, rather than on the second-hand inspirations of the so-called comedian. Porpoises have lived for short periods in aquaria. The last exhibit—"Percy" of the Brighton Aquarium—covered over 10,000 miles in four months. Observations have established the fact that these animals practically never cease to swim, although their rate of travel may vary greatly. The force of "Percy's" spout was considerable, sufficient to dislodge a hat from a human head brought within a few feet of his blow-hole.

The manatees, dugongs and sea-cows
Aquatic Mammals

are believed to be close relatives of the elephants, and there is much in their make-up that suggests an elephant-like creature that might millions of years ago have taken to the water to escape terrestrial foes. If this surmise is correct, it was a case of "out of the frying-pan, etc.," for by taking to the water the creature lost the use of its hind legs, met a new set of foes in the form of sharks, etc., and finally succumbed to the spears and bullets of civilised man. Sea-cows at the present day inhabit the estuaries of many tropical rivers. Once they flourished all over the Continent and many remains have been gathered from the Thames and other home waters. Like the whales, these harmless creatures have but one young at birth, which is cuddled beneath one flapper and suckled at the breasts. Looking at a stuffed specimen, or rarely at a living one as shown occasionally in the Zoological
Gardens, one easily realises how our forbears, when first introduced to the beast, conceived such fantasies as the mermaid or siren. Like the whales, sea-cows are richly endowed with blubber, even the bones being soaked with oil, and carefully cleaned skeletons set up in museums may, after thirty years of exhibition, develop large black patches of grease, which once ensured the animal against the rigours of climate.

As previously mentioned, aquatic mammals are nowadays represented by a few score animals, but a large number may be considered as almost aquatic, since they only come ashore to sleep or breathe. The seals and sea-lions, which are related to the domestic dog, are especially adapted to an aquatic life. The seal is a dog that has undergone extraordinary modifications in compliance with its passion for a life afloat. A popular jest maintains that people living in damp
localities acquire webbed feet, and this has actually come to pass in the case of these animals. The bones of their hands are four times the length of any terrestrial animal, and the strong elastic webs joining the digits have completed them as most efficient paddles. Add to this the dense layer of fat to give warmth and buoyancy and the tough skin covered with dense hair impervious to damp, large eyes, nostrils placed high up on the nose, and one has a creature perfectly equipped to enjoy a "life on the rolling waves." Seals and sea-lions are fast joining the great majority. The warm pelts of their furs, not to mention the abundant oil which they supply and their tasty flesh, have led to terrible ravages on the part of man. The story of seal hunting and the bitter rivalry between the Seal Companies, makes unpleasant reading. These animals are chiefly restricted to the colder seas, where
they rely almost entirely upon fish for sustenance, and this has been made an excuse for much wanton persecution. Most sea-lions will if hard pressed vary their diet with an occasional sea bird or egg when opportunity arises. A Zoo sea-lion once engulfed a penguin whole. For many years the sea-lions and the penguins lived in harmony. One day, however, one of the sea-lions caught hold of a whiting at one end of the body whilst a penguin seized the fish at the other end. In a moment of desperation the sea-lion engulfed both the fish and the bird. The meal was evidently to the sea-lion’s liking, for from that day he proceeded to attack the remaining penguins, who had to be removed and housed in a different part of the gardens. Seals and sea-lions are gregarious, shifting in vast herds sometimes numbering many thousands. The sexes meet only in the breeding season when the males engage in sanguinary
conflicts, victor and vanquished alike emerging from the fray covered with blood and with their hides torn to ribbons. The females when pregnant withdraw to secluded spots and there bring forth their young in peace. It is chiefly yearling sea-lions or two-year-olds that the fur hunters covet, and these are segregated from the main herd and driven slowly to a feeding pen a few miles distant. It was a tragic day for the seal when man first decided that his own skin and hair were insufficient covering. A case in point is that of the elephant seal, the largest seal known and distinguished as regards the male sex by a short trunk like that of a tapir. At one time this animal had a wide distribution, but to-day its range is very limited and it is restricted to such widely separated localities as the Antarctic seas, certain small islands off the Californian coast, and the island of Guadaloupe, off the coast of
Mexico. In 1892 the species was in fact recorded as probably extinct. In 1911, however, the American survey ship *Alabatros* discovered a herd of 125 on the island of Guadaloupe, and a few young specimens were shipped to various Zoos.

A big male elephant seal may measure twenty-two feet in length, but females are only half this size. In these days, sea elephants, except in certain hunting areas, seldom come into contact with humans, and it is interesting to learn that the sea elephants discovered by the *Alabatros* Expedition had to be treated somewhat roughly before they would "clear the gangway" and make room for the explorers with their movie cameras and other apparatus to pass through their ranks. The huge males were covered with festering sores from past fights, and elders who had seen many years of conflict had the skin of their breasts and necks almost bare. Like the
fur seals the sea elephant probably lives on small fish and squid, but captives do well on raw fish finely chopped. The elephant seal is remarkably plastic and can bend backwards till its snout nearly touches its heels, a feat impossible to any animal with the exception of the human contortionist.

In the Hooded Seal of the Arctic Seas, a near relative of the sea elephant, the nose is surmounted by a loose sac, which can be inflated with air until it doubles the size of the animal's head.

It may be mentioned, in conclusion, that in recent years nearly 400 fur seals have been annually slaughtered in the South Shetlands alone. According to latest reports no definite steps have yet been taken despite a certain amount of agitation, to protect the Guadaloupe colony of sea elephants. The Mexican Government, however, hopes to give the matter some attention—revolutions permitting.
Conclusion

In the foregoing chapters some attempt has been made to review the multitudinous life of the water world and to give some idea of the interdependence of the various groups. Life from small beginnings has tended and still tends to develop more and more complex forms which in turn rely for their continued existence upon other forms lower in the scale. The leviathan that ploughs the ocean and the water flea that populates the stagnant ditch are not mere isolated phenomena, but integral parts of a vast harmonious whole. But one is led to ask "What of the future?"

All the evidence to-day points to the present age as being the hey-day of the mammals. No giant shark or reptile of
the past ever exceeded the modern whales in bulk or nearly approached them in intelligence. Such a creature as the Killer has only man as his foe. It can drag down a polar bear, or cut up a forty-foot squid. Left to themselves there is no knowing to what length the aquatic mammals might not develop. Their high intelligence and capacity to pick up a living in almost any sea continually opens up fresh worlds for them to conquer. With the advent of Man, however, the whole situation has changed, and the great sea beasts are joining the majority along with their terrestrial relations. As remarked upon in a previous chapter, whaling is a dying industry, and only drastic legislation has saved our food fishes from sharing the whale's melancholy fate. Even so, the food fishes are continually obliged to seek fresh grounds where they can breed unmolested, and the steam trawler ever hard upon their
track drives them farther afield each succeeding year. So great in fact is the havoc wrought in recent times amongst the flat fishes that numerous species once despised as food now bulk largely in the national diet sheet. Such creatures as oysters, mussels and lobsters are now artificially fostered with as much care and "applied science" as any garden plants or field crops.

The natural elimination of one form of life is gradual, and in the past the waning of one group heralded the dawn of another which took its place and so preserved the balance. When, however, Man once sets about the systematic destruction of a group there is no such compensating substitute forthcoming, and a race may be blotted out effectually and finally in the course of a few years. As a result of human activities it will soon become incorrect to refer to the "balance of Nature"—a balance which
we are at the present time ourselves continually upsetting.

The query "What of the future?" must therefore remain unanswered, for the last decade has brought home to us with unpleasant clarity the fact that, as far as the higher animals are concerned, the seas and rivers as well as forests and fields are by no means inexhaustible, and that the toll spasmodically levied by Nature in her most destructive mood is trifling compared with the tireless and calculated killing by civilised Man. Even our close relations, the apes, are being exterminated in order to add a few extra years of vigour to the flower of creation—*homo sapiens*.

THE END