

CHAPTER VI.

THE NATURAL TREASURES OF THE RED SEA.

The arm of sea which springs from the great Indian Ocean and bears the name of Red Sea or Arabian Gulf is a genuine tropical sea, although it stretches northwards far beyond the tropic. Though it is separated from the Mediterranean Sea only by the isthmus of Suez, in the character of its animal life it is sharply distinguished from the former sea, and only a few cosmopolitan forms are common to both, a proof that in recent epochs at least there has been no communication between the two. Recently this neck of land has been cut through by the strong hand of man and the waters of the north have been wedded to those of the south. Perhaps a certain emigration and immigration of the animals of both seas may take place in time, but from their union up to the present time nothing of consequence on this subject has been made known. The conditions of life in both seas are still very different, and the canal lying between offers many hindrances.

We get up betimes in the morning in order to observe, in all its freshness, the active life that prevails in the warm and briny deep. And this is a very easy matter for us; we do not need to wade in mud and sand up to the middle, nor do we require Moses' rod to lay the sea dry; we simply wait until the moon passes over our heads or that of our antipodes. At such times the sea sinks a yard or sometimes two, and we can reach almost dryshod the rocky surface of the fringing or coast reef, which here, as a rule, is not separated from the shore by a lagoon. Over this we may venture a long way, as far as the edge, indeed, where the breakers are raging, without fear of being swallowed up like Pharaoh and his host by the billows of the returning flood.

The naturalist will do best to choose the summer months, especially those of the late summer. "When the Nile rises the sea falls," says the inhabitant of these parts. During this time, that is to say, especially before and at the autumnal equinox, the surface of the sea is at its lowest level at ebb tide. During the winter, on the other hand, from October to the vernal equinox, the sea never sinks far enough (except about the New-year) to expose the whole surface of the reef, though this is frequently the case in summer. This lowness of level, which is also noticeable at high water, may be a consequence of certain currents, or of the north winds that almost exclusively prevail at this time, and drive the waves southwards; it may partly also be due to evaporation, the sea being closely shut in by burning coasts, and having a dry and heated atmosphere above it.

ON THE SHORE.

The sea is still standing like a shallow lake above the surface of the reef, which, with a breadth of about a hundred paces, extends far along the shore; the powerless waves, their strength being broken on the slope of the reef, beat against the fearfully desolate sandy or rocky shore. The naturalist, however, finds it by no means so desolate; numerous bones of vertebrate animals, bleached shells, and branches of coral lie about, and these he picks up as he chips them out of the rocks into which the might of the eternal elements has baked them. He has no intention of adding these weather-worn and broken specimens to his collection, he wishes to compare them with others which he will obtain fresh and uninjured from the sea. Perhaps some of the forms may no longer exist as living forms, and in this case they must remain in the collection as evidence of the former existence of an extinct species. The shore on which we are wandering is under the influence of puzzling forces; it is rising while the sea is withdrawing, as already mentioned in Chap. IV. p. 234. The geologist calls this phenomenon "the secular elevation of the land."

But also living children of the sea display their activity on the arid coast. We never tire of watching the comic behaviour of the sand or mouse-crabs (*Oecypoda*), which run about in immense numbers on the sandy beach, especially on summer evenings. Beyond tide-mark, and often a considerable distance from the sea, but never so far as that the sand below is not moist, they dig burrows of the size of their bodies. They do not take long journeys by land like the West Indian land crabs (*Gecarcinus*). The holes penetrate for 3 or 4 feet either obliquely or in any direction, and are inhabited by a single crab, or by a pair of the same or of different sexes. The sand that falls down as the animal is digging is carried out between one of the nippers and an anterior foot, in which operation the hairbrush existing on the second pair of feet may be of service, the other side is left free and enables the animal to crawl out of the hole. On reaching the entrance the crab flings the sand to some little distance from the hole with a sudden jerk, and having performed its toilet by cleaning its jaws with its arms, as with a tooth-brush, slips back again into its dwelling. After an interval it reappears and acts in the same manner. The sand cast out gradually rises into a pyramid a span high, which the active crab climbs with each new parcel of sand, and dexterously forms the top into a fine point. A field containing a thousand of such pyramids gives ample testimony to this activity. Every act is carefully weighed and considered beforehand. When it comes out of its hole it remains standing, the feet on one side still within the threshold of its domicile; it then elevates its wary club-shaped eyes, assures itself of the state of matters in the vicinity, and if convinced of the absence of every danger, continues its work. The observer must, therefore, remain quite still at a little distance. It is not very easy to get hold of this shy and light-footed crab. It perceives us long before we can get near it, and scuttles off with inconceivable rapidity, always keeping one side foremost, towards its well-known dwelling; into this, however, it does not at once disappear, but remains on the threshold to take a survey, and having maliciously allowed the enemy to come quite close to it dives

in at the last moment with the quickness of lightning. If we come upon it and intercept it when on one of its excursions, and at a distance from its hole, it eludes us by a hundred turns and crafty movements, running on occasion almost as well forward as sideways, and always making for the sea, by the waves of which it allows itself to be carried away, and in an instant has disappeared under the sandy bottom or in some hole in the rocks. If we prevent this by driving it away from the sea, it presses itself in despair in among the sand, throws a covering of sand over itself, and our eyes can often no longer distinguish the dull yellowish-gray carapace of the crab from the similarly coloured sand. We may find it again, however, and think there is no escape for it this time; but if we incautiously seize it we shall in all probability have to fling it from us, with a lively feeling of the effects of its sharp and powerful nippers on our fingers, so that after all we may ourselves give it its liberty. The simplest way is to throw a cloth over it, and this we do when, after some hard work, we dig it out of its deep hole in the sand.

The rock crabs (*Grapsus*), swarms of which enliven the shady rocks, walls, and stones near and in the sea, are no less clever. They are also very swift runners, but their forte is climbing and hiding. It is a trifle to them to clamber up and down perpendicular rocky walls 50 feet high, provided these have inequalities enough in which to insert their pointed claws and spiny feet. They also make game of the crab hunter, allowing him to lay his hand over them, but when he attempts to grasp them, suddenly darting off to hide in the nearest crevice. When they are caught it is somewhat difficult to tear them away from their position, and to avoid letting the hand be injured by their sharp claws. There is less reason to fear a pinch from their nippers, which are blunt and spoonshaped. It is advisable to use a cloth in laying hold of them too.

A hermit-crab, by name *Cænobita rugosus*, is an important inhabitant of the coast. It might lay claim to be considered sacred, since, like the vulture, it clears the coast of carrion; but it is also an audacious thief, and with the utmost effront-

ery takes advantage of every unguarded moment in order to attack the stores of the traveller. Its number is legion. We hear behind a stone or rock a mysterious, rustling, clattering sound. Stepping up to the spot we perceive a fish or some other unfortunate creature of the deep, half reduced to a skeleton, and closely covered with a great number of uni-valve shells of all shapes and sizes, but chiefly the round-mouthed shell (*Turbo radiatus*). Everything is as still as a mouse, and if we lift up or move the putrefying carcass all the shells fall off. Some of them are fresh and clean, but the majority are worn, damaged, and discoloured; in many of them we notice a little round hole. Picking one up we see that the mouth is tightly closed by the operculum, and thinking that it will suit our collection we keep it in our hand and continue our investigation. In a little we feel a scratching and pinching in our hand; we open it, but see nothing except the shell with its aperture tightly closed. But we now notice some peculiarities about the operculum, and soon find that it is no operculum at all, but the claws and anterior parts of a crustacean—a pale-coloured crab with long feelers, bulbous eyes, and well-sized nippers, but with only two locomotive feet visible on either side. We endeavour to rescue it from its prison, but it draws itself back and remains motionless again in its chamber. The last joints of its feet and its nippers close together so as to form a smooth surface shutting up the aperture. We try to pull the animal out, but it will let its head and feet remain in our fingers rather than allow us to get possession of the soft and shellless hinder-part of its body, which is only brought to light by smashing the shell. The animal can be made to crawl entirely out by putting it in a liquid which is disagreeable to it, such as putrid sea-water, or by the somewhat cruel joke of heating the shell with a live coal or a cigar. As a rule it lives in its shell like Diogenes in his tub (it is sometimes called the Diogenes crab), runs about with it, not actively to be sure, but unweariedly, and even climbs rocks, walls, and trees. It often goes a long distance from the coast, and like the mouse-crab digs for itself holes in the ground. These

holes are shallow, being only about half a foot deep, and are not left open like those of the crab just mentioned. The fishermen, who use it for bait, discover its dwelling by a circular or horse-shoe shaped linear depression round a little heap of loose sand or round a flat sandy surface. In selecting a shell as an abode in which it can protect its soft and easily injured tail, the crab seems to prefer those of which the original inhabitants have perished by some external cause, such as the piercing of the shell by other animals—a faculty possessed by many molluscs and annelids. This explains why so many of the dwellings inhabited by the hermit-crabs have holes in them.

Another hermit-crab is the black and yellow striped *Clibanarius signatus*, which also occurs in immense numbers. It also leaves the water to feed on putrefying substances with the previous species; but as it requires more moisture it does not go beyond the shore, nor does it dig holes for itself. It cannot place its feet so as to closely shut the aperture of its shell. It is not so large as the other species. Very young specimens inhabit the tiniest shells, especially the needle shells (*Cerithium*), and it does not despise worm tubes and other habitable articles. This species inhabits the reef up to the immediate vicinity of the surf, and is here one of the most abundant animals; it conceals itself among stones, and at spots which are first laid bare at ebb-tide, but still afford shade and moisture.

If we stir up the sand on the beach within flood-mark we shall be sure to find at the depth of a few inches some species of mollusc, such as the *Cytherea arabica*, with its many markings, or the *Mesodesma glabratum*, called by the natives "sea-egg." Under stones creeps a little flat crab, the thorax of which is marked with all shades from milk white to raven black. Once discovered, it does not know how to rescue itself like its relative and associate the grapsus and the little *Doto sulcatus*. In these localities, which, though wet, have yet a sufficiency of air, land-slaters and millepeds live a kind of amphibious life along with water-slaters, and molluscs, and salt-water worms. Flat-worms (*Planaria*) glide rapidly over

the rock, and when cut in pieces each begins a separate life as lively as before. There lie a transparent white holothuria (*Synapta*), and an inextricable tangle of thread-worms (*Borlasia*, *Meckelia*, *Nemertes*). Where the soil of the beach is muddy, long, many-jointed rose-red sea-scolopendras wriggle; these are sought by the fisherman as bait for his hooks. Thousands of sea-fleas (*Orchestia*) hop out when we disturb the sea-weed on the beach or turn up the damp sand; they are as active as the little guests that derive their food from our bodies, and to bring a dozen of them together is a work of much patience and circumspection.

Until the reef is entirely uncovered with water we may contemplate the winged inhabitants of the air and water, who find their food (perhaps also their drink) in the briny deep. Only a few of them are permanent residents; in order to get a drink of fresh water they must fly a long distance into the mountains. Most of them are birds of passage, or perform at least local migrations. The flocks increase in spring and autumn, when the birds seek a more congenial climate. Then appear all kinds of plovers, snipes, herons, and water-hens, also ducks, cormorants, gannets, gulls, and sea-swallows. They are generally the same species as are found in the north in summer; but some are peculiar to these regions, or are more southerly forms, such as the courser (half a desert, half a shore bird), the giant heron, and the gulls and sea-swallows belonging to the Red Sea. The migrations last the whole winter through. In summer, on the other hand, bird-life in this region of the sea almost entirely ceases, the only birds remaining being the fishing eagle and a few plovers and sandpipers; even gulls, sea-swallows, and herons disappear. The vulture is a permanent shore-bird. The hyena and the dog are nocturnal visitors to the shore and the reef.

PREPARING FOR A VISIT TO THE REEF.

The waters have begun to withdraw, the outermost shore-zone of the reef becomes passable, and we prepare to set foot

on it. We could get on very well with boots, by choosing the higher and drier spots, and perhaps under favourable conditions might reach the edge of the reef next the sea without wetting more than our soles; but the sea-water, when assisted by the jagged surface of the rock, has a very destructive effect upon leather. Even water-boots of Russian leather are not to be recommended, as they soon burst and shrink; nor are the best patent soles of any service. Besides, who could repair this foreign foot-covering here? It is best then to follow the custom of the country, and put on sandals of a kind of leather prepared for holding water, and called *zem-zemûych*. We also wind a piece of cloth turbanwise round the tasselled cap to prevent the rays of the sun from causing sun-stroke. In other respects we have no need to fear the heat; the sea-wind fans us and keeps us cool, becoming stronger the higher the sun rises; in this warm zone, indeed, the mid-day hours in summer cannot be spent more coolly and agreeably anywhere than on the reef and in the sea. We have an attendant with us carrying a basket divided into compartments, and containing tin cases of different sizes, a good steel hammer, and a steel chisel, also perhaps some hoop and other nets and a pair of pincers.

THE REEF.

Thus equipped we wander over the jagged rocky surface of the shore zone. A glance on the dark-coloured rock, which here is generally bare, teaches us that it is no ordinary rock, but a conglomerate formed of lime, shells, worm-tubes, and especially coral blocks, like the rocks that we saw from the land projecting towards the shore. The reef, a so-called coast-reef, commences immediately at the shore-line and extends seawards for 200 to 400 paces, presenting on the whole a flat surface, and running along the shore for miles without a break except opposite the entrance of some valley, which formerly brought down fresh water and sometimes does so still. When more closely examined, however, some differences of level present themselves. A slight elevation of the

shore zone is generally noticeable, the consequence of which is that it is the portion first left dry when the tide is going out and last covered when the tide comes in. The main surface, which at ebb-tide is laid bare at once, besides presenting various projections and irregularities, embraces a number of larger and smaller depressions, the bottom of which becomes filled with sand, and in these hollows the water is retained even at ebb-tide, forming pools that receive the name of *kalaua* from the Arabs. Only in the shallowest depressions does the water evaporate. At ebb-tide, then, the reef presents the appearance of a net-work with lagunes as meshes, or when they communicate with each other, and are very numerous, a kind of archipelago is formed. At spots here and there large blocks of stone, similar to erratic blocks, rise from the surface of the reef. These are regarded by the common people as "petrified vessels." They are continuous with the surface of the reef, and consist of the same kind of rock as this and as the rocks on the shore. Other blocks are loose, not joined on to the rock below, and are moved about by the violence of the waves. In other respects the surface of the reef is, generally speaking, level. The formation of the reef surface is only to be explained by the hypothesis that the secular elevation of the land withdrew the coral polyps next the shore from their natural conditions of life, thus causing them to die out, while next the sea the formation of the coral was still continued. In the Red Sea, accordingly, this reef-formation is not brought about, as Darwin and Dana claim to have shown in the case of the islands of the Pacific, by the sinking, but on the contrary by the elevation of the sea bottom.

OUTER SHORE ZONE.

The outermost zone of the reef, as remarked above, enjoys the refreshing influence of the cool sea-water only for a few hours. In summer, therefore, the water in the small shallow pools becomes so hot at low tide as to compel the sudden withdrawal of the naked foot. On several days of the year high water can scarcely be noticed at all, the reef remains

dry for one or two days, and this occurs, as a rule, once in winter and once in summer. When this takes place the temperature of the water in the pools becomes so high in summer and so low in winter that the animals living in them, fish in particular, die in great numbers. Some kinds of worms that are never seen at other times now come out of their deep lurking places in the sand and die on the surface. In this zone thrive gasteropodous molluscs of the genus *Nerita*, species of which are found also in brackish and in fresh water. One species (*Nerita polita*) has always a smooth and polished surface, that of another (*N. albicilla*), which exposes itself more to the sun and air, has generally a weather-worn appearance. The holes and crevices in the porous rock afford welcome hiding-places to the beckoning-crab (*Gelasimus tetragonon*). Its dwelling is here and not on the beach. It does not dig holes in the sand as is said to be the habit of the Brazilian species (*G. vocans*), but the sand that accumulates in its rocky dwelling through the rise of the tide is rejected in the form of small round balls as soon as the water withdraws again. It is not a particularly quick runner, and therefore cautiously remains in the neighbourhood of its abode. Its eyes are supported on long foot-stalks. The full-grown males carry an enormous nipping-claw compared with the animal's size and that of the other claw; the young ones have it of more moderate dimensions. The females have two small nipping-claws both of the same size. It is often said that they block up the entrance of their hole with this large claw, but this is not correct, as they almost always hold it before them when crawling in. A pair are generally found in the hole. When running the males have a habit of holding their claw aloft, or of keeping it before them like a boxer on guard, the powerful nippers always ready to pinch. It is this position that has gained for it the name of beckoning-crab.

A similar skulking mode of life is practised by the large-eyed-crabs (*Macrophthalmus*) and the *Chlorodius Edwardsii*, which is common all over the reef, but especially here. The latter varies greatly in its colouring, and often has a cross

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and other figures painted on its back. Small black mussels (*Mytilus variabilis*) are attached by their beard (byssus) to the coral rock, and surround the pools and clefts in the rock like a wreath. As their valves gape slightly the fine green edge of their mantle may be seen. Under the stones and in the pools are found a multitude of periwinkles (*Littorina*), and large and small needle-shells (*Cerithium*), together with *Nerita*, as well as the hermit-crab that takes possession of their shells (*Clibanarius*). On ridges of the reef that have become dry and warm a *Purpura*, known as the horse-chestnut shell (*Purpura hippocastanum*), crawls about with the others just mentioned, while limpets (*Patella variegata*) and chitons as long as the finger (*Chiton spiniger*) have attached themselves by suction to the rock, surrounded by little balls of dirt formed by them. When taken by surprise they may easily be detached by a flat instrument and used as food (at least the *Patella*); but if the danger is noticed in time they stick so close that they cannot be removed without rupturing their bodies, unless a chisel is used and they are clipped off along with the piece of rock below them. The chitons roll themselves up like wood-lice after being detached. These two sorts of molluses are not altogether condemned to one spot, they can crawl, though certainly not much more quickly than a plant grows. Being exposed to the rays of the sun and other influences, their shells have generally a coarse and worn surface, like the *Nerita albicilla*.

In the sandy pools we may observe, after the water has run off, a multitude of little hills with a crater-like hole in the top, from which at intervals a jet of water shoots; fine threads enveloped in sand radiate from all sides of the crater, and even from the sides of the hill, but they are only observed when they are being withdrawn. Occasionally a thick fleshy thread is projected from the crater. On digging into the hillock we find tubes winding about in many directions and formed of particles of sand and fragments of shells. The inhabitant of these is a tube-worm (*Terebella*); it withdraws so deeply into the sand that it can scarcely be got hold of. Out of one hole, in front of which there is an eddy in the

water, we notice, after a little observation, a crab peering and waving its upper feelers; in another, out of which a stream of water is forced, we see the long feelers and the nippers of a small long-tailed crab, an *Alpheus*. Holes with small round balls in front of them belong, as already mentioned, to the beckoning-crab. Many little hillocks of sand are surrounded by a multitude of small sand-cylinders; these are the fragments of a long round sand column which is forced out at intervals through a hole in the hillock, like vermicelli from the tube in which it is formed; the author of this phenomenon cannot be laid hold of. There lies a smooth sheet of sand rolled up in a spiral form; after drying it crumbles at the slightest shock; it is the spawn of a species of *Natica*. The delicate thread-like alga (*Phycoseris reticulata*) of the pools are covered with myriads of the spat of *Cerithiums*, *Patellas*, and other molluscs. The bright-green fronds of the *Phycoseris* swarm with the lively-coloured, almost microscopical, *Cyclops*. Almost the only fish found here during the ebb are young gobies and sea-leapers (*Salaria*), and the remarkable *Cyprinodon dispar*, belonging to the fresh-water family of the toothed-carps (*Cyprinodontidae*). The male and female of the latter appear to be quite different fishes. When the pools threaten to dry up these fishes slip under stones and into crevices of the rock, or work their way over a piece of dry ground into hollows better filled with water. Here flourish also in many inlets of the sea thickets of the laurel-like shore shrub (*Avicennia officinalis*, see p. 210). But on the whole this part of the shore zone is poor in forms, and the animals that do exist withdraw from the investigator into the unfathomable clefts of the hard rock which lies below the slight deposit of sand that covers the bottom of the pools, and somewhat annoyed we proceed a little farther towards the sea.

THE INNER SHORE OR SEA-GRASS ZONE

The pools among the rocks, which are either bare or covered with a blackish and red mucilaginous sea-weed, are now filled with greater quantities of sand, and on this soil

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grow green phanerogamous grasses of the family of the Naiadeæ (*Halodule australis*, *Halophila ovata* and *stipulacea*, and *Cymodocea ciliata*). By stripping the hand through them a person may fill it with the very small but pretty shells of the *Neritina Rangiana*. Here creep and feed sea-hares (*Aplysia*), pleurobranchs (*Pleurobranchus*), bubble-shells (*Bulla physis* and *B. ampulla*), the gigantic conical Dolabella, all sorts of sea-lemons (*Doris*), and other nudibranchiates (*Eolis*). A number of species of wing-shells (*Strombida*) knock against each other in hopping about; one of the commonest is *Strombus gibberulus*, white, with a beautiful carmine-red mouth. It is found thrown up in quantities on the beach. The allied finger-shell (*Pteroceras byronia*) is almost a foot long, and its flesh is boiled and eaten. These Strombi cannot crawl, they can only hop by planting and suddenly extending the slender arm-like and very protrusible foot, which is furnished with a toothed and claw-like operculum. By this method of locomotion the animal can turn its shell round at pleasure, and hop forwards, backwards, and sideways.

Among the grasses small shrimp-like crabs—the transparent Palæmon, green Hippolyte, and almost microscopical Mysis—swim about. A species of shy-crab (*Calappa*) skulks along the sandy bottom and conceals itself under a slight covering of sand, pushing itself in sideways or backwards. Similar habits are displayed by the swimming crabs (*Lupæa*, *Thalamita*, *Portunus*, *Matuta*). They are common enough also near the shore in the sandy and muddy bay forming the port, and conceal themselves under stones and mud. They are good runners, swimmers, diggers, and climbers, and can, in addition, escape from their pursuers by stirring up the mud and rendering the water turbid, an artifice which enables them to hide themselves or swim from the spot without being noticed. The rare grayish-green *Lupæa Tranquebarica* is one of the largest crabs of this sea. Deep in the sand of the grassy pools, their byssus attached to the underlying rock, the brittle Pinne hide themselves, one species (*Pinna nigrina*) reaching a length of 2 feet. In these

are found the celebrated Pinnotheres or pinna-guard, a little crustacean, which, in former times, when poets and singers rode upon dolphins, carefully guarded the entrance to the house of the blind pinna, but has now sunk to the level of a despicable parasite. If we clear out the sandy pools we find, besides various kinds of worms, a multitude of shells of the genera Tellina and Lucina come to light, though generally only the empty valves; the living shells are down in the cool depths. The rare watering-pot shell (*Aspergillum*) also lives here, as well as a peculiar annelid that hides itself in a conical tube. We had expected to find more bivalves here, but beyond the ones just mentioned and those named before, some Venus-shells (*Cytherea*), ark-shells (*Arca*), heart-shells (*Cardita*), and the like, there are not many regular bivalves in this sea. Both in number of species and of individuals this section stands far below the univalves or snails; the greater number of its forms belong to the Monomya, Heteromya, and Dimya with unequal valves.

On the rocky projections of the reef between the pools sit large numbers of limpets, chitons, and all the shore molluscs. Leaving the grassy pools the pear-shells (*Pirula*), large-sized navel-shells (*Natica*), sharp-pointed needle-shells (*Terebra*), in numerous species, and the hoop-net shells (*Nassa*), which can creep quickly for a snail, enjoy the sun and air. The majority of the clefts and crevices have been taken possession of by gray, brown, and black serpent-stars (*Ophiocoma crinaccus* and *scolopendrina*). They have some of their arms or rays at rest and extended to the upper surface of the rock, which is covered with a thin layer of water, while they sit with the others twined up together in the hole; or their arms are stretched out from the hole and rest in the numerous gaps in the rock. It is only when they feel themselves seized that they withdraw their arms, pressing these pliant and prickly appendages more and more firmly to the rock within the more their assailant pulls, till at last, instead of the body of the animal, a few fragments of its broken arms come away in the hands of the astonished star-fish hunter. Since they are constantly liable to the attacks of fishermen (for

bait), fish, and other enemies, some of their rays are generally broken, or they exhibit various other marks of injury. The lost members soon sprout and grow again, but the new portions remain for some time not fully developed and brighter in colour than the articulations nearest the body disk. A collector who wishes complete Ophiuras must carefully pull the disk-formed body itself, or hew the animals out of the rock, or surprise them when detached and bathing themselves in the water.

Side by side with the serpent-stars star-shaped egg-urchins (*Echinometra lucunter*) peep out of narrow holes. When it depresses its prickles voluntarily this animal can easily slip out and in, like a vessel that lowers its mast when passing under a bridge. When it is violently pulled, however, it elevates its pretty strong prickles so as to make it even more than fill the hole, and all attempts to move it are useless, especially as the prickles, which are not very hard or sharp, do not afford a good grasp for the hand. These animals would seem often to bore holes in the rock for themselves.

THE DIVISION INTO ZONES.

Our division of the reef, from the shore seawards, into zones that correspond to various depths or horizons is not an arbitrary one. Here, to be sure, as in nature generally, there are no abrupt transitions. In different districts some one or other of the zones may be hardly represented at all or may preponderate over the others, and the inhabitants of one zone often extend into others. But these zones force themselves upon the notice of the explorer again and again; each has its own peculiar character and its prevailing species. New forms appear in the second zone that were not met with in the first; forms that have already occurred become rarer or vanish altogether; the external aspect changes.

STYLOPHORA OR CORALLINE ZONE.

We have passed through the shore zone, and have found an outer girdle, followed immediately by the subdivision of

the sea-grass pools. The genera prevailing here we have seen to be *Clibanarius*, *Gelasimus*, *Nerita*, *Litorina*, *Strombus* and *Pirula*. The second chief zone begins with a moss-like alga which covers the rock, and forms, with the sand retained in the midst of its fronds, a soft covering which is far more comfortable for the feet than the sharp ridges of the shore zone. The pools are deeper and larger, filled with pure transparent water, and resembling wells. A characteristic feature is the occurrence of corallines, and the first appearance of corals, the earliest forms of the latter appearing in the branchy *Stylophora*. Everything that lives here loves pure, fresh, and not too hot water, which is not apt to be much disturbed. At many points this portion of the reef is somewhat higher than the shore zone, and wide stretches of it are almost entirely clear of water at every low tide, the only water remaining being that in the deep pools or wells. This elevation probably arises from the fact that the surf waves, already broken on the slope of the reef, are able to throw the foremost portion of their water up here and deposit their sand. In other places this zone lies lower, and even at low tide extends for the most part as a lake until close to the shore. But also in this case there generally remains behind the surf of the outer slope a higher surface which assures the quietness of this zone, and in spite of difference of appearance the moss-like Algae, the Corallines, the *Stylophora*, and the forms to be mentioned below, at once tell us where we are. This portion of the reef we call the *Stylophora* zone. It may correspond to the quiet lagoons behind the reefs of the Pacific Ocean.

JOYS AND SORROWS OF THE NATURALIST.

The fauna and flora of the portion of the reef occupied by this coralline zone are exceedingly rich. For years one may make an excursion to this zone at every low tide, may wander over its soft surface, turn over and shatter the stones in the wells and the blocks of coral broken off the slope of the reef by the violence of the surf, strip off the Algae, smash the living polypites, empty out sandy holes, and try to catch the fish;

something new will always be found. If a person, believing he has exhausted one district, examines another and more distant district, he will see essentially the same things. There is no use, therefore, in going very far, since the good things lie so near, but still the toil and trouble of larger excursions are not quite unrewarded. The naturalist is more easily satisfied than the treasure-seeker; the latter, on finding after a long search an old copper coin, throws it away in a rage, but the former, if he finds to-day a single species previously unknown to him, carries it home quite contented. During his investigations he will also have collected in his phials some species previously known to him, but rare; he will have made some new observation, or cleared up some phenomenon about which he was previously in the dark. His realm is boundless. To-day the fishes obtain the most of his attention, to-morrow he prefers the crustaceans; at one time he studies the mollusca, at another the annelida; and, lo! in the very cavity that he has examined a hundred times he finds some entirely new members of that kingdom to which to-day he has specially devoted himself. But what he takes with him he must always study thoroughly at home; he must know what he has, and what may still remain to be got, otherwise he will not distinguish nearly allied animals, but let them lie: an unscientific person, therefore, one who does not study, will never make a good collector. It would be very agreeable to be a specialist on this teeming sea, to devote one's whole life, as European naturalists do, to a small section of the boundless empire of Nature; but in truth the feelings rebel against this, and the strictest determination in this direction brought from the clear-headed North melts away amid the magnificence and variety of the tropic sea. Who could disregard this Doris so beautifully coloured, or simply put it in spirits without investigation in order to investigate the habits of a worm? Who could refuse a remarkably formed fish which a fisherman brings, and which, possibly, has never been seen by naturalists, simply because he is studying the crustacea alone? The fauna of this sea, although brought to light by many distinguished naturalists, is not yet, so to speak, ripe for one who is purely

a specialist. Here the naturalist collects everything that comes into his hands, though paying more attention to those classes in which he is specially interested, and which are most richly represented, and he leaves it for time to decide when his labours are to be finished. Accordingly the naturalist remains banished for years, not merely for months, if he can prevail on himself to spend so much of his existence among the semi-barbarous inhabitants of these uncultivated tracts.

No occupation is free from its disagreeable concomitants, and the harmless role of the naturalist is no exception to the rule. Long rambles on the jagged surface of the reef, some excoriations of the skin, a sun-burned nose, an often very painful erythema on the naked arms and feet, exposed at once to both sun and salt-water, an involuntary bath, uncomfortable postures in investigating and observing, are trifles that the naturalist makes no account of. A gigantic eel, of serpentine aspect, that endeavours to bite his fingers and toes, a crab that pinches him with its claws till the blood comes, a fish that hovers round his naked feet, and is provided with a half-poisonous sting, are bugbears that prove their reality but do not disturb his composure. But sometimes his patience and endurance are sorely tried. For example, on a warm summer afternoon the naturalist, after hammering and grubbing for hours on the reef, returns heavily laden to his house, and finds on his threshold a crowd of children who offer him the marine wonders that they have found to-day in greater numbers than at other times, while fishermen bring him some remarkable fishes. This very day the whole has, if possible, to be carefully examined, determined, taken note of, separated, washed, prepared, placed in spirits, or probably skinned and drawn, for in the aquarium the half would either eat each other or die and become putrid. Scarcely, however, is he begun when some other urgent business turns up, or a loquacious friend finds it necessary to waste his time, and to his chagrin he is interrupted in his self-imposed task. Or it may happen that he examines his treasure-chamber and observes with despair that cats, dogs, mice, and insects have taken anything but a benevolent interest in his collection.

Sometimes the out-door labours of the naturalist are altogether interrupted, as on the short, gloomy, and stormy days of winter when the ebb-tide uncovers as a rule only the highest projections of the reef, against which the stormy winds dash the waves; when the storm ripples the surface of the lagoons and wells, and the eye cannot penetrate their depths. It is not without an effort that the foot is now planted in the cool, not to say chilly water, and an arm that has been dipped shivers in the winter's breeze. Even the native fisherman avoids entering the sea that is now so reduced in temperature, and angles either on the shore or from a boat; or giving up all thoughts of catching fish, he mends his damaged nets at home. At such times the naturalist also must either give himself up to idleness, or examine, study, and arrange his collections, and see to the packing of them, this last and most difficult labour. And such days of leisure extend to weeks and months, until the sun rising higher in the heavens calms the sea and warms its waters.

THE INHABITANTS OF THE STYLOPHORA ZONE.

But we are standing in the Stylophora region. The above-mentioned serpent-stars now spring forth in greater luxuriance than ever from every crevice; on the dry ridges of the reef living and extinct clam-shells are immured in the rock, their coarse shells, which resemble their mother soil, giving one rather the idea of chance-formed nodules than of organized beings. The *Olibunarius signatus* here gives place to a green-spotted hermit-crab, which now becomes the leading crustacean. The Neritas are now replaced by the pearly Pharaoli's shell (*Monodonta Pharaonis*), the most charming of this sea, and by elegant Columbellas or pigeon-shells, of which a black and yellow striped species (*C. mendicaria*) is collected for the market in order to be imported into the Soudan (see p. 309). Limpets and chitons, and the horse-chestnut shell are still everywhere to be met with here. In shallow pools the swelling tentacles of a sea-anemone (*Cercus*) of considerable size display themselves, the rest of

the animal being generally invisible. If an attempt is made to seize it it withdraws itself quickly, and is found only at some depth, and after the surrounding sand and stones have been removed. It can only be obtained uninjured when it has fixed itself upon stones lying loose in the sand, and not upon the surface of the rock. In many of the smaller water holes another slender Actinia (*Heptaktis*), similar to the Edwardsia, stands upright and displays its starry crown; it withdraws itself even deeper, and is still more difficult to dig out of its narrow hole.

LIFE IN THE POOLS.

We lift up a stone that lies loose in one of the well-like pools. How it teems with life both externally and internally! Over its surface move quickly great numbers of the pretty univalves known as Stomatellæ, with their varying markings and colours; we saw these also in the sea-grass pools of the previous zone. Here sit also highly coloured sea lemons (*Doris*), with their branchy waving anal branchie, yellowish red Pleurobranchi, small five-lobed disc-stars (*Asteriscus*), needle-shells (*Cerithium*), pigeon-shells (*Columbilla*), tower-shells (*Pleurotoma*), and so-called shore-shells (*Eulima*, *Rissoa*); among bivalves may be seen small wing-shells (*Avicula*), pouch-shells (*Perna*), and young pearl-shells (*Melcagrina*), as well as ark-shells (*Arca*) and mussels, attached by their byssus, and everywhere oysters are attached to and growing on the rock, sometimes planted one above another. The latter are generally too small to be worth the trouble of picking them off and eating them. Besides, the native-born inhabitants consider oyster-eating as a barbarous practice. The old pearl-shells, with their celebrated oriental pearls, occur at greater depths, and are obtained, as already mentioned, by diving.

And the porous interior of the stone, which may often be broken up by the hand! Not an opening in it but is occupied. The most important and preponderating tenant here also is the serpent-star (*Ophiocoma crinacrus*). It rapidly

detaches itself from its lurking-place when this is broken into, allows itself to fall, and creeps into the first suitable hole it can find. This species is associated here with another species, the *Ophiocoma Valencia*, somewhat more slender and spotted with green, and with a very small reddish scaly-star (*Ophiopsis*). Green or brown spotted grasshopper crabs (*Gonodactylus gonagra*), the length of one's finger, make their appearance, but draw back and make haste to get out of the way as soon as the explorer notices them. They run quickly on the dry land, are adepts at hiding themselves, and if they fall into the water they paddle away, shooting rapidly along by a series of jerks. When they are seized they bend themselves round, make their large nipping claws fly out from their body with an audible noise, and dig them into the fingers of their persecutor, who lets go his booty more from astonishment than pain. Of similar habits are the already-mentioned small long-tailed crabs (*Alpheus*), the species of which are very numerous, and generally have fixed abodes. On the stones here the *Alpheus Edwardsii* is the prevailing form. The joints that bend inwards the disproportionately large nipping claws are very tender, and the latter are detached with the slightest pull; in catching the animals, therefore, they are not to be laid hold of by these.

In the blocks of stone there also conceal themselves those small or middle-sized crustaceans in which the Red Sea is so rich, belonging to the genera *Zozymus*, *Actæa*, *Actæodes*, *Pilodius*, *Actumnus*, *Chlorodius*, *Pilumnus*, &c. The most common among them are the hairy *Actæa hirsutissima* and *Actæodes tomentosus*. Motionless sponges, lively coloured simple and compound ascidians, and the cell-colonies of the Bryozoa form with corallines and nullipores brightly coloured coverings, disguises, and ornaments. The tiny mussel-like or coin-shaped calcareous shells of the Rhizopoda or Foraminifera, of which a considerable proportion of the sea-sand consists, cover the surfaces of the stone like white points or dots, while the little tubes of the tube-worms (*Serpula*) form wavy streaks on it; the serpentine dwellings of the wormshells (*Vermetus*) penetrate the block in all directions. In

the smallest vacancies and passages of the labyrinth Annelidæ, Sipunculidæ, and Nemertineæ have established themselves, whether by simply crawling into holes already existing or excavating them in the stone for themselves.

Some worms, such as *Clymene* and *Terebella*, build their dwellings by cementing together fragments of bivalve shells, grains of sand, and shells of foraminifera, and retain possession of these until their dwellings are destroyed by violence. Others, the predaceous worms, namely, employ the holes merely as hiding-places, and seek their prey abroad. A worm of considerable size often met with (*Notopygus*) at the least touch brings into play its stings, which resemble silky tufts; these bore with their barbed points into the skin of the person touching it, and produce a sharp stinging pain. Flat annulose worms with "wings," or imbricated worms of a brick red or green colour (*Polynoe*), attach themselves to the stones as if by the force of suction, like the limpets. A large round rose-coloured annelid (*Dasybranchus*) lies in the rock wound up in a clew, and almost always gives off pieces of its body when it is pulled or even disturbed, like the ribbon-worms (*Nemertes*). Still more sensitive are the nimble *Syllis*, each joint of which gives out in the darkness, and often even in the daytime, a splendid green or blue light. Like the flat-worms (*Planarida*), these live when divided into pieces, each piece commencing a separate existence.

The upper surface of the rocks in these pools is generally covered with shaggy sea-weed, among which live small amphipodous crustaceans, as well as crabs with remarkable beaked carapaces belonging to such genera as *Menæthius*, *Pisa*, *Cyclax*, *Huenia*, &c. The uneven or hairy surface of the carapace and feet of these forms is covered with a flourishing growth of sea-weed or grasses, or if clean and smooth it takes on the colour of the plants among which these crabs live, and in one and the same species will vary from dark-brown to emerald-green. From the sand that lies scattered among the sea-weeds project crabs (*Micippe*) of a hideous form and grayish colour, scarcely to be recognized as living creatures,—so ugly, indeed, that in an æsthetic system of clas-

sification they would be at the bottom of the scale when compared with other representatives of the animal kingdom. These animals that take on an appearance assimilating them to their surroundings are surpassed in cunning by the woolly crab (*Dromia*), which covers the naked parts of its somewhat hairy back with a piece of sponge bent into shape or a frond of sea-weed which the far extended hind-foot has constantly to keep in position, and thus the animal deceives its greedy enemies by counterfeiting the appearance of an object which they do not use as food.

A NOCTURNAL VISIT TO THE REEF.

A nocturnal promenade on the reef at ebb-tide, when the stick stirs up a thousand sparks in the pools, and every foot-step leaves a phosphorous track behind, is truly a wonderful experience. This phosphorescence is mainly due to the destruction of worms or gelatinous animals of a very low organization (*Noctiluca*), and doubtless also to scattered particles of animal matter of various kinds in a state of decay. When the surface of the sea is thickly covered with such animalcula over a considerable area the celebrated "luminosity of the sea" is produced. It is well known that when it is filtered, and the animalcules thus removed, the sea-water is no longer luminous. Here and there, too, at a greater or lesser depth, slowly swims a large luminous body which proves to be a medusa; the great cat-like eyes of the *Priacanthus* also glean upwards; and large shining balls probably belonging to the corals appear.

A BLOCK OF STONE.

A huge block of stone which has been detached by mighty storm-waves or by the hand of man from the region of the reef-slope, and has been rolled into this quieter zone, rests in a slight depression of the reef, the edges of which now afford it a secure support. Its upper surface, only occasionally washed by the waves at high water, rises naked, gray, and

dry above the surface. On this surface needle-shells, shore-shells (*Eulima*, *Rissoa*), and tiny hermit-crabs sun themselves, and the small but active rock-crab (*Nautilograpsus minutus*) clambers about. The last occurs in the greatest abundance over the whole of this zone where it is laid dry, popping out of one hole and into another; it is the representative here of the larger *Grapsus* of the shore. If we examine the holes and crevices of the block that still remain under water, a few small fishes dart out, chiefly belonging to the families of blennies and gobies (*Salaria*, *Blennius*, *Gobius*, *Eleotris*), while small and often strangely-shaped long-tailed decapods also hop into the light of day (*Palamon*, *Lyssmata*, *Hippolyte*, *Athanas*). The sides of the crevices are belung with hairy trumpet-shells (*Tritonium pileare*), frog-shells (*Ranella*), sea-ears (*Haliotis*), small sea-cucumbers (*Holothuria* and *Sporadipus*), and ark-shells (*Arca*); here, too, may be obtained in particular abundance the inexhaustible sea-lemons (*Doris*), already mentioned repeatedly. Oysters, ascidians, and sponges cover and colour the walls of the clefts. One after another certain bodies let themselves fall down into the water; these are the inevitable serpent-stars (*Ophiocoma crinaecus*), which are also accompanied by certain other species (*Ophiocoma elegans* and *Valenciae*), by a scaly serpent-star (*Ophiolepis Cincta*), the already-mentioned egg-urchin (*Echinometra*), and common apple-like sea-urchins (*Echinus*) either white or brightly coloured. If we roll the stone over we will often find, in addition to the above-mentioned creatures, some very large-sized lobsters (*Palinurus*). The latter, however, are best caught at night when they leave their lurking-places. Such stones also afford a hiding-place for the brownish-red octopus or sea-polyp, which, when discovered, swims off at once, and if the danger is imminent discolours the water with its ink. It is not easy to master this powerful and slippery creature; it is almost impossible to bear the clinging of its sucking arms to the skin. Under the block we are sure to find also some beautiful though common porcelain-shells (*Cypraea*). Of these there are in this sea more than a dozen species, from the large marketable

Cypræa pantherina or panther-shell, to the small *Cypræa trivia*. With these the cone-shells (*Conus*), which are found from a line to a span in length, vie in variety, and in some cases also in beauty. Provided with a strong shell these sluggish animals withstand the assaults of the waves as well as attacks from other quarters. They love the hottest water, and therefore seldom conceal themselves at low tide, but lie exposed and almost motionless in small shallow depressions in the sand.

REEF-POOLS.

Let us give up work for a time, and gaze quietly into one of the 2 to 4 feet deep pools or wells. The circular edges of these are overgrown with algæ of all kinds—flat and crust-like, high and bushy, soft and watery, cartilaginous, or hard as a stone, green, brown, and reddish, moss-like or fern-like, fruit-bearing and fruitless. Here and there sprouts the coral known as *Stylophora*, yellowish-brown or reddish in colour, in many cases small and slender, but forming stronger and broader stony bushes the nearer it approaches the breakers and the open sea. While in the cells of the upper branches life is exuberant, and new matter is rapidly formed, the coral animals die out gradually towards the root, and dark, dirty algæ and corallines cover the extinct generations like a winding-sheet. Between the walls of the pools we see zigzags and waves, some of them a span and a half long, blue, green, or spotted with bright brown, gleaming out in a wonderful manner from beneath the water; they belong to the mantle of the large *Tridacna*, which, fixed in some crevice of the rock, opens its valves very readily. Half hidden under the overhanging walls of the pools lie deep-black gleaming spheres, from which radiate lances a span long and as fine as a needle, while between these appear sky-blue gleaming lines and points running perpendicularly over the surface of the sphere. Above, at one of the poles of the sphere, a black club with a cinnabar-red extremity turns round. This is the diadem sea-urchin (*Diadema Savignyi*), and the revolving club its rectum. Raised and enlarged by the transparent covering of water above

it, this creature affords, with all these attractions, as beautiful a sight as its pointed, brittle spines, with their almost microscopical circle of prickles, produce violent burning pains when they have penetrated the skin of the fingers. The long spines remain always under water, and accordingly the body lies at a certain depth. Unfortunately the spines fall on drying, and are very difficult to keep uninjured, so that these animals are little adapted to transportation. The bottom of the pool is covered with loose stones of various sizes with sand between, and here, too, there sometimes rise plurigerous grasses, algæ, and corals. This is where the sea-urchins (*Echinodermata*) are found in greatest abundance. Here, stretched out openly, lies comfortably at rest, a sea-cucumber (*Holothuria vagabunda*) which appears black, but, as the stain on the fingers that touch it testifies, is in reality purplish-black; it is surrounded by grains of sand either single or closely adhering together, and grows to the length of two spans. Another and still larger *Holothuria*, with great yellow lateral spots, from its plasticity appears quite a prodigy, in turns assuming a sausage shape or that of a disc or loaf of bread. All these holothurians are disposed to commit suicide; as soon as they are withdrawn from their usual conditions of life they force their intestines out at their anal opening, diffusing at the same time a rank disagreeable smell, or they divest themselves of their epidermis only, a proceeding which brings about their dissolution with equal rapidity. The black species of holothurians are so rigid and motionless that they are readily confounded with the species of bathing sponge that occurs here, which is quite black in its fresh state, and assumes all possible forms. The sponges of commerce are yellowish or gray in colour because they have been subjected to repeated washings and bleachings. Here we see also the *Synapta*, which at one time resembles a water-skin filled with water, at another hanks in its body at intervals, so as to make it resemble the large intestine in man, and according to the extent of the contraction it subjects itself to, appears as a wide bag the length of one's arm, or as a thin cord. When touched by the fingers its upper surface clings disagreeably to the skin, by

means of little anchor-shaped projections. It can cover itself up with sand and rubbish on occasion. In its company are found also various kinds of beautiful echinodermata, in some cases lying exposed, in others under stones or in crevices of the rock; we may mention the "bride of the sea" or the comb-star (*Astropecten*), the sea-turban (*Cidaris*), the shield-urchin (*Clypeaster*), and the warty-star (*Acrocladia mamillata*), as well as the *Ophidiaster Ehrenbergi*, which, from the abortion of individual arms, often assumes singular shapes, and the Scytaster, which is of a beautiful scarlet colour, like the star of some order of knighthood, but unfortunately soon fades.

FISH OF THE POOLS.

As in the shore zone the fish in these pools still continue to consist chiefly of gobies and blennies. These fish are very cautious and cunning, and on the approach of any person conceal themselves immediately. It is only when one approaches slowly and seats himself quietly that they allow themselves to be looked at, as they nibble and feed upon the sea-weed, or half swimming half leaping dart this way and that on the surface of the water, sometimes also slipping into crevices and worm-holes, and roguishly showing their heads peeping out; while, at the last extremity of danger, as we have seen in the case of various other animals, they spring out of their pool and scramble somehow over the dry ground into another. The short arm-like and stunted ventral fins may stand these leaping fishes in good stead when they engage in such gymnastic feats. The best leaper is the *Salarias tridactylus*. In these pools we also meet with several of the finely-coloured coral-fish of the family of the ctenoid-scaled labroid or wrasse-like fishes (*Labroides*, *Ctenoidei*, or *Pomacentridæ*), especially young *Glyphisodon*s, gray or black and yellow striped, and the small golden *Colibri* among fishes, the *Glyphisodon antjerius*, with its gleaming blue or green dorsal stripe. These small fishes are shy and difficult to catch. Small silvery fishes, scarcely an

inch in length (*Myxus*), keep circling about constantly at the surface of the water, and rival in brilliance the ripples that glance under the rays of the sun. Here we see a serpent-like creature winding through the pool and hiding itself in a crevice, from which it peeps out after a little with its long-snouted head, and gives a steady gaze. It is no serpent, however, only an eel, but the pet aversion of the reef-fisherman for all that. From pure enmity the natives condemn to death every individual they meet with; to eat them they could never bring themselves. These creatures can also wriggle their way very well over dry ground.

FAUNA OF THE STYLOPHORA BUSHES.

A piece of work still remains to be done, one of the most profitable of all the labours that can be carried on on the reef, viz. to disentangle and break down the corals known by the name of Stylophora. The spaces between the branches and twigs of these are selected as places of abode by marine creatures of all kinds, but more particularly by small crabs and other crustaceans. Besides many of the sorts that we have already noted as inhabiting the stones of the pools (such as *Gonodactylus*, *Alpheus*, *Aetæa*, *Zozymus*, *Chlorodius*, besides *Columbella*, *Cerithium*, small *Cones*, *Ascidians*, and sponges) there lives here a peculiar and characteristic fauna which can be met with scarcely anywhere else. It consists chiefly of certain species of small square-shelled crabs belonging to the genus *Trapezia*, which cling so closely with their claws to the branches of the corals, or climb about among them so cleverly that a person can get hold of them only by breaking down the corals. Here also sits the slimy and sluggish crab *Cymo*, which adheres still more firmly to the corals. The observer will seldom miss the small long-tailed crabs, *Harpilius*, *Pakemon*, *Athanas*, the fantastically ornamented *Hippolyte*, and especially a bright red *Alpheus*. Here also the small univalve *Purpura madreporarum* makes for itself a small protuberance, on which it sits closely adhering. The serpent-stars so often mentioned (*Ophiocoma erinaceus* and

Scolopendrina) are here remarkably rare; instead of these we find in abundance the black and yellow *Ophiocoma elegans*, and the green *Ophiocoma Valencia*. If we lift up one of these bushes quickly and let the brittle mass fall on the ground and break in pieces, a multitude of small fishes are sure to hop out, such as *Eleotris* and *Gobiosoma*, and the *Gobius echinocephalus*, which is a form very characteristic of these bushes. It is not an easy matter to get one's hands on all these little creatures at the right time and in the right place, especially the crabs. Unless caution is employed the collector will see with sorrow that these have suffered the loss of an arm or a feeler. When the branches of the corals are broken, in the central mass of a great many, indeed the most of them, a flattish cavity is seen, which a date-shell fills so completely as to have but very little room to move. Only a comparatively small aperture leads from the outside into this strange abode.

TRANSITION OR PRÆ-CORAL REGION.

We move across the reef a little farther in the direction of the sea, and enter upon a region which bears to the Stylophora zone the same relationship as the sea-grass zone to the shore zone, that is, it is a transition district. Its external appearance is still essentially the same, only this region is almost always covered by the sea, and can only be walked upon at the very low tides of the after-summer. The water is in greater commotion, and serves as the fresh source of an active coral-life; the waves of the surf reach as far as this, but their strength is already broken on the edge of the reef. The Stylophora corals continue to prevail universally, and thrive still better than nearer the land. The other corallines generally form layers, spheres, and protuberances, which, like a frieze, adorn the borders of the pools that now become deeper and deeper, or they grow up from the bottom of the pools, or spring here and there from the upper surface of the reef. To this region belong many star-corals (*Heliastrea*, *Solenastrea*, *Leptastræa*), mesh-corals (*Porites*), honey-comb

corals (*Favia*), brain-corals (*Maandrina*), many millepore corals (*Millepora*), and the well-known organ-pipe coral (*Tubipora*), with its purplish-red stone pipes. The rest of the fauna of this region is characterized by a mingling of the fauna of the previous with that of the following zone.

CORAL ZONE PROPER OR SURF ZONE.

The appearance and conformation of the reef now show a remarkable change. The ground is now to some extent converted into a slippery sea-weed steppe, and the naked feet, as they slip among the luxuriant vegetation, are everywhere threatened by the sharp edges of the apertures of the worm-shells, the tubes of which grow as it were in a piece with the rock. Among the plants we are struck by a sea-weed that gleams with a blue colour; but when it is withdrawn from the water the gleaming ceases, and, like most other sea-weeds, it appears brown. The pools now become deeper, and often form abysses with overhanging edges, to the bottom of which the eye cannot penetrate. These abysses have often subterranean communications with one another and the open sea, and this portion of the reef for the most part manifests itself as the rocky covering of a grand system of caves opening to the upper world by clefts and circular crater-like holes. The swell and heaving of the open sea, though broken to some extent, is continued through these ocean caves, and produces in the openings of the rock an alternate rise and fall of the water at regular intervals, combined with a frightful hollow gurgling and hissing. When the sea is at rest, however, the water in these dreadful abysses also remains at rest, and from some secure stand-point on the reef the eye can penetrate unimpeded far down into the transparent depths. Nowhere can one contemplate the life of the corals and what belongs to it more quietly and comfortably than here, although he has to lie on his belly—a trifling matter for the naturalist—and hold his magnifying-glass at the point of his nose above a coral bush. Such days, however, when the tide is so low as to lay the reef quite bare even to the outer edge, and when the wind

at the same time is still, are extremely rare, and do not occur even once a year. In order to examine the coral world on the large scale it is better to make use of a boat. For the present we only remark that on the accessible portion of the surf zone the madrepore coral has become the prevailing coral, without, however, completely crushing out the Stylophora, and we take advantage of the time during which the reef is uncovered to investigate the remaining fauna.

FAUNA OF THE SURF ZONE.

The serpent-star (*Ophiocoma erinaccus*) has now entirely disappeared, and instead of it we find curling about among the rocks the already-mentioned *Ophiocoma Valenciæ* and other genera of serpent-stars, such as *Ophiothrix* and *Ophiomyx*. The green-spotted hermit-crab is still also found, but never the *Clibanarius signatus*. On the other hand, many miniature species of this genus of the *Paguri* are common. A giant species (*Pagurus tinctor*) is often found in large univalve shells, such as the tun-shell (*Dolium*) or the triton's horn (*Tritonium*), on the outside of which there is regularly seated a certain kind of sea-anemone (*Adamsia*), sometimes in large numbers, while between the anemones are frequently shells of the family *Capuloidæ*. Here, therefore, we see a colony of several different creatures living together. Between the two regular inhabitants of these shells there is a remarkable bond of connection. With regard to the northern species Mr. Gosse has made the interesting discovery that the crab lifts with its nipping claws the sea-anemone on to the shells in which it wishes to live, so that the latter animal must be of service to it in some respect or other, though we do not yet know in what. The sea-anemone seems to make use of its dwelling-place as a means of locomotion, so that it may be carried to places where there is food both for it and the crab, or may also, so to speak, enjoy change of air; the crab, on the other hand, may allow the actinia to catch parasites that would annoy it, though this certainly remains to be proved. The *Adamsia* cannot live free, however, and is found

sometimes on stones, though less frequently than on the shells inhabited by the hermit-crab. At small depths and in clefts lie large and small species of the genera *Ricinuia*, *Fasciolaria*, *Turbinella* (chank-shells), *Turbo* and *Trochus* (angular and round-mouthed top-shells), all with thick shells which, without protection, set at nought the breakers. A large and beautiful blue arcuated crab (*Zozymus æneus*) is common here, exposing itself without protection to the wash of the surf. The higher rocks, which on the retiring of the waves are periodically exposed to the air, are often covered with a multitude of sea-acorns (*Balanus*). Under the covering of sea-weed new forms of pointed crabs conceal themselves (*Cyclax*, *Stenocinops*, *Pseudomicippe*). Over crevices in the rock gigantic sea-anemones, such as *Discosoma giganteum*, spread themselves out along with the social *Thalassianthus aster*; it is only with difficulty that they can be extracted from the rock. The rare gigantic annelid, *Eunice gigantea*, here occasionally shows itself, rapidly crawling out of sight again like a serpent, and the collector considers it quite a master-stroke to lay hands on it before it disappears into its unfathomable hiding-places.

The best spots for the collector here also are under stones and between the branches of the corals. Loose stones that would only require to be turned over in order to get at the booty beneath are not found here at all, being hurled back to the *Stylophora* zone by the force of the waves, or flung into the depths of the rocky chasms. To be sure numerous blocks of stone with masses of living and growing coral lie mingled together in wild confusion, but all are solidly attached to the rock and to one another, no doubt by the action of the superabundant calcareous elements contained in the seawater, which supplies the material of which the coral rocks are built. The attachment at first is often only a loose one, many holes and crevices remaining between the block and the rock beneath, and furnishing shelter for a multitude of living beings whose tender bodies could not withstand the unbroken force of the waves. Here is the home of a multitude of small round crabs, generally of different species and

genera from those inhabiting the preceding zones. New annelids of changing hues, and various genera allied to the shrimps now make their appearance. Sometimes by the removal of the blocks a narrow cleft is disclosed, the sides of which are closely covered and overgrown with moss-like Bryozoa, mossy sea-firs (*Sertularia*), small polyp-colonies of chalky or leathery consistence (*Cænopsammia* and *Cilicia* being of the former description, *Zoanthus* and *Polyzoa* of the latter), a small red *Gorgonia* (*Mopsis Erythraea*), small social actinias, sponges, and ascidians. Oysters, ark-shells, and thorny-oysters (*Spondylus*) have also attached themselves to the walls, and here have taken refuge the delicate feather-stars which live free but do not swim.

THE INHABITANTS OF THE CORALS.

The fauna for which the Stylophora corals afford hiding-places is not much altered here, and with it that of the bushy cup-star corals (*Pocillopora*) agrees. Similar, but still with distinct characteristics, is the madreporal coral (*Madrepora*). Instead of the quadrangular-shaped crabs (*Trapezia*) we find here the similar genus *Tetralia*; the shrimp-like crustaceans are also represented by different but allied genera. Between the branches of the fragile bush-corals (*Xenia*) a small crab of the genus *Camptonyx* is seldom absent. The massy corals are not well suited for hiding-places, but nevertheless a number of creatures of very diverse forms have obtained a lodgment in their interior. To these belong the *Magilus*, which prefers for its abode certain star-corals (*Leptastræa*) and mæandrine corals (*Galoria*), and along with these is already found in the transition zone. The young *Magilus*, a grayish dome-shaped shell, lies loose in a smooth dome-shaped cavity not much below the surface of the coral colony, like the date-shell in the Stylophora, and this cavity communicates with the surface, where the coral-stars open, by means of a small hole or narrow canal. The older ones, such as are seen in particular in the mæandrine corals, lie deeper, and through the solid substance of the mass, from the shell

proper to the surface, a thick tube variously bent and twisted extends. This tube also lies loosely in its canal; it is very brittle, and difficult to procure whole by breaking up the coral rock. After the animal has once penetrated the coral, accordingly, no farther boring takes place, it simply adds to its tube according as the surface of the coral rises, and as the shell grows larger the hole in which it lies also enlarges.

Another parasite on, or at least dweller in, the coral is an abnormally-shaped crab, by name *Cryptochirus*, which not long ago was brought into notice by Heller. It ensconces itself, like the worm-shell (*Vermetus*), in a short cylindrical tube made by itself, and penetrating perpendicularly from the surface of the coral. Its similarity with the worm-shell is all the greater from the fact that the shield-formed head of the crab forms externally a kind of operculum closing the aperture. Its abodes are almost always observed in the rounded masses of coral, whether it be that it chooses these, or that it disturbs the life of the corals in its vicinity, and so produces this rounded conformation.

The dwelling of a *Serpula* of considerable size is similar; but the latter penetrates much deeper into the rock, and is found in bushy and massive corals. The living animal forms a beautiful sight when, protruding the anterior part of its body, it bathes its brightly-coloured spiral gills or branchiæ in the water. In radiate corals (especially *Goniastrea*) a cirrhipede of the genus *Pyrgoma* has imbedded the tubular portion of its shell; the upper portion forms elliptic warts which much resemble the stars of the corals.

THE CORAL SLOPE.

In order to inspect the realm of corals and the treasures of the deep sea leisurely and at our ease, though our glance must be somewhat unsteady, we step on board a boat and proceed to the reef. The sea must be perfectly quiet, otherwise no boatman would be so rash as to voluntarily steer his craft towards the breakers of the reef, and the surface must be as smooth as a mirror, the least ripple rendering it impos-

sible to see down into the depths. The lower the tide is too, the better objects are seen, and it will contribute to the same result if a little oil is poured on the surface.

The line of the declivity runs on the whole pretty nearly parallel to the shore; where the latter exhibits an indentation of any size there is also a corresponding one in the slope-line. At particular points, to be sure, there is not such a close correspondence, the breadth of the reef varying between 200 and 400 paces. The slope-line also is much more winding and indented. Where the reef is interrupted by a harbour, the slope-line forms a bend so as to almost reach the shore, while the slope gradually diminishes in depth and coral life ceases. The slope is at some points steep and precipitous, perhaps even forms an overhanging cliff, at other points it sinks gradually, or in the form of terraces, towards the open sea. The depth of the water, measuring from the surface of the reef, may average from 5 to 8 fathoms, so that the eye can generally perceive the sandy bottom immediately in front of the reef; the bottom rapidly sinks, however, and at the distance of a few paces from the reef seawards we see only what for the eye are blue unfathomable depths.

This slope, then, like the staging of a greenhouse, is entirely covered with those brightly-coloured many-formed animal growths which we call corals, or, to speak more correctly, it entirely consists of these or their remains, bare and lifeless blocks on which new generations begin to build, while around them swarm and browse the coral fishes, so distinguished for splendour of colouring and strangeness of form. "As humming-birds sport around the plants of the tropics, so also small fishes, scarcely an inch in length and never growing larger, but resplendent with gold, silver, purple, and azure, sport around the flower-like corals, on the leaf-like prehensile arms of which feed beautifully tinted shell-less and strangely-shaped snails (*Æolidæ*), like the caterpillars and garden-snails on the leaves of plants."¹ All this is enveloped in the magic mantle of the transparent briny flood, which, by peculiar effects of refraction, raises and magnifies the distant forms, and lends

¹Ehrenberg *Ueber die Korallenbanke*, 1832.

them colours so deceptive that, when taken from the water, they can scarcely be recognized. We feel drawn downwards as it were by a mysterious power towards these objects, apparently so near, yet rendered by the foreign element so distant and unattainable, and we gaze dreamily into the depths, sunk in nameless feelings and dim impressions regarding fairy beings flitting about in the gardens of some marine paradise. Against such ideas even the Arabian fisherman, unsentimental as he is, is not quite proof; apart from the elephantine "sea-maiden" (*Halicore ctacea*), which can be caught and skinned, for him, too, there are below the waters charming genii who are eager to marry human beings, though, to be sure, only when the latter have mortified themselves for months previously with unsalted bread and water, so as to give to their flesh and blood a half-ethereal character.

The naturalist, however, cannot allow himself to be allured by dreams and phantasies; he insists upon seizing and taking to pieces those forms to which the water lends such an indistinct and magical effect. He wishes he had a diving bell and a diving helmet in order that he might get down to the bottom at once, and he would fain catch the fishes with a net. But the former appliances are unknown here, and the water is too clear and the bottom too uneven and treacherous. The gallant divers, however, that sit in the boat are able to fulfil every desire, quickly bringing up the corals to which they are directed by a stick or by description, and by means of baited hooks catching one after another the finny denizens of the deep. They use hooks of various sizes, and different kinds of bait, such as small fishes, or morsels of fish, worms, serpent-stars, pieces of crabs or other shell-fish, and algae, according to the size and likings of the fish. It requires a practised eye to distinguish the corals on the spot where they grow; it is indeed difficult, and often scarcely possible, with the microscope to make out the species at home and by the study table. If the divers are left to their own choice, they will be sure to bring a limited number of species, but of these as great a number of examples as possible. The same species often exhibits very different external forms and colours, and

vice versa, different species often exhibit the same general forms and colours. In catching fish much depends upon the appetites of the fish, but the fisherman knows the tastes of the several fishes, and can pretty accurately determine beforehand what fish will take such and such a bait.

THE CORALS.

In multiplicity of species and forms, and in the number of its individual colonies, the great genus of crown-corals (*Madrépora*) characterizes before all others the outer slope of the coral reef. The colour of the animals and their dwellings varies generally from dark brown to yellowish and greenish, the points of the branches being usually conspicuous from their lighter shade, which sometimes passes into bluish and rose-red. The coral structures or colonies assume sometimes the appearance of a sward of grass, stems comparatively low, and with few branches rising in tufts above the general flat surface; sometimes they resemble a net-work of leaves and grass with a rounded or gyrate periphery, the branches and twigs uniting to form a much broken surface; or, lastly, they grow to a considerable height, with a bushy or tree-like form. Of these three typical forms, the first is found especially on the higher part of the reef, the species of the second often cover large areas on the slope and form tabular prominences and terraces, the third form belongs mainly to the deep water. Many such madrepore trees reach a height of three or four feet, some form bushes, which, growing in great numbers beside each other on the bottom in front of the slope, appear like extensive woods or steppes. The thistle-like bushes of the *Seriatopora*, with its delicate and much interwoven stems, have a habit similar to the latter.

But these loose and brittle corals, in regard to which we cannot but wonder how they withstand the force of the breakers, are not proper rock-building corals. The blocks of which the reef is built are produced by the massive forms, and in particular by the mesh-corals (*Porites*), which are consolidated together into huge bluish, brown, or black

spheres, bosses, and columns, and to the meandrine or brain corals (*Leptoria*, *Coeloria*), which have polyps with shimmering green flesh, and which fringe the prominences of the reef in rounded wavy masses. Rocks are formed also by the great family of the star-corals (*Astræa*), which form convex expansions, and also balls and bosses. The stars or openings of the individual animals have a certain size according to the species, from the large *Acanthastrea* and *Prionastrea* to the elegant *Goniastrea* and peculiar *Astræa*. The flat crusts of the flat *Montipora* shimmer in light, yellow and violet colours. The urchin-coral (*Echinopora*) spreads itself out as a half free crust, or as an undulating brown or yellow table, with a very rough surface, the substance rising here and there into knobs and pillars. The solid *Hydnophora* grows similarly and exhibits a bench-like appearance. The millepore corals (*Millepora*), called by the natives "fire-corals" from the sharp stinging nettle-like pain they cause, and classed by some among the *Medusa*, sometimes rise in the form of upright, thick, abruptly terminating tables and walls, or they form variously-shaped crusts on worm-tubes, shells, &c., or lying free they form themselves into knotty protuberances. Some, lastly, rise in the form of thin net-like plates, which readily fly in pieces and terminate above in yet more fragile twigs. One of the most beautiful corals, and one that at once attracts notice on account of its cherry-red colour, is the cup-star coral (*Pocillopora*), which grows mainly on the upper part of the slope, and generally in tufts, though also forming beds. The colour belongs to the stony structure, though only to its extremities, like the blue colour of the madrepores; the lower portion and the polyps themselves are brown. The *Stylophora* still continues to be well represented on the upper part of the slope alongside of the *Pocillopora*, and, like it, varies from a brownish to a rose-red colour. Besides those mentioned there are many other corals, which, from their smallness or scarcity, however, are of subordinate importance in the formation of the reef; such are the *Cocnopsammia*, which forms a little tree, sometimes of a deep black at other times of a blackish-green appearance, the mushroom corals (*Fungia*),

which are attached only in earliest youth, and afterwards lie free on the ground, sometimes having a flat round body (*Fungia patella*), sometimes having a lengthened elliptical shape with a longitudinal furrow, and then assuming the deceptive appearance of a petrified roll of bread (*Fungia Ehrenbergi*, *Herpetholitha*). The sight of rosy-rayed and pretty rare Galasea always excites joy and admiration in the discoverer. At a great depth grows the well-known black coral (*Antipathes*), a six-rayed sclerobasic coral. In the Red Sea there are but few representatives of the numerous family of the eight-rayed sclerobasic corals so richly represented elsewhere, especially in American seas, and to which the well-known red coral belongs. While the reef is so thickly overgrown with algæ up to the line where it sinks into the surf zone, vegetable life appears to cease altogether when we approach the deep water. Instead of plants leathery corals or *Aleyonaria* now flourish luxuriantly, and by an ignorant observer would be at once mistaken for them. The polyps of these, however, generally project considerably, and are easily noticed; they are distinguished from the animals of most other corals by possessing eight rays and as many feathery tentacles, while other polyps have generally only six rays. The colour of these animals changes very remarkably according as they expand or contract themselves, and a person might easily think that a colony or bank when disturbed belonged to quite a different species from the same when not so disturbed. From particles of lime interspersed throughout their entire tissue, some of these "flesh corals" possess a leathery consistence, as is the case with the cork-corals (*Aleyonium*), while in others the calcareous particles are reduced to a minimum, and the stems remain almost soft (*Xenia*, *Sympodium*). The *Ammothæa* is a coral that has a remarkably plant-like appearance, often forming lofty stalks and bearing "catkins."

THE FISHES.

The Red Sea is extraordinarily rich in fishes, the number of species at present known amounting to about 520.¹ They are most plentiful on the slope of the coral reef. Whether there are real coral-eating fishes is still doubtful; the hard substance of the corals at least can only be nibbled at, and the soft animals withdraw into their cells on the slightest disturbance. Many fishes eat plants, others subsist on the numerous worms and molluscs that live here, or on decaying animal matter; the greater number are predaceous, and eat other fishes. The slope of the reef, with its crevices and deep pools, affords admirable hiding-places, and since the locality exhibits a number of bright colours, the fishes do so likewise, according to a law which generally prevails in nature (that of *mimicry*), although not without many exceptions.

In splendour of colour and diversity of form the fishes of the coral region do not yield to the most brilliant birds. As among birds the parrot takes the first rank for brilliant plumage, so among fishes the same rank is taken by the parrot-fish (*Scarus*), the jaws of which have a remarkable resemblance to the beak of a parrot. It is rivalled by the remaining members of the great family of the wrasses (*Labroides*), especially by the rainbow-fish (*Julis*), as also by the squamipennes with their disk-like forms, their very small mouths, and their delicate teeth, the most remarkable of these forms being the genera of the brittle-teethed fishes (*Chaetodon*), the opercular-spine fishes (*Holocanthus*), the whip-thong fishes (*Heniochus*); we must also add the sea-surgeon (*Acanthurus*), the unicorn thorn-tail (*Naseus*), with its sharp tail-spine, the trigger-fish (*Balistes*), and lastly, the elegant, though generally small, Pomacentridæ, the humming-birds among the fishes. These fishes are for the most part comparatively poor swimmers, and do not venture far from the slope of the reef, being also met with frequently in the deeper pools on its

¹ See on this subject my complete "Synopsis of the Fishes of the Red Sea" in the *Transactions of the Imperial Royal Zoological and Botanical Society of Vienna*, 1870-71.

surface. Many fishes of the sea-bream family (Sparoids) also love to frequent the slope, though less exclusively, and their colours are commonly not so brilliant. The nearly allied fishes of the genus *Cæcio*, which swim about in shoals in front of the slope, at once attract the spectator's notice by their beautiful sky-blue colour.

The predaceous species among these coral-fishes are the perches (*Percidae*), especially the saw-perches (*Serranus*), so numerous in species and so rich in colouring, the notched-perches (*Diacope*), and the thorn-perches (*Myripristis*), that generally lead a nocturnal life, the toothed-perches (*Priacanthus*), the spiny-gilled perches (*Holocentrum*), and the Chilodipterus. The sea-eels (*Muraena*) show themselves more on the reef itself and in the pools; a gigantic species, *Muraena Javanica*, reaches a length of 6½ feet or more, and occurs also on the slope.

Among the inhabitants of the reef surface, in the zone of the breakers, are the repulsive-looking mailed-cheeked fishes (*Cataphracta*), such as the dragon-head (*Scorpana*), and the most hideous of all fishes the *Synanceia*. They lie here motionless and hidden between stones and grass, and as they can imitate the colour of their abodes in the most surprising manner, the invader of their haunts is often not aware of their presence until, having set his foot on them, they suddenly start up and inflict on him very painful wounds with their spines. The stings of the *Synanceia*, at least, are almost as painful as those inflicted by the scorpion. This hideous creature has usually the points of its dorsal spines concealed under a thick skin like the claws of a cat. It can voluntarily withdraw this skin, however, whereupon, according to the fishermen, a milky drop exudes, a kind of eating poison, which makes the wound so painful. One of the finest sights in this sea is afforded by the winged-fish (*Pterois*), when it swims about in a pool or creek with its large brilliant and delicate fins. But care must be taken not to let it touch the naked skin, as the sharp and slender dorsal spines form weapons capable of inflicting very severe wounds.

The balloon-fish (*Tetrodon*), which generally occur in bays,

are also remarkable creatures. When danger threatens they quickly rise to the surface of the water, in doing which they are assisted by their large swimming-bladder, and here they gulp up air with a certain noise. The air passes through the gullet into a sack (an extension of the peritoneum), which lies between the peritoneum and the skin, and in ordinary circumstances is in a state of collapse; as the sack becomes inflated the fish thereby gradually assumes the form of a sphere, which floats on the surface of the water like an inflated bladder. The back being the heavier portion turns undermost with the belly above it. The surface of the sphere is almost everywhere closely beset with prickles, which this procedure causes to stand stiff and erect. In the case of the urchin-fish (*Diodon*) these prickles are very large and strong. In this state these fishes have no active means of defence; they can no longer swim at pleasure, since their fins have become withdrawn, and they are altogether at the mercy of the waves. But as the hedgehog among mammalia is safe against attacks when curled up in a ball, so, too, these piscine hedgehogs are protected by their spiny armour, the more so that a bladder when swimming is by no means easy to lay hold of even though unprotected by spines. According to the magnitude of the danger they inflate themselves much or little, and when they are very greatly disturbed their bodies swell almost to bursting. When the danger is over they let out the air gradually and with some noise, and then they resume the appearance of an ordinary fish and swim away. All the species are not equally inflatable, however. The beak of these fishes has some resemblance to that of a parrot, but while the bite of the latter is comparatively harmless, these globe-fish bite severely whatever comes into their neighbourhood. Their heads are looked upon as very poisonous, even for cats, while the rest of their bodies are much eaten, at least by the ichthyophagous Bedouins. Their bite is not poisonous, nor are there any other poisonous fishes in this sea, though several, when eaten at certain times, cause pains and purging, as, for example, a mackerel (*Scomber Kanagurta*), which otherwise is not bad eating.

The trunk-fishes or coffer-fishes (*Ostracion*) have a form which apparently marks them off from all other fishes. They possess a hard, rigid, and box-like coat of mail, composed of separate polygonal plates joined together, and out of this only the fins, the mouth, and the tail project as movable extremities. Accordingly they swim very badly, and may be even taken with the hand. A closer examination of their structure, however, shows the greatest similarity with the globe-fishes. The bases of the spines of the latter have, in the case of the coffer-fishes, become broadened out into the form of simple plates, and are grown together, while the spines have diminished in size or disappeared altogether.

Other strange forms which swim about in the creeks and pools are the tobacco-pipe fishes (*Fistularia*), the sea-needles (*Syngnathus*), and the well-known, though here rather rare, sea-horses (*Hippocampus*).

Rays and small sharks may sometimes be met with on the surface of the reef, though mainly as casual visitors. Colossal specimens of the former are sometimes thrown up dead on the shore, of which the genera *Cephaloptera* and *Ceratoptera* may be mentioned. Such a monster of the deep is also the so-called swimming-head or sun-fish (*Orthogoriscus*), which is closely allied to the globe-fish.

The sea-grass meadows (*Gisua* of the Arabs), which we have already often mentioned, and which are met with partly in depressions in the surface of the reef, partly on the bottom of the sea (especially in harbours), afford concealment to a special class of fishes, many of which are distinguished by possessing a green colour. To these belong several sea-needles (*Gastrotekeus*), the knife-fishes (*Ampelisca*), several of the sea-bream family, especially *Lethrinus*, the Percis, young broad-fish (*Platax*), and some of the genus *Diagramma*.

On a sandy bottom in front of and on the reef, as well as on the bottom of the harbour, live the flat-fishes (*Pleuronectidae*), or, as they are here called, the Moses-fishes, half covered over and generally lying quietly in wait for their prey; along with these we also find the flat-heads (*Platycephalus*), which belong to the mailed-checks; and, lastly,

rays, especially the *Torpedo*, which gives slight electric shocks. These ground fishes have this in common, that they are flat, and have the under surface, or, as in the case of the *Pleuronectidae*, one of the sides, pale and colourless. It is only the *Gerres ojeana*, which sometimes, though rarely, makes a trench in the sand with one of its sides, that has scales gleaming like silver all over its body.

A number of species of fishes are always on the move. The shoals of these are met with in the harbour and on the reef, but do not go far but into the open sea. At high-water they swim over the reef towards the shore, always making for the shallows, probably from fear of the predaceous fishes, and at low-water they return to the harbour, if they have not allowed themselves to be imprisoned in the pools by the receding tide. Such wandering fishes are the barbels, the mullets, the members of the genera *Gerres*, *Therapon*, and *Pristipoma*, and these are accompanied, especially at night, by some of the coral fishes, such as the parrot-fish, and several of the genera *Chrysophrys*. They are mostly good swimmers.

The open sea also is not poor in fishes, though by no means so rich as the reef region. They are all excellent swimmers, able to make long journeys, and accordingly have generally a wide geographical distribution. Many of them are not only spread over the whole of the Indian Ocean, and as far as Japan and Australia—which is also the case with many of the previously-mentioned fishes, even the coral fishes proper—but also over the Atlantic Ocean to the American coasts, and into the Pacific Ocean. Some few are even found in the North Sea and in the Mediterranean. These strong-swimmers are almost all of a monotonous colour, which becomes paler on the belly; and members of the same species, though inhabiting regions widely separated, differ from each other in no respect, not even by a mere shade, while the reef-fish proper generally exhibit race differences at least in colouring.

The fishes, and the fauna generally, of the East African coasts and islands, up to the Mozambique, are most closely connected with those of the Red Sea, as well in the number

of species possessed in common as in similarity of colouring, while farther towards the East the species and races gradually become more and more different. Of the 520 species of fishes found in the Red Sea 140 are known from this sea alone up to the present time; 26 are common to it with the East African sea, while the remainder, that is the greater number, are spread over the Indian Ocean, and as far as Japan and Australia. In the Atlantic Ocean, also, live 19 species, being confined chiefly to the tropical portion of it; only 7 are found in the Mediterranean. Of the latter one species (*Caranx trachurus*) is a citizen of the world, being found from England to New Zealand; the others belong to the above-mentioned strong-swimmers or fishes of the high sea, namely, the well-known pilot-fish (*Naucrates ductor*), the remora (*Echeneis naucrates*), the coryphene or dolphin (*Coryphæna hippurus*), the hammer-headed shark (*Zygana malleus*), the long-nosed shark (*Lamna Spallanzani*), and the smooth hound (*Mustelus*).

The fishes of the open sea belong chiefly to the families of the mackerels and tunnies (*Scomberidæ*), the mackerel-pikes (*Scomberesocidæ*), the arrow-pikes (*Sphyrapidæ*), the sharks, and the herrings (*Clupeidæ*). Among the first may be mentioned the scad (*Caranx*), remarkable for the number of species it presents; these are predatory fishes, and prey especially on herrings and allied fishes, the periodical shoals, of which they follow, like them appearing periodically. The tunny-fishes proper do not make their appearance here in shoals of any size, but the single individuals are often of large size. A remarkable fish, closely allied to the tunny, is the large and rather rare sail-fish (*Histiophorus*), the sword-fish of this sea. It has an extraordinarily high dorsal fin, and laying itself on its side, and forming an arch about 12 feet wide, it is able to make several leaps to the height of 3 or 4 feet above the surface of the sea. Other leaping-fishes are mackerel-pikes (*Scomberesocidæ*), the half-beaks (*Hemiramphus*), the mullets and the herring-like *Chirocentrus*, while the flying-fish proper (*Exocoetus*), by means of its large and wing-like pectoral fins, can support itself in the air for

considerable distances. The flying-gurnards (*Dactylopterus*) have not yet been observed in the Red Sea, but, on the other hand, a fish which is here met with, viz. the *Apistus-Israelitarum*, closely allied to the scorpion-fish or dragon-head (*Scorpana*), is capable of flying, according to Ehrenberg's observation. The sail-fish or fan-fish (*Pterois*), formerly mentioned, has pectoral and ventral fins so large as to resemble wings, and some persons have believed it able to fly, but this is not the case, as its fins are too delicately constructed. It is strange to see how shoals of these leaping and flying fishes suddenly leap from the water and take the same direction, all rising together, as if at the word of command, or as if impelled by the same external influence, the same thought and will. This community of feeling is, generally speaking, peculiar to fishes that move about in shoals.

The pilot-fishes (*Naucrates*), as is well known, swarm around the sharks, greedy as these are for most sorts of animal food, without the latter doing them any injury, and in company with the sharks they often follow ships for long distances. By means of the sucking-disc which it has on its head and shoulders, and which is nothing else than a modified dorsal fin, the remora (*Echeneis*) attaches itself to the skin of a shark, and often to the bottom of a vessel, and thus travels over the whole world. Herrings and sardines appear periodically and in great shoals, and are always accompanied by a multitude of fishes of prey. They are generally small, though some allied forms (*Albula*, *Chanops*, and *Elops*) grow to a large size, and these occur in both the Indies without it being possible to make a specific distinction between them. All the fishes mentioned are strong-swimmers, travel far out into the open sea, and are found also in the harbours, but only a few of them seem to care for living on the reef. Here the perches ply their predatory trade.

Some fishes remain almost always close below the surface of the water, as the sea-pike or garfish, and the half-beak (*Hemiramphus*); others love only shallow water, or keep at a moderate depth; while others again only feel comfortable at a great depth, and seldom make their appearance above.

This diversity of habit depends upon the species, and often upon the age of the fishes. Many species are never met with except of a large size, as is the case with species of *Serranus*, *Plectropoma*, *DiaCOPE*, *Holocentrum*, *Sphærodon*, *Pagrus*, *Dentex*, *Aphareus*, *Sphyræna*, *Thynnus*, *Caranx*; such species may pass their youth in localities where they cannot be caught by the hook, probably in deep water. Some species retire to greater depths as they grow old, while the younger ones are met with nearer the surface; this is the case with several of the genus *Serranus*. The fishes that are hooked at great depths present this peculiarity, that their bodies are distended, and their throat and œsophagus forced forward to their mouths. This is evidently a result of the diminished pressure on the gases of the body, and analogous to the swelling up of a frog under the air-pump. When the fish voluntarily comes up it can gradually restore the equilibrium by means of its swimming-bladder. The lower animals that live at great depths have their water-vascular system, or something corresponding, as a means of equalizing the pressure. Many fishes that live deep down "in the purple darkness" have, strange to say, a bright red colour, while other similar species and individuals that live higher are darker and grayer, or are brightly coloured. Besides the locality they live in (the coral reef or the open sea), sex has some influence on their colours; this probably accounts for the striking diversities of colouring exhibited by some of the parrot-fishes and rainbow-fishes, which do not have the slightest difference in form; but too few observations have been made, and the sex cannot be easily detected except at spawning time. At this time some of them, as in the genus *Caranx*, show more lively colours, afterwards becoming lean and gray. On this subject also further observations are desirable.

Many fishes show themselves only at night, and these night-fishes, as well as those living at a great depth, have generally large eyes. There are, to be sure, large-eyed day-fishes also. The "eye-fish" (*Priacanthus hamrur*) has two very large eyes, with wide cloudy-looking pupils which, when it is alive, shine in the dark like the eyes of a cat. To the luminous

fishes belong the genera *Scopelus*, *Maurolicus*, *Astronesthes*. They have peculiar round corpuscles or glands in their bodies, and these often gleam like precious stones, amethyst, for instance, and are said to be luminous at night. A considerable number of Red Sea fishes produce sounds, and especially when they are taken out of the water.

But we have already ventured with our frail boat too far in the billowy open sea with its cruel sharks and saw-fish, its companies of sportive dolphins, its sirens, and its gigantic turtles; we might come too near a gigantic sperm-whale, and accordingly we prefer to return to the quiet harbour. There we may, perhaps, have the good luck, rare in this sea, to catch some of the *Medusæ* or a chain of *Salpæ*, which creatures sometimes cover the surface of the water in the harbour, generally about once in two years, and especially after east and south-east winds. Or we may catch some of those gleaming sepias that swim with a succession of jerks. If we dip into the sea a fine-meshed net, such as is used for catching butterflies, and drop what it retains into a glass of sea-water, we shall be sure to find various minute creatures, such as *Polycystina*, *Infusoria*, and larval forams. If we have a trawl-net we may let it down and hoist a sail, and then we shall, no doubt, catch some of the rare inhabitants of the bottom. The trawl-net cannot be much employed here, however; it soon becomes frayed and torn on the rocky bottom of the harbour, and still more on that of the sea in the neighbourhood of the coral reef, where also the depth is generally too great.

We finish our labours by collecting a few gnats that were dancing above the water, some of the sea-runners (*Halobates*) that run about upon the surface of the sea, sand-beetles (*Cicindela*) on the sandy shore, and tiny spring-tails (*Podura*) under stones in the water; these assure us of the existence here of the insect world, so sparsely represented in the sea, where the numerous varieties of crustaceans take its place. Thus we return to land laden with the treasures of all the zoological kingdoms, from the mammals to the Protozoa.