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ANIMAL LIFE BY THE SEA-SHORE.

THREE STARFISHES AND A BRITTLE STAR.

Asterias rubens and *Solaster pallidus* BELOW, *Asterina gibbosa* and *Ophiotlitta fragilis* ABOVE.

ANIMAL LIFE BY THE SEA-SHORE

BY

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PREFACE.

THIS little book is intended to serve as a manual for the use of the amateur naturalist at the seaside, and the authors have aimed at brevity in their accounts of the various groups, in view of the class of readers for whom they are intended. Far from attempting anything in the way of an exhaustive or strictly scientific manual, they have only tried to provide those untrained in zoology with a means of identifying the principal of the innumerable forms of animal life which are likely to attract their attention when on the beach, or, better, on the rocks and beds of weeds uncovered by the great ebb tides which afford such grand opportunities in the western parts of the English Channel; and also of acquiring some notions concerning the often puzzling organs displayed by these creatures, their functions, as well as some of the most salient facts of their life-histories.

There are a number of popular works dealing with the curiosities of the seaside, foremost among them the charming little book of Philip Gosse, "*A Year at the Shore*," now somewhat antiquated, but few that are well illustrated and at the same time deal briefly with the whole Animal Kingdom, enumerating and explaining the principal forms occurring on or close to our shores. A strictly systematic treatment has been avoided, the classification adopted being intended to meet the requirements of the non-scientific reader, who is introduced to the subject in the simplest manner compatible with accuracy. The book is divided into the following chapters:

I.—FISHES.

II.—ASCIDIANS (Tunicates or Sea-squirts).

III.—MOLLUSCS (Cuttlefish, Shell-fish, Slugs, etc.).

IV.—CRUSTACEANS AND OTHER ARTHROPODS (Prawns, Crabs, Insects, etc.).

V.—WORMS.

VI.—ECHINODERMS (Star-fishes, Sea-urchins, etc.).

VII.—POLYPS, JELLY-FISHES AND SPONGES.

These chapters were originally written to appear as a series of articles in *COUNTRY LIFE*.

The animals alluded to are designated by their popular English names in addition to their scientific, Latin denominations. The figures consist of original photographs and of outline drawings; some of the latter have been prepared from actual specimens, while others have been copied from the works of reliable authorities, the source, in every case, being duly acknowledged.

Who, among those interested in natural history, does not remember his joy, when wading for the first time among the remote beds where tangle grows, accessible only for a short time at the spring tides, on finding a multitude of creatures new to him, such as large sea-slugs, crabs covered with seaweed, large or brilliantly coloured sea-squirts, etc., and his regret at not having at hand a little book through which to obtain some information regarding these strange things? To supply his wants, as well as those of less enterprising explorers of the seashore, the authors have often been compelled to enter into details which may at first appear a little too scientific to some of those in whose hands this book may fall; but he may be assured that, with a little attention, and having before him the animals themselves, all difficulties will soon be surmounted, no scientific term having been employed without its being first explained in simple language. The numerous figures, needless to say, will be of great use, not only to the beginner, but to many a zoologist who, not specially versed in all groups of marine natural history, desires to utilise his holiday in making himself acquainted with the denizens of the seashore. The authors have themselves experienced all the difficulties of the beginner and felt the want of such a guide; in endeavouring to supply it they have appealed to their recollections in view of the requirements of an educated layman interested in the marvels of Nature, but without any previous knowledge of zoology.

Minute forms of life, which cannot be examined without a microscope, are entirely left out, or are merely alluded to in order to give some idea of the life-histories of the larger creatures. Nor has it been attempted to refer, even by name only, to all the very numerous species of our fauna; but the more striking have been mentioned.

I.—FISHES.

IN endeavouring to help the rambler on the seashore to learn something about the innumerable "curiosities" which come across his path on the beach, or reward his search in the rock-pools or among the beds of seaweed uncovered at low tide, we will fancy ourselves at some spot on the South-west Coast, Devonshire or Cornwall, or on the opposite side of the Channel, where rocky cliffs, interrupted by sandy beaches, offer the best opportunities to the naturalist. We shall only deal with the small fishes commonly found under such conditions. The larger fishes which give joy to the angler, or which are brought on the market, will be entirely left out, as, being edible, they are far better known. We must, however, make an exception for the Wrasses, as being so intimately associated with tidal rocks covered with seaweeds.

In thus offering our services as a guide to the novice in marine zoology, the first thing to do is to enable him to distinguish the different kinds of fishes with which we intend to deal, Avoiding, for obvious reasons, a strictly scientific classification, we will direct his attention to certain characters of the fins, easy of appreciation, by means of which he will readily get at the name of the genus to which any given fish has to be referred, without further trouble than the use of an ordinary pocket-lens in the case of very small specimens. Therefore, first, a few words of explanation as to the terminology of the fins, assuming our readers to be absolutely ignorant of the most elementary rudiments of ichthyology.

Taking a Wrasse as an example of a more typical fish, we notice two pairs of fins and three vertical fins, as shown in the illustration (Fig. 1). The paired fins represent the limbs of higher animals, the front pair, the upper in this case, termed pectoral, corresponding to the fore limbs, the other pair, the ventral, or pelvic, to the hind limbs. In the more primitive types, such as a shark or dog-fish, or, higher up in the scale, a trout or a herring, the ventral fins are a long way behind the pectorals, as becomes their homology; but, in the course of evolution, they have gradually been shifted forwards to below the pectorals, or even beyond, so as ultimately to bring the

insertion of the paired limbs in a position which is the reverse of the primitive. We may distinguish three principal types of ventral fins according to their position: (a) Abdominal, inserted well behind the vertical of the base of the pectorals. (b) Thoracic, below or just behind the base of the pectorals, as in the Wrasse here depicted. (c) Jugular, in front of the base of the pectorals. In some fishes the ventral fins, instead of being paired, are united into one, the whole or part of which may be converted into an adhesive disc between and below the pectorals; fishes so constituted forming a fourth division in this artificial classification. A fifth division is characterised by the absence of the ventral fins. The unpaired fin on the back is termed the dorsal. In the Wrasse it is single, formed of stiff, spiny rays in front and of soft branched rays behind; in other fishes it may be divided into two or three, or the part formed of soft rays may be preceded by a series of isolated spines. The anal fin, opposed to the dorsal, and behind the vent, differs in like manner according to the genera. The fin which terminates the tail, called the caudal fin, may be rounded, truncate, notched or more or less deeply forked; it is sometimes absent. These three fins, the dorsal, the anal and the caudal, may be confluent into one, running round the tail.

Having thus explained the terminology of the fins, we may proceed further with the classification chosen as the most appropriate for dealing with the fishes likely to be met with in the surroundings mentioned above:

(a) *Fishes with Abdominal Ventral Fins*.—If these fins are formed of several rays, we have probably to do with the young of marketable fishes, such as the Grey Mullet (*Mugil*) or the Priest (*Atherina*), which are often found among seaweed or in rock-pools, or the Herring, so common in the estuaries at certain seasons. If each of these fins is reduced to a spine, we have the Sticklebacks (*Gastrosteus*), easily recognised by their series of isolated, erectile, dorsal spines.

(b) *Fishes with Thoracic Ventral Fins*.—This group includes the Wrasses (*Labrus*), covered with large imbricate scales, with a single dorsal fin, and thick, fleshy lips concealing strong teeth; the Bull-heads (*Cottus*), naked, with large spines on the head and two dorsal fins; and the Pogge (*Agonus*), covered with an armour of bony plates and with two dorsal fins.

(c) *Fishes with Jugular Ventral Fins*.—When these fins are well developed, with five to seven rays, and two dorsal fins are present, the fish is a Dragonet (*Callionymus*) if the ventrals are wide apart from each other and the first dorsal

FIG. 1.—BALLAN WRASSE. DIAGRAM EXPLAINING THE TERMS USED IN DESCRIBING FISHES.

is formed of slender, flexible rays ; a Weever (*Trachinus*) if the ventrals are close together and the first dorsal consists of pungent spines ; and a Rockling (*Onus*) if the snout and chin are provided with feelers or barbels. Are the ventral fins reduced to two or three rays, we have a Blenny (*Blennius*) if the dorsal fin is composed of soft rays and quite distinct from the caudal ; a Viviparous Blenny (*Zoarces*) if the dorsal and caudal, formed of soft rays, are confluent with the caudal ; or a Gunnell (*Pholis*) if the ventrals are rudimentary and the dorsal consists of a series of stiff, pungent spines.

(d) *Fishes with the Ventral Fins United into One.*—If we find, in combination, the body covered with scales, the ventrals formed of rays as in most fishes, and two distinct dorsal fins, there can be no mistake : the creature before us is a Goby (*Gobius*). If, on the other hand, the ventrals are completely transformed into a sucker, or surround a sucking disc, and a single dorsal is present, we must hesitate between a Lump-sucker (*Cyclopterus*), a Sea-snail (*Liparis*) or a Sucker (*Lepadogaster*). The first is distinguished by the presence of warts and tubercles on the body ; the second by its perfectly smooth skin and a long dorsal fin, at least half the length of the fish ; and the third by a flattened, prominent snout, a shorter dorsal fin, and the division of the sucker into two parts.

(e) *Fishes without Ventral Fins.*—These fall into two groups : those in which the body is naked or covered with minute, almost imperceptible scales, and those in which it is mailed by bony scutes in the form of rings. To the first belong the Eel and the Conger, which are outside the scope of this article, and the Sand-eel (*Ammodytes*), distinguished by a shorter body and a forked caudal fin, this fin being rounded and confluent with the dorsal and anal in the eels. To the second belong the Sea-horse (*Hippocampus*), with short body and prehensile, finless tail, and the Pipe-fishes, with very elongate, serpentine body. The latter are referred to two genera—*Syngnathus* with well-developed pectoral and caudal fins ; and *Nerophis*, without pectorals and with the caudal rudimentary or absent. We may now proceed with an enumeration of the principal species found on our coasts.

The Wrasses, although not appreciated as food-fishes, afford amusement to the novice angler at the seaside, owing to their abundance about weed-covered rocks and the readiness with which they take a bait. They are often brilliantly coloured, and in some the differences in colour and markings between the two sexes are so great as to cause them to be commonly

FIG. 2.—STRIPED WRASSE, MALE AND FEMALE.

looked upon as distinct species. The Wrasses occurring on our coasts are referred to two genera—*Labrus*, with three spines in the anal fin, and *Centrolabrus*, with four or five. The largest of our Wrasses is the Ballan Wrasse (*Labrus maculatus*), growing to nearly two feet, a very handsomely coloured fish when adult. The young are uniform green or olive, sometimes yellow on the belly, but larger specimens are ornamented with whitish or orange spots on the body, separated by a network of the olive ground colour, and orange streaks on the head; some are orange or brick-red above. The Striped Wrasse (*L. mixtus*) is also a handsome fish, but does not exceed a length of nine inches; the male is blue and yellow or orange with interrupted pale blue streaks, while the female lacks the blue colour, but has two to four black or blackish spots on the back, at the base of the dorsal fin and on the caudal peduncle (Fig. 2). The Goldsinny (*L. melops*) is distinguished by a dark, red or blue spot on the side of the head behind the eye, a black spot on the caudal peduncle, and the reddish or green body is ornamented with vermicular red, purplish or dark brown stripes or longitudinal series of spots. It is impossible to convey in a few words an idea of the extraordinary range of colour-variation which obtains in these fishes, even on the same individual according to its surroundings. The Rock-cod (*Centrolabrus exoletus*) is a rarer and smaller fish, only four or five inches long, reddish brown or orange in colour, with pale blue lines on the sides of the head. The habit Wrasses have of sleeping, lying down on one side, is well known, and has often been witnessed in aquariums, especially at night. These fishes build nests for the protection of their eggs and the minute fry that issue from them; the nests are made of seaweeds, zoophytes, corals, broken shells, etc., and are found in spring and early summer in crevices of rock, both the male and the female taking part in their construction and later in watching over their progeny. The food of Wrasses consists chiefly of crustaceans and molluscs, fragments of the shells of which are often found in their stomachs.

The Fifteen-spined Stickleback (*Gastrosteus spinachia*) is also in the habit of making nests, which are, in this case, the work of the male alone. The nest, six to ten inches in length, is elegantly constructed of seaweed interwoven by threads secreted by the kidneys, and hangs suspended, usually from the frond of a wrack or fucus, in a sheltered rock-pool between tide-marks. When the nest is finished, in May or June, the male entices the female to enter it to deposit her eggs, which

are zealously watched over by the devoted father, ever ready to defend the nest and to prevent the young from escaping while still too feeble to shift for themselves. The eggs of this Stickleback are, in proportion to the adult, the largest produced

FIG. 3.—STICKLEBACKS, THREE-SPINED AND FIFTEEN-SPINED.

by any of our bony fishes, measuring nearly one-eighth of an inch in diameter. The smaller Three-spined Stickleback (*G. aculeatus*), so common in many of our ponds and streams (Fig. 3), is also occasionally found in the sea, near estuaries, and in brackish lagoons; it is a noteworthy fact that this lively and pugnacious little fish can be transferred suddenly from fresh to salt water without appearing in the least inconvenienced.

The Bull-head, Sea-scorpion, or Fatherlasher (*Cottus scorpius*) is a near relative of our fresh-water Miller's thumb (*C. gobio*), but grows to a much larger size, females up to nine inches (Fig. 4). A second species occurs on our coasts (*C. bubalis*), distinguished by the presence of a series of small spinose scales along the side of the body. The male of the Bull-heads, characterised by a long anal papilla, measures only five inches. These fishes, of unprepossessing appearance, are usually found on beds of zostera (sea-grass) or ulva (sea-lettuce), sometimes in rock-pools. The red or orange eggs are attached to the lower surface of stones among the weeds, rarely to the weeds themselves, and form a lump varying in size from that of a pigeon's egg to that of a man's fist. The bold and irascible male remains in the neighbourhood of the eggs, ready to defend them against intruders. The Pogge or Armed Bull-head (*Agonus cataphractus*) is easily distinguished from the above by its bony cuirass,

measures only four or five inches, and often occurs in brackish water. The eggs have been found attached to the roots of laminaria or tangle, and resemble those of the Cottus in colour, but they are much smaller, forming clumps of the size of a sparrow's egg.

A beautiful and curious fish is the male Dragonet (*Callionymus lyra*), which in the full-grown, breeding condition is decorated with yellow and blue longitudinal bands. Inversely to the Bull-heads the female (Fig. 5) remains smaller than the male, which grows to nine inches. The first dorsal fin is much produced in the adult male, which is further distinguished by a long anal papilla. The female and the young are pale brown, yellowish or reddish brown, barred and mottled with darker, harmonising with the sandy or pebbly bottom on which they rest. The young are often found in shallow pools at low tide, partly buried in the sand, and difficult to detect when they

FIG. 4.—BULL-HEAD (*Cottus bubalis*) AND POGGE (*Agonus cataphractus*).

remain still ; if disturbed, a few wriggling movements will soon cause them to disappear completely under the sand. The adults usually dwell in deeper water, where they breed at the end of winter, the operation being preceded by a lengthy courtship.

The eggs are pelagic, that is to say, float at random in the sea, and *Callionymus* is the only exception known to the rule for fishes laying such eggs to show no marked differences in form or colour according to the sexes.

With the Weevers (*Trachinus*), which are somewhat related to the Dragonet (Fig. 5), we have to deal with very dangerous fishes, provided with poison organs at the base of the spines which arm their gill-covers and form the anterior dorsal fin. Partly buried in the sand in low water, they are often trodden upon by people bathing, with serious results.

From the days of the earliest naturalists, poisonous properties have been attributed to the stings inflicted by these fishes.

FIG. 5.—DRAGONET (FEMALE) AND GREATER WEEVER.

"Aculeos in branchiis habet ad caudam spectantes sic ut scorpio lædit dum manu tollitur," says Pliny. And this view has always been shared by fishermen, who are in great fear of being pricked by the weevers when emptying their nets. At some time, however, in the early part of last century, there was a general tendency among scientific naturalists to regard this belief as one of many vulgar errors which were gradually being swept away in the light of careful investigation, and no less an authority than the great Cuvier denied the possibility of weevers inflicting poisoned wounds, his disbelief being based on his inability to detect any gland or duct by which poison could be secreted and conveyed. However, when in August, 1839, the late Professor G. J. Allman was wounded near the

FIG. 6.—SHANNY, BUTTERFISH, AND THREE-BEARDED ROCKING

top of the thumb by a lesser weever, which had just been taken in a seine with herrings and sand-eels, the question was reopened, and investigations proved the popular belief to be correct. The sting is very painful, of a burning character, accompanied by swelling, sometimes by fever, delirium, and bilious vomiting; the effects may last for several days, and result in gangrene. A case is known of a sailor being incapacitated from work for many weeks through such an accident.

The opercular and dorsal spines bear two deep grooves, in which distinct glands are present to secrete the poisonous fluid; these poison-glands had escaped the attention of the earlier investigators, who had sought for them, not under the integument which covers the spines, but at their base.

The name Weever is probably derived from the Anglo-Saxon "Wivere" (serpent), like the heraldic dragon or Wivern. Two species are found on our coasts, the Greater Weever (*T. draco*) and the Lesser (*T. vipera*). The former grows to a length of eighteen inches, and has a small spine above the eye; the latter does not exceed eight inches, and lacks the said spine. In both the eyes are directed upwards, and the first dorsal fin is black in front, or entirely black, and is regarded as a danger-signal when erected (warning coloration).

The Rocklings (*Onus* or *Motella*) are members of the Cod family; young specimens are of common occurrence in tide pools. They are easily distinguished from all other fishes of our coasts in having three or five feelers or barbels, two or four on the snout and one on the chin; they have two dorsal fins, the first feebly developed and lying in a groove, the second very long (Fig. 6). The two species, the Three-bearded Rockling (*O. tricirratus*) and the Five-bearded (*O. mustela*), can be identified by the number of barbels, as their names imply. The former grows to a length of eighteen inches, the latter rarely exceeds ten inches. They are mostly found among *zostera* and *fucus*. The eggs are buoyant, like those of the Dragonets and Weevers.

The Blennies (*Blennius*) are the commonest denizens of the rock-pools (Figs. 6, 7). The four best known are the Shanny (*B. pholis*), without appendages on the head; Montagu's Blenny (*B. gallerita*), with a fringed crest on the middle of the head between the eyes, followed by a fringe of hair-like filaments; the Tompot (*B. gattorugine*), with a fringed appendage above each eye, not much longer than the latter; and the Butterfly Blenny (*B. ocellaris*), with a longer fringed appendage above the eye, the anterior rays of the dorsal fin much longer than the others,

and a blackish ocellar spot on the anterior part of the dorsal fin. The length of our Blennies is from four to six inches. The dentition is often remarkable for the presence of a large curved canine tooth on each side, denoting predaceous habits; the Shanny, in which these canines are strongly developed, is said to be an expert at detaching molluscs, such as mussels and limpets, from the rocks. Blennies are very active creatures, and when stranded have no difficulty in making their way back to the water, leaping and wriggling on sand or gravel. They can live for hours out of water among damp seaweed. The Shanny may be kept for a long time in a small aquarium provided with an island of stone or rockwork, on which it will sometimes rest, completely out of the water. The amber-coloured eggs are

FIG. 7.—HEADS OF BLENNIES.

(*Blennius galerita* and *gattorugine*).

deposited in a single layer under stones, sometimes in whelk-shells, and are vigilantly guarded by the male, who carries away in his mouth anything that might interfere with the circulation of the water around them, and, by movements of his pectoral and caudal fins, produces currents for their better aeration.

The Viviparous Blenny (*Zoarces viviparus*), of elongate shape and with a series of dark spots along the base of the dorsal fin, is a more Northern fish, rarely met with in the Western part of the Channel, and occurring only on sandy coasts. As its name implies, it is remarkable in producing its young alive, about two hundred in number, at a comparatively advanced state of development, measuring one and a-half to two inches,

FIG. 8.—BRITISH GOBIES.

Giant Goby (top), Rock Goby (left), male (above) and female of Sand Goby (right).

FIG. 9.—LUMP-SUCKER AND, ABOVE, TWO SPECIES OF SUCKERS: LEPADOGASTER GOUANI (SIDE AND LOWER VIEWS) AND L. PUCCANDOLLI.

the adult growing to a length of twenty inches. Like the preceding, the Gunnel or Butterfish (*Pholis gunellus*), represented on Fig. 6, is of elongate shape, and the orange or pale brown body is compressed and bears a series of ten to thirteen black, white-edged ocellar spots along the base of the dorsal fin. The young have the dorsal and anal fins barred with black. Eight inches is the greatest length reached by this fish, which is quite common under stones, among fucus. The white eggs form an oval ball, about the size of a large nut, and are laid in January or February; the female protects them by coiling herself round the ball, and in this the male occasionally assists, the two parents sometimes taking up the duty in turns.

The Gobies (*Gobius*) are small or very small fishes with the ventrals united into one, without, however, forming so efficient a sucker as in the genera mentioned hereafter (Fig. 8). Several species occur on our shores. The commonest are the Sand Gobies (*G. minutus* and *G. microps*), sand-coloured creatures, only two or three inches long, darting away in sand-pools; the equally small Spotted Goby (*G. ruthensparri*), varying in colour from yellowish brown to almost green, with large pale spots on the back and a black blotch at the base of the caudal fin, found among weeds; the Rock Goby (*G. paganellus*), growing to nearly five inches, greyish or yellowish brown to dark purplish brown, with a yellow or whitish band along the top of the first dorsal fin, common in rock-pools; and the so-called Black Goby (*G. niger*), similar to the preceding in size and coloration, but without the light band on the dorsal fin, and found mostly in estuaries. The Giant Goby (*G. capito*), attaining a length of ten inches, with the eyes wide apart, is not uncommon on the North Coast of Brittany, and occurs locally between Polperro and Falmouth, in oyster ponds and rock-pools, often in places reached only by spring tides. In this genus, the male, often more brilliantly coloured than the female, and distinguished by a long and pointed anal papilla, mounts guard over the eggs, which are fixed in single layers to the under surface of stones or weeds, or in a sort of nest built and kept in constant repair by him. The nest of the Sand Gobies is usually made of the shell of a limpet or a bivalve, or of the empty carapace of a crab, with the convexity turned upwards and covered with sand; the sand underneath is hollowed out and a round opening at the side, coated with a mucus secreted by the skin of the male fish, gives access to the interior; the eggs, which are elongate and pyriform, are stuck to the inner surface of the roof. The breeding season lasts throughout spring and summer.

The Lumpsucker (*Cyclopterus lumpus*) is an extraordinary-looking fish, flabby and covered with warts and tubercles, growing to a length of two feet or more (Fig. 9). Between February and April the male makes pits in the sand between stones in shallow water, in which the female deposits the eggs, pinkish in colour and forming a ball; he takes care of the eggs and also of the young, which cling to his body with their suckers.

The Sea-snails (*Liparis*) are diminutive Lumpsuckers, with perfectly smooth skin and a longer dorsal fin. They measure only two to five inches, and the coloration is very variable, some specimens being uniform yellowish-brown or orange, others mottled or spotted with dark brown, or bearing dark longitudinal lines. The larger *L. vulgaris*, with the vertical fins continuous, is a northern species, rarely found in the Channel. The common species, *L. montagui*, with the caudal fin quite distinct from the dorsal and anal, is found at low tide among weeds or under stones. The yellow or orange eggs form a small ball attached to the fronds of seaweeds or to zoophytes.

The Suckers (*Lepadogaster*) have the ventral disc or sucker divided into two, the anterior between and embraced by the rays of the ventral fins (Figs. 9 and 10). They are small fishes, two to

FIG. 10.—VENTRAL DISCS OF GOBY, SUCKER AND SEA-SNAIL.

four inches long, found among seaweeds, or sticking to stones in rock-pools. Three species are to be met with at low tide—*L. gouani* with the dorsal fin much longer than the anal, these two fins embracing the caudal, with a long, bifid

tentacle on each side near the nostrils, red or purple with or without brown spots, with two pale blue spots behind the eyes ; *L. decandollii*, with the dorsal fin much longer than the anal and free from the caudal fin, usually yellowish with the fins and a spot on the gill-cover red ; *L. microcephalus*, with the dorsal fin not, or but slightly, longer than the anal, and widely separated from the caudal, green, marbled with brown, yellow, or crimson, or brown with darker and lighter marblings. The eggs are yellow, elliptical, disposed in a single layer under stones or on the broad blades of laminaria, and are watched over by both the parents.

The Sand-eel or Lance (*Ammodytes lanceolatus*), characterised by its silvery elongate body with forked caudal fin and its

FIG. II.—SAND-EEL OR LANCE.

pointed, prominent chin, burrows in the sand, and appears in enormous quantities on the surface during full-moon nights in summer, the beach sometimes glittering with these silvery creatures, which make excellent "fritures" (Fig. 11). The oval eggs stick to the sand in water about three fathoms deep.

The last group of fishes which we have to mention, the Sea-horse and the Pipe-fishes, is highly remarkable for the manner in which the male carries the eggs and young, either in a pouch or fixed to the belly. The Sea-horse (*Hippocampus antiquorum*) is too characteristic to require more than a figure, which depicts it in the erect attitude in which it holds itself, anchored to a weed by means of its grasping tail (Fig. 13). The brood-pouch is situated under the tail, just behind the belly, with a small anterior opening by which the eggs are introduced, and the young expelled when in a fairly advanced state of development. This little fish is only three or four inches long. It is not commonly found on our coasts. Some thirty years ago, however, two Leigh fishermen had an order from London to procure specimens for aquariums, and when shrimping near Harwich they succeeded in collecting about one hundred in the course of one summer.

The Pipe-fishes (Fig. 14), distinguished from the Sea-horse by their elongate, snake-like form, belong to two genera and several

species. The generic characters have been mentioned above, and to this definition we may add that the male *Syngnathus* is provided with a brood-pouch under the tail, formed of two flaps of skin meeting on the median line and splitting open for the release of the young, while in *Nerophis* the male carries the eggs attached to the belly. The Great Pipe-fish (*Syngnathus acus*) has the snout shaped like the Sea-horse's, but longer, and grows to seventeen or eighteen inches. The Broad-nosed Pipe-fish (*S. typhle*), which grows to about thirteen inches, differs in the much deeper snout, which is nearly as deep as the part of the head behind the eyes. The Snake Pipe-fish (*Nerophis æquoreus*) has the snout equal to, or rather larger than, the remaining part of the head, but not more than half its depth, and the tail ends in a rudimentary, very indistinct fin. The Straight-nosed Pipe-fish (*N. ophidion*), a much rarer species, differs in the deeper snout and the tail tapering to an almost

FIG. 12.—MALES OF SNAKE PIPE-FISH AND LITTLE PIPE-FISH
WITH EGGS ATTACHED TO THE BELLY.

filiform point, without any trace of caudal fin. This Pipe-fish, and the two others of the genus *Nerophis*, often rest in an erect position, with the tip of the tail loosely curled round weeds or other projecting objects—an attitude approaching that of the Sea-horse, although the tail is not prehensile to the same degree. These fishes reach a foot, or a little over a foot, in length. The Little Pipe-fish (*N. lumbriciformis*), only five inches long, is the commonest in shallow water, and easily distinguished by its very short snout, turned upwards at the end. Although so much smaller than its congeners, this fish has the eggs larger and consequently much fewer, forming a single band of three or four longitudinal series on the belly instead of two bands each composed of four or five series (Fig. 12). Male *Nerophis* with eggs are to be found throughout the summer. *Zostera* beds are the favourite resort of the Pipe-fishes.

As regards the mode of propagation, the fishes with which we have thus briefly dealt may be arranged as follows :

FIG. 13 -SEA-HORSE

FIG. 11. THE FISHES GREAT PIPE-FISH, SNAKE PIPE-FISH AND BROAD-NOSED PIPE-FISH

(A) Eggs Buoyant, Isolated: *Callionymus*, *Trachinus* and *Onus*.

(B) Eggs not Buoyant, usually Adherent to Other Bodies :
 (1) Isolated, sticking to sand: *Ammodytes*. (2) Aggregated, fixed and usually guarded by the parents, without a nest of weeds. (a) In a lump: *Cottus*, *Agonus*, *Pholis*, *Cyclopterus* and *Liparis*. (b) In a single layer: *Blennius*, *Gobius*, *Lepadogaster*. (3) In a nest made of weeds: *Labrus* and *Gastrosteus*.

(C) Eggs Carried by the Male: (1) In a pouch under the tail: *Hippocampus* and *Syngnathus*. (2) Sticking to the belly: *Nerophis*.

(D) Eggs Hatched in the Body (viviparous fish): *Zoarces*.

Another and very different type of eggs, which cannot fail to attract the attention of the wanderer on the beach, belongs

FIG. 15.—EGG-CAPSULES OF DOG-FISH AND SKATE.

to fishes which are outside the scope of this article. Of large size, and encased in a tough, leathery capsule, these eggs are those of Dog-fishes and Skates (Fig. 15). The egg-cases of the latter,

of a black colour, and terminating at both ends in a pair of horn-like processes, are known as "Mermaid's purses," and are washed ashore empty after the escape of the young. But the eggs of the Dog-fish (*Scyllium*) may be found attached to weeds in sufficiently deep water not to be uncovered by the tide, the attachment being by means of tendrils, of which the horns of the Mermaid's purse are the basal remains. Such eggs are here figured in outline.

We cannot dismiss the fishes without saying a few words about an extraordinary creature, the Lancelet or Amphioxus (*Branchiostoma lanceolatum*), long placed in the class Pisces, but now associated, in a division named Protochordata, with the Ascidians or sea-squirts, which will be dealt with in the following chapter. It was first described, in the eighteenth century, from a specimen obtained on the coast of Cornwall, and many years elapsed before it was again rediscovered

FIG. 16.—LANCELET.

on our coast and elsewhere, it having a wide but very local distribution in Europe. The Lancelet (Fig. 16) is a small, colourless, elongate, compressed creature, pointed at each end, two to three inches long, without heart, in the ordinary sense of the term, eyes or brain, or even cartilages, the axis of the body containing an elastic rod, known as the notochord, which in the development of all vertebrate animals precedes the vertebral column, the vertebræ being formed above or around it. Curious tentacle-like cirri form a fringe round its mouth, and were first taken for respiratory filaments or gills, whence the misleading name *Branchiostoma*, first proposed for it. It was not until 1866, when the Russian zoologist, Kowalevsky, published the results of his researches on the development of the Lancelet and the Ascidians, that a close relationship was shown to exist between these two types, so different in appearance in their perfect condition; the Ascidians had until then been placed near the Molluscs or near the Worms. The Lancelet is not often met with on our coasts, but may be found in plenty in Jersey, burrowing in the sand in shallow water. It has even been found on the shore at Polperro, not in a pool, but buried in a small quantity

of sand, about fifty feet from the receding tide. If the reader should be fortunate enough to meet with this creature, he must bear in mind that he has before him one of the classical types of zoology, about which more has been written than on any other of low standing, and which has given rise to much controversy among evolutionists, some regarding it as a connecting link between Invertebrates and Vertebrates, others endeavouring to demonstrate that it is derived by degeneration from the latter.

II. —ASCIDIANS.

ON inspecting forms of life in rock pools and oyster-beds the observer's eye cannot fail to be attracted by berry-like red or pink creatures fixed to stones, oysters or fucus-fronds, provided with two funnel-shaped openings, through which, when touched, jets of water are ejected with considerable force, hence the name sea-squirts popularly bestowed on these creatures, scientifically known as Ascidians or Tunicates. Looking at one of these sea-squirts, the Currant Squirter (*Cynthia grossularia*), for instance, one of the commonest species on our coasts, the uninitiated would surely take it to be a very low form of the animal kingdom, yet, as we shall explain, it is placed in the zoological system close to the Vertebrates or backboned animals, and forms part of a great division which includes the Lancelet, long regarded as a fish, and mentioned, in connexion with fishes, at the end of the preceding chapter. This proposition may appear almost incredible when we consider the perfect creature alone; its justification is afforded by a knowledge of the much more highly organised larval form, free-swimming and tadpole-like, which will be briefly described. Previous to doing so, however, we must impress upon the mind of the beginner in zoology that, in certain types of animals, the perfect or adult condition constitutes a state of degradation, a simplification of the organism, which obscures its natural relationships. Further on we shall have occasion to adduce another perfectly similar instance in the case of the Barnacles and the Sacculine, the position of which among Crustaceans did not become apparent until a knowledge of their transformations during development had been acquired. The theory of evolution does not necessarily imply a gradual ascensional series; far from it, it holds that many animals, instead of competing with equally or better organised forms, have maintained themselves by acquiring a simplified structure which fits them for life under certain conditions, thus to fill vacant positions in the economy of Nature; hence we talk of them as degraded or degenerate, taking into consideration their derivation, as shown by earlier stages in their development.

Before becoming fixed to a fucus or stone the sea-squirt has enjoyed for a time a free-swimming larval existence, and was even provided with an unpaired eye. Not unlike a frog-tadpole in shape, this larva has a long, finned tail, the axis of which consists of a notochord, a structure, mentioned *à propos* of the Lancelet,

FIG. 17.—DIAGRAM OF ASCIDIAN LARVA.

which is characteristic of all vertebrate animals, in their embryonic condition at least, and unrepresented in the invertebrates proper (Fig. 17). In some Ascidians, however, such a larva does not exist, and the embryo passes gradually into the perfect form, the development being direct, without metamorphosis, while others remain permanently in a condition similar to the larval.

Many of the Ascidians found between tide marks on our coasts belong to the sedentary, fixed types, globular or barrel-shaped, sac-like, with two short funnel-shaped apertures: one at the top, which may be called the mouth, the other a little lower down on the side, which corresponds to the vent. They have been compared to a leather bottle with two spouts. The current of water enters the upper aperture, and after passing through a large branchial sac comes out through the lateral aperture. Like practically all fixed animals, Ascidians are hermaphrodite. We find on our coasts several species of *Cynthia*, solitary Ascidians varying in size from that of a small pea to that of a plum. Some are brilliantly coloured—yellow, orange or red. *Ciona intestinalis* is of very elongate shape, and the largest of our Ascidians, occasionally attaining a length of nearly a foot. *Ascidia* (*Phallusia*) *virginea* is shorter, but also of a large size, measuring up to three inches in length, with tough outer covering, yellowish or pinkish white; although distinct, individuals sometimes form bunches.

The colonial Ascidians are represented with us, in shallow water, by *Clavelina lepadiformis*, forming colonies on rocks. The individuals, only one-fourth of an inch in length, vase-shaped, transparent, with yellow lines, are separate except at the base, where they are connected by a common creeping

FIG. 18.—ASCIDIANS (CYNTHIA, ASCIDIA, CLAVELINA, BOTRYLLUS).

process or stolon, from which buds are periodically produced; these buds grow up into individuals which produce eggs, out of which free-swimming larvæ disperse to establish new colonies. When the larva first fixes itself to some suitable surface the tail remains for a time stretched, but soon becomes shorter and gradually disappears, as in a tadpole, having first been drawn within the sac-like body, where it is finally absorbed. *Clavelina* forms part of an interesting group connecting the simple Ascidians, which reproduce only by eggs, and the

compound Ascidians, which form a common mass and reproduce by gemmation or budding.

Such compound Ascidians are found in abundance on rocks and stones uncovered by the tides, forming gelatinous expansions which attract the eye by their brilliant colours, *Botryllus violaceus* appearing as a beautiful mass of purple, on which groups of individuals stand out as tiny greenish-white stars.

This *Botryllus*, common on all our rocky coasts, is an excellent example of a compound Ascidian, not a single animal, but a commonwealth of beings combined into systems, systems combined into masses. It is not surprising that such creatures have long been regarded as Polyps, and, no doubt, they bear some resemblance to certain representatives of the Coral tribe. Each star in the colony of *Botryllus*, as represented in the figure on page 20, constitutes a system with as many components, each having its own mouth, as there are branches to the star, while a common vent is present in the centre. Another compound Ascidian, found locally on our coasts, is the Sea-fig (*Polyclinum ficus*), sometimes forming vast masses of olive-green colour, in the interior of which the viscera of the individuals appear as yellow spots suggestive of the seeds of a fig.

III.—MOLLUSCS.

THE animals with which we shall deal in this chapter are known as shellfish, in the more restricted sense of the term, slugs, cuttlefish and their allies, and constitute the division Mollusca, one of the most important of the animal kingdom. This division is well circumscribed, and the bonds of union between its very numerous members are apparent enough, notwithstanding the fact that, adapted for most diverse modes of life both on land and in water, their structure is often profoundly modified in accordance. Three organs are especially characteristic of the Mollusc, and are present in the more typical examples, viz., the foot, the mantle and the shell. The foot is the organ of locomotion, essentially a thickening of the ventral musculature; it often attains a very great relative size, and can be modified to subserve almost any kind of movement—creeping, swimming, grasping or burrowing; it is very rarely absent, as in a few fixed forms, the Molluscs, like most other groups of animals, including strongly degraded types. The mantle is a fold of the dorsal integument, enclosing a space known as the mantle-cavity, the primary function of which is the protection of the breathing organs, of the nature of gills in the typical marine forms. The mantle, moreover, secretes the shell, an inorganic, calcified structure which protects or affords complete shelter to the soft body. The shell is, however, much reduced or absent in many forms.

The Molluscs are divided into four primary groups, the names of which are derived from the structure of the foot: (1) Cephalopods (Octopus, Cuttlefish and Squids); (2) Gastropods (Snails, Slugs and Chiton); (3) Pelecypods (Bivalves); (4) Scaphopods (Tooth-shells). In the first two of these groups there is normally a distinct head, bearing sense-organs in the form of eyes and tentacles; in the other two the head is so much reduced as to be almost unrecognisable.

The Cephalopods are the most highly organised of the Molluscs, and in many ways contrast strikingly with the other members of this great division. They have a better brain, protected by a cartilage, and their large eyes recall those of

fishes; their predaceous habits and the rapidity of their movements have, in most cases, allowed them to dispense with the shell which affords such effective protection to other Molluscs. As the name Cephalopods suggests, the front part of the foot has come to surround the head, and it is divided into a number of long mobile arms, or tentacles, which, at least in all the British representatives, are provided with large suckers. The hinder part of the foot is modified to form a muscular protrusible funnel directed forwards on the middle line, just in front of the mantle-cavity, which opens to the exterior by a slit-like orifice at its base. Water is continually taken in through this slit, and, after passing over the gills, is expelled through the funnel with sufficient force to propel the whole animal backwards when swimming. The mantle-cavity also receives the openings of the kidneys and the gut, and in connexion with the latter there is, in all the British forms at least, a peculiar gland which secretes an ink-like fluid, stored in a tough bag and expelled through the funnels by the animal when alarmed, with the evident object of obscuring the water in view of facilitating its escape. The mouth, armed with two black, horny jaws, like the beak of a parrot, is in the middle, between the bases of the arms. The Cephalopods found on our coasts have no external shell; but all except the Octopus have a sort of internal shell or "bone" embedded in the muscles of the body. That of the Cuttlefish is often found on the beach, and is utilised in canaries' cages for those birds to sharpen their bills; it is of large size and formed of chalky substance, which is ground to make tooth-powder, and was formerly much used in pharmacy as an anti-acid. In the Squids the "bone" is very different, thin and horny, in some species resembling a quill pen. It is represented by two minute vestiges in the Octopus. The Cuttlefish furnishes the best sepia ink of commerce. The sexes are distinct in all Cephalopods, the males being distinguished by some modification of one of the arms in connexion with the reproductive function. Some of these animals attain a gigantic size. On April 28th, 1911, a huge Squid, probably *Architeuthis harveyi*, was caught in the Atlantic off the coast of Ireland and landed at Milford Haven. The body is stated to have measured seven feet in length and two feet in width, the longest tentacles measuring about twenty-four feet. We have seen a photograph of this monster, of which, unfortunately, nothing was preserved.

The largest species to be found close to the shore is the well-known Octopus, *Octopus vulgaris* (Fig. 19), with the head confluent

with the short, sac-like body, from which four pairs of long arms radiate when it is at rest or crawls about, or are directed forwards when it swims (forwards in the sense of the orientation of the animal, backwards according to the mode of progression). These arms are furnished with cup-shaped structures which function as suckers, and as each arm may be over a foot in length, the Octopus is a powerful animal; feeding chiefly on fish and the larger crustaceans, it is very injurious to fisheries. A plague of Octopus occurred at the end of the last century on the South Devon and Cornish coasts, as well as on the opposite side of the Channel, and the fisheries for edible crabs and lobsters were most seriously affected for a few years. Isolated specimens are often found among rocks at low tide, and, when dislodged from their retreat, crawl away with great rapidity over the sand or stones, always making straight for the direction of the sea; they are evidently gifted with a special sense of orientation. It is very difficult to keep them alive; a fair-sized specimen soon exhausts the oxygen in a large bucketful of water, and, after a few minutes, suffocating, makes desperate attempts to get out. Another peculiarity of the Octopus is the rapid changes of colour which it undergoes, passing from brown to pink, yellowish or blackish in an even more startling manner than a chameleon. Were it not for the repulsive appearance of the animal, in most people's eyes, the flesh of the Octopus would be in great demand with us, as it is in Italy, where it sells at a high price. All Cephalopods, in fact, are edible and regarded by many as a delicacy. The eggs of the Octopus are small and number thousands. A smaller Octopus occurs, though more rarely, on our coasts—*Eledone moschata*—distinguished by its suckers forming a single series along the arms instead of two, and by the musky odour from which it derives its specific name.

The Cuttlefish (*Sepia officinalis*) is the next largest Cephalopod common with us (Fig. 20). The body, which is very distinct from the head, and longer than broad, commonly measures from six to nine inches; besides the eight tentacles of the Octopus, which are shorter than the body, there is an additional pair of much greater length, terminating in a spatulate expansion, underneath which are numerous suckers; these long appendages are protruded for prehension, otherwise they lie concealed in a sheath in the mantle. Bunches of the large black eggs of this creature are often washed ashore and are known as "sea-grapes"; on being opened, these eggs may be found to contain miniature Cuttlefish with their yolk-sac.

FIG. 19. OCTOPUS.

166 20.—CUTTLEFISH.

The diminutive *Sepiola rondeleti* (Fig. 21) is common in many places, and great numbers are taken by the shrimpers; examples are often found mixed with whitebait. The body is short, with wing-like lateral expansions.

The Squids (*Loligo forbesi* and *L. subulata*) differ from the Cuttlefish in their longer body, pointed behind (Fig. 22); the first species is the larger and usually measures over a foot when adult, the tentacles not included. A specimen taken by spratters at the mouth of the Colne, in November, 1891, measured, according to Dr. Murie, two and a-half feet, body and shorter arms included, its pen (cuttle-bone) being some fifteen inches long. The eggs of the Squids are colourless and transparent, and form clusters of up to nearly forty thousand in the larger species.

The Gastropods, which follow the Cephalopods in a natural classification, form a very large group,

FIG. 21.—SEPIOLA.

FIG. 22.—LOLIGO FORBESI AND PEN.

including such well-known examples as the whelks, periwinkles, limpets, snails and slugs, univalve or with the shell reduced or wholly absent. To these may be added the outlying group typified by the peculiar form known as Cliton. The more typical

Gastropods are characterised by a marked asymmetry, the greater part of the body being coiled up spirally in a shell, and the foot expands into a broad flat sole, by the muscular movements of which a creeping movement is effected. The head is distinct

FIG. 23.—WHELK AND ITS EGG-CAPSULES.

and provided with eyes and one or more pairs of tactile tentacles which, in some forms, our garden snail for instance, carry the eyes. One of the largest and best known of the British marine types is the Whelk (*Buccinum undatum*), which displays all the characteristic features of the group (Fig. 23). When fully extended the animal is not unlike a land-snail in general shape; the head, however, bears but a single pair of tentacles, at the base of which the small eyes are situated. Another conspicuous character which distinguishes it from the land-snail is the operculum, a circular calcified disc carried on the posterior dorsal side of the foot, forming a kind of lid closing the opening of the shell when the animal completely withdraws into it. The mantle cavity containing the gill is on the left side of the body, within the shell, and, in order to allow the access of water, the opening of this chamber is produced into a long tubular siphon, a contrivance which is characteristic of the marine snails. The Whelk holds a very secondary position as an article of food; it is, however, extensively fished for on the East Coast, where the sum derived from this fishery has been estimated at over twenty-five thousand pounds per annum. Clusters of the Whelk's egg-capsules are very familiar seaside objects, being frequently washed ashore; the whole mass of spawn has a honeycombed appearance and consists of a large number of parchment-like cells, each of which contains many small eggs. The majority of small snail-like creatures, which we find living in rock-pools

FIG. 24.—SHELLS OF COMMON BRITISH MARINE GASTROPODS.

Left to right.—Top: *Purpura lapidus*, *Trochus cinerarius*, *Cypræa europæa*, *Littorina littorea*.
Bottom: *Natica calens*, *Turritella terebro*, *Murex erinaceus*, *Nassa reticulata*.

FIG. 25.—SECTION OF COWRY SHELL.
Showing spiral structure.

or whose empty shells lie on the beach, are conformed very much like the Whelk. The commoner forms, some of which are figured here (Fig. 24), are easily known by the shape and sculpture of the spiral shell. We may mention the Periwinkles (*Littorina littorea* and *L. rudis*) of commercial importance, the latter of special interest for the long period, up to a month, it may remain beyond the reach of the sea, and as a viviparous marine mollusc; the Sting-winkle (*Murex erinaceus*); the Purple (*Purpura lapidus*); the Dog whelk (*Nassa reticulata*); the Sea-snail (*Natica catena*); the Tower shell (*Turritella communis*); and the beautifully marked species of *Trochus*, such as *Trochus cinerarius* and *T. zizyphinus* (Fig. 36), the latter, with its conical smooth shell, resembling a top. Some of the *Murex* and *Purpura* secrete a peculiar fluid which gives a purple-coloured dye, a member of the former genus being the shell-fish from which the ancients obtained their well-known Tyrian purple.

A very common Gastropod is the Limpet (*Patella vulgata*), found between tide-marks on all rocks, to which it adheres with extraordinary force by means of the circular foot. It is further remarkable for the fact that the shell has acquired a secondary symmetry; that this symmetry is not a primitive feature is shown by the young, which has a coiled shell. Although the same individual limpet may be seen day after day in exactly the same position, the animal is not without powers of locomotion, for, when covered by the tide, it often travels great distances in search of sea weeds on which it feeds, invariably returning to the same spot before the tide recedes. This "homing instinct" is a most interesting trait in the habits of this curious creature.

The Ear-shell, or Ormer (*Haliotis tuberculata*), is a close ally of the limpet, abundantly found on the coasts of the Channel Islands and of Brittany. The much-flattened shell has a low spiral and is perforated by a series of holes, the object of which is to allow the escape of the water aerating the gills in the mantle cavity. The inner surface of the shell is beautifully coated with mother-o'-pearl. Another type of shell of highly aberrant appearance is the small Cowry (*Cypræa europæa*), the reduced British representative of the more ornamental exotic species which adorn the shell-cabinet, and not unlike the Indo-Pacific Money-cowry, which has long been the currency among the negroes of some parts of Africa. The shell of the Cowry, with its oval shape and long, slit-like opening, looks quite symmetrical; but when young it has the ordinary spiral shape, and as it approaches the adult condition, a thick outer

coating envelops the whole structure, concealing the spire, which is visible in section (Fig. 25).

Another assemblage of marine Gastropods consists of a number of slug-like creatures, in which, as in the terrestrial slugs, the shell is considerably reduced or absent (Fig. 27). Perhaps the best-known British example of this section is the Sea-hare (*Aplysia punctata*), often found at very low tide crawling over beds of sea-grass and sea-lettuce, and browsing on these weeds (Fig. 26). It is a strange-looking animal, often four or five inches long, of a deep purplish black colour, with two pairs of tentacles on the head, the larger pair, at the base of which the eyes are situated, being flattened and erect, suggesting the ears of a hare. The shell is much reduced and not calcified, but flexible, and partially covered by two lobes of the foot, which is reflected

FIG. 26.—SEA-HARE.

over the mantle, the latter being folded behind to form an excretory siphon. When molested the Sea-hare has the power of discharging a large quantity of purple fluid from the inner surface of the mantle. The true Sea-slugs, belonging to the division of Nudibranchs, or naked-gilled Gastropods, have no shell at all in the adult condition, but the larger species possess a very tough skin, strengthened with small, hard rods, known as spicules. Such forms as *Doris*, *Aeolis* and *Tritonia* are of great beauty owing to their lovely pink, lilac, yellow or bright green colours. *Doris johnstoni* is often found on rocky coasts, and for its yellow blotches is popularly called the Sea-lemon; its body, reaching a length of three inches, is oval and flattened, with two tentacles on the head and a rosette of retractile, plume-like gills surrounding the vent or the hinder part of the back. This rosette is not present in *Aeolis* and *Tritonia*, which

FIG. 21.—THREE TYPES OF MARINE SLUGS.
Acolis papillosa (above), *Acolis conoida* (right), *Doris bitumellata* (left)

breathe mainly through the general surface of the body, although the large papillose appendages disposed in rows on the back (simple in *Aeolis*, branched in *Tritonia*) may have some respiratory function. The British species of *Aeolis*, of which there are many, *A. papillosa* being the largest, are often found among rocks crawling over colonies of zoophytes, which they devour. The eggs of our Sea-slugs are laid in gelatinous bands, and the fry that issue from them are provided with a thin, transparent shell, closed by an operculum, which is cast off in the course of development. The bands of eggs may be so long and convoluted as to have given rise to the name "*Vermicelli di mare*," by which the spawn of the Sea-hares is known to Italian fishermen. The spawn of a single *Doris* may contain six hundred thousand eggs. Unlike the Sea-snails, in which the sexes are always distinct, but like the land and fresh-water snails and slugs, the Sea-hare and the Sea-slugs are hermaphrodite.

The Chitons, or coat-of-mail shells, are often placed with the Gastropods in classification. They differ, however, from these as well as from all other molluscs in having the shell composed of eight pieces overlapping like the tiles of a roof. They are symmetrical, and the animal has rather the shape of a limpet, the foot being flat and adapted for crawling over rocks and stones. They have the power of rolling themselves up after the manner of wood-lice. The sexes are distinct.

Nearly all the British species are small, the largest (*Chiton fascicularis*) not exceeding a length of two inches (Fig. 28).

The Pelecypods are Molluscs essentially modified for a sluggish existence, the typical members of the group being more or less sedentary and feeding on the minute vegetable and animal organisms in suspension in the water. They possess neither a distinct head nor cephalic sense-organs, and the whole body is enclosed in two large mantle folds, which secrete a shell consisting of two valves. The gills are usually large and lamellar or plate-like, hence the term Lamellibranchs often applied to the group, also known as Bivalves. The name Pelecypods alludes to the fact that the foot is often hatchet-shaped, and thus adapted for ploughing through sand and soft

FIG. 28.—CHITON
FASCICULARIS.

mud. The two valves of the shell are connected by an elastic ligament, the action of which is indirectly controlled by the animal, becoming relaxed and causing the valves to gape after death, when the muscles cease to function. As a typical marine bivalve we may mention the Cockle (*Cardium edule*), so common on sandy shores, especially near estuaries, where the salinity of the sea is reduced by an influx of fresh water. It usually lives just buried below the surface of the sand, or a mingling of sand and mud, and, in order to keep up a respiratory current, the mantle is produced into two tubular structures which project from the shell and function as inhalent and exhalent siphons. The Cockle burrows by means of the long bent foot (Fig. 30) which is also used to perform peculiar leaping movements, for this Mollusc is remarkably active at times and able to jump considerable distances.

The Clam, or Gaper (*Mya truncata*), lives much in the same situations as the Cockle, being, however, a more stay-at-home animal, remaining embedded, often a foot deep, in sandy mud; in relation with this mode of existence, the united siphons are extremely long (Fig. 29). The valves of the shell differ from those of the Cockle in being oval and devoid of radial ridges. The oval shell is characteristic of many of the marine Pelecypods,

FIG. 29.—CLAM, WITH ARROWS SHOWING INHALENT AND EXHALENT ORIFICES OF SIPHON. (After Woodward.)

the species of which are somewhat difficult to define briefly; two are here figured (Fig. 31). *Tellina balthica* is noticeable on account of its delicate colouring; the valves are white, pale pink, or yellow externally, bright pink internally. Another pretty shell to be found commonly on the beach is *Donax venustus*, of more elongate shape and of a violet colour in the interior. *Cyprina islandica* is a larger and more massive and convex shell, of brown colour.

The extraordinary-looking Razor shells (*Solen ensis* and *S. siliqua*) differ strikingly from our other littoral bivalves in their greatly elongated form, reaching a length of

FIG. 30. -PRICKLY COCKLE WITH FOOT PROTRUDED

eight inches or even more. We usually come across empty shells only, but the living creature may be found at extremely low water buried deep in the sand; being sought for as bait, the fishermen catch them by means of a barbed-wire

FIG. 31.—TELLINA BALTHICA (LEFT), DONAX VENUSTUS (RIGHT), AND MYTILUS EDULIS.

thrust quickly into the small holes in the sand which betray their presence. Preferring the open sea, the Razor-shell usually avoids estuaries. As in all burrowers, the foot is large and may protrude considerably from the gaping valves of the shell.

The Bivalves mentioned above are able to move about, but many among our British representatives of the group are, except when quite young, permanently attached to rocks, wrecked ships, breakwaters, wooden piles of piers, etc. So it is with the Edible Mussel (*Mytilus edulis*), of which such large colonies are to be found on our coasts and in the brackish water of the mouths of rivers (Fig. 31). As behoves its sedentary existence, the Mussel has the foot much reduced and unfit for locomotion, but it secretes a bundle of long, tough threads, known as the byssus, by means of which it attaches itself. As in the cockle, there is a separation of the sexes. A larger and rarer mussel, the Horse Mussel (*M. modiolus*), often twice

as large as the common species, but not valued for food, has the shell of an orange or dark brown colour, quite unlike the bluish-black of its ally. The shells of mussels are often covered with barnacles, hydroids or weeds.

The most valuable of all our molluscs, the Oyster (*Ostrea edulis*), is another permanently fixed bivalve, but, unlike the mussel, it spins no threads, attachment being by one of the valves of the shell, which are unequal in size, the right being flat, and functioning as a kind of lid. In accordance with the lack of locomotory power, the foot is very much reduced, vestigial in fact, and to the reduction of this tough muscular organ the universal popularity of the oyster as an article of food is in great part due. The gills form a fringed frill, popularly known as the beard. Our British oyster is hermaphrodite, while other edible species, such as the American and Portuguese oysters, have the sexes distinct. The breeding season extends from May to August, according to individuals, when a large number of minute eggs are produced; but instead of being immediately discharged they first spend some time within cavities above the gills. When in this condition oysters are said to be sick, and are not fit for consumption. Cases of poisoning through eating oysters during the period of reproduction are not infrequent, and this fully justifies the popular notion that one should abstain from this delicacy during those four months in the year the names of which are without an "r." After a few weeks the young oysters escape from the parent as tiny swimming larvæ, which, after a few hours' freedom, fix themselves to some suitable support, rapid growth following. Natural oyster-beds are now no longer abundant round our coasts, and occur in fairly deep water, where the fry or "spats" are collected and transferred to artificial oyster-beds or parks. What are called "native" oysters are such as have been reared in or near the Thames estuary, although they may have developed from spats obtained elsewhere. The Colchester beds are among the few natural settlements on the East Coast.

The oyster is only one of many bivalves in which the two halves of the shell differ in size and shape. We meet with another case in the Scallops or Fan-shells (*Pecten*), in which the dissimilarity of the two valves is very pronounced. *Pecten maximus* is the species of the greatest commercial importance, from its large size, occasionally as much as eight inches in diameter. Although usually resting on the deeper right valve, scallops sometimes display considerable activity, and swim vigorously through rapidly opening and closing the shell by

FIG. 32.—FIDDOCK IN THEIR BURROWS IN STONE.

FIG. 33.— BORING MOLLUSCS PIDDOCK AND SHIP-WORM, THE
 LATTER WITH THE MUCH REDUCED VALVES SHOWN DETACHED.
 (AFTER GWYN JEFFRIYS.)

flapping movements. The body is brightly coloured, some of the organs being of a vivid orange; the foot is small and of no service in locomotion; the margins of the mantle are frilled, and bear a row of conspicuous black eyes of considerable complexity, in relation, no doubt, with the active habits of this mollusc. *Pecten opercularis* and *P. varius* are smaller species, the latter rarely exceeding one and a half inches in width, and varying in colour from whitish to bright yellow, orange or red. The scallops are hermaphrodite.

The Pelecypods further include various molluscs which, owing to their powers of excavation, cause considerable damage to wooden piles, and even the stonework of piers and jetties (Fig. 32). Such borers have usually taken on a somewhat worm-like shape, though retaining the bivalve shell. The Piddock or Stone-borer (*Pholas dactylus*) is common, and considered an excellent bait for certain fishes (Fig. 33). Its shell is thin and brittle, of a pure white colour, and gaping at each end, the siphons project behind and the foot in front. The siphons are long and stout, and, being united along their whole length, contribute to the animal's vermiform appearance; the foot is short and truncated, and probably acts as the chief excavating organ, although the sharp and rasp-like edges of the shell serve to supplement its action. The Piddock can bore not only in chalk and limestone, but even in slate and other except the very hardest rocks, making tubular excavations exposed at low water. Dr. Murie describes these molluscs as common at the base of the chalk cliffs near Margate and in the neighbourhood of Dover; the blocks of stone forming the Folkestone pier are also said to be full of holes tenanted by *Pholas*.

The Ship-worm (*Teredo navalis*) is a still more remarkable bivalve, extraordinarily destructive to timber in many districts (Fig. 33). Vermiform and from six to twelve inches long, *Teredo* would scarcely be recognised as a mollusc were it not for the small shell-valves at the anterior extremity, much too small to shelter the whole animal, which therefore secretes a thin supplementary shell round the tube-shaped body. The worm-like shape is due largely to the great elongation of the fused siphons. The shipworms excavate long parallel galleries in almost every kind of timber, thus causing serious damage to wooden ships, piers, etc. The boring is performed by the sucker-like foot, and the *débris* are ejected by the respiratory current through the exhalent siphon.

In concluding this brief survey of our bivalve molluscs, it may be well to advise the amateur naturalist to pay more

attention to the animal than to the shell when, as at the seaside, he is in a position to examine both. Far from deprecating the formation of a collection of shells, we only wish to point out that the interest in these beautiful or curious objects is much enhanced by a knowledge of the structure of their tenants. We can gain some idea of them by an inspection of the inner side of an empty bivalve shell, where distinct impressions are left by some of the more characteristic organs of the animal. Scars caused by the insertion of the large muscles which extend from one valve to the other and close the shell will tell at a glance whether one or two of these organs were present; if two whether they were equal in size or not, while a narrow line connecting these scars and running nearly parallel with the edge of the valve is the impression left by the muscular border

FIG. 34.—INSIDE OF LEFT VALVES OF CITHEREA CHIONE AND PECTEN VARIUS; *h*, THE HINGE LIGAMENT; *a a*, SCARS OF ADDUCTOR MUSCLE; *p a*, POSTERIOR ADDUCTOR; *p i*, IMPRESSION OF FOOT; *p*, PALLIAL LINE; *s*, SINUS OCCUPIED BY RETRACTOR OF SIPHON.

of the mantle (Fig. 34). This line, termed the pallial line (from pallium, mantle), if incurved near one of the muscle-scars, reveals the presence of a retractile siphon, and its degree of curvature is an index to the size of this organ in the animal.

The Scaphopods (the name meaning spade-foot) form the last principal group we have to mention. It is a quite small group, including only the peculiar Tooth-shells, represented with us by *Dentalium elephantinum*, the shell of which is suggestive of an elephant's tusk in form and whiteness, but hollow throughout and open at each end. The animal is slender, and its foot, which may be seen projecting from the wider anterior orifice, is conical in shape and provided with two

FIG. 35.—WOOD BORED BY SHIP-WORM.

lateral lobes. As in the Pelecypods, there is no distinct head ; eyes and gills are also absent. The sexes are separate. The Tusk-shells may be found living buried in mud or soft sand on the limit of low-water mark, and empty shells are among the common objects of the beach in some localities. When buried, the posterior or thinner extremity of the shell projects to give access to the respiratory current.

FIG. 36.—TOP-SHELL, *TROCHUS ZIZYPHINUS* (AFTER WOODWARD).

IV.--CRUSTACEANS AND OTHER ARTHROPODS.

THE Crustaceans form a subdivision of an enormous group of invertebrate animals known as the Arthropods (jointed-limbed), which includes, besides the Arachnids (Spiders, Scorpions, Ticks, etc.), the Myriopods (Centipedes and Millipedes) and the Insects. In their typical form they may be distinguished from the other Arthropods by the presence of two pairs of antennæ or feelers on the front part of the head, and also by the larger number, combined with great diversity in structure, of the limb-like appendages carried by the jointed body. The majority of Crustaceans breathe by gills, which are generally developed from the appendages; many of the lower forms are devoid of special organs for this function. After the Insects, the Crustaceans probably constitute the largest of all classes of animals, and, although mainly marine, they have representatives in almost every possible situation, in fresh waters, and even on land. The most familiar forms are naturally such as find place on the fishmonger's slab; the lobster, crawfish, prawns, shrimps and crabs are excellent examples of what are known as the higher Crustaceans. A rapid inspection will show that these types agree in many important characters, the body being divided into a large firm carapace bearing a pair of stalked eyes anteriorly, and a jointed abdomen, popularly but quite erroneously regarded as the tail, consisting of six rings or segments and ending in a flat piece or telson, the true tail. Both the carapace and the abdomen bear limb-like appendages modified to subserve almost every purpose. The first two pairs are antennæ or feelers, situated to the front of the carapace; on the lower surface, surrounding the mouth, there are six pairs set close together and acting as jaws, while the posterior part of the carapace bears five pairs of long walking-legs, some of which may form pincers at their extremities. The rings of the abdomen are provided with swimmerets, two-rayed appendages used in swimming. The five pairs of walking-legs are by far the most conspicuous of these appendages, and for this reason the name Decapoda has been bestowed on this division of the higher Crustaceans. Even the most superficial observer will notice

that these Decapods fall into two main divisions, according to the condition of the abdomen—one in which it is conspicuous and stretched out, as in the lobster; the other in which it is reduced and held permanently flexed in a groove on the lower surface of the carapace, as in the crabs. The forms with conspicuous abdomen have been named long-tailed, *Macrura*; the

FIG. 37.—LOBSTER.

carapace is generally shorter than the abdomen and is produced in front into a pointed "prow" or rostrum, the eyes are not sunk in orbits, and the abdomen terminates in a fan-shaped flap formed by the tail-piece and the enlarged last pair of appendages. For practical purposes the *Macrura* may be divided into creeping and swimming forms. The former include our two most important edible crustaceans, the lobster and the crawfish or spiny lobster (*langouste* of the French hotels). The Lobster (*Homarus vulgaris*), too well known to require description here, lives among rocks well below low-water mark, and is not often seen close to the shore (Fig. 37). It breeds between July and September, and the eggs, three thousand to ten thousand in number, are carried by the female, attached to the abdomen; they take ten to twelve months to hatch, and the free-swimming larvæ which issue from them require four months before attaining the perfect form and assuming the crawling habits of their parents. The growth is a slow one; six to ten years are required for a lobster to reach a length of ten inches, and it has then passed through something like twenty moults since it left the larval condition. In moulting, the fleshy parts of the limbs are withdrawn first, and the whole animal then passes out through a slit between the thorax and abdomen. The operation does not take more than half an hour, but it requires three or four weeks before the new carapace acquires its full thickness and hardness. While in the soft condition, after leaving its

shell, the lobster seeks shelter in holes, its presence being often betrayed by the empty armour lying in proximity.

This moulting or ecdysis is rendered necessary by the hard nature of the outer covering of the body and limbs, an armour, secreted by the skin, which, being incapable of increasing in size, must be cast off entire as the underlying soft tissues grow (Fig. 38). Considering the small calibre of the basal segment through which

FIG. 38.—HOW A MOULTING LOBSTER WITHDRAWS THE MUSCLES FROM ITS CLAWS.

the fleshy parts of the enlarged claw of many crustaceans have to pass in this moulting operation, the process seems wonderful, but is explained by the fact that, just before ecdysis, the water and blood which swell the muscular part are withdrawn and cause the tissues to shrivel up to such an extent as to allow its being forced through a narrow opening. The parts of the limb are very much distorted immediately after their release, but they soon resume their natural form with a proportionate increase in size. A diagrammatic sketch of a lobster's claw is here given to make the explanation clearer. In this sketch the fleshy or muscular part of the claw, just before the moult, is represented by a dotted area, showing how this part shrivels to insignificant proportions in order to pass through the small calibre of the basal segments. As soon as the animal is released from its shell, the claw becomes turgid with water and blood, and in a very short time swells out to even a larger size than before.

The Crawfish (*Palinurus vulgaris*) differs chiefly from the Lobster in having no large pincer-claws. It is not uncommon in the Western parts of the Channel, but becomes rare in the North. The swimming forms comprise the equally familiar creatures divided by the fishmonger into shrimps and prawns, according to size, a classification which, however convenient it may be for trade purposes, is without meaning to the naturalist, who distinguishes many species irrespective of size. The true shrimp (*Crangon vulgaris*) is easily recognised by the slightly flattened carapace and the small size of the prow or rostrum, here reduced to a minimum (Fig. 39). The first walking-leg ends in a comparatively large pair of pincers of a peculiar type, the last joint folding back over the penultimate like the blade of a pen-knife. One of the most abundant of the coast species, it is found with us wherever there is a plentiful supply of fine sand. When alive, it is of a speckled grey colour, harmonising with its surroundings; boiled, it is of a reddish-brown tint—the brown shrimp of commerce. In size it rarely exceeds two inches and a-half. The majority of the other edible forms of this division fall into two genera, *Pandalus* and *Leander* (*Palæmon*), and, according to their size, are sold as shrimps or prawns; of a bright pink when boiled, the smaller specimens of these genera are called pink shrimps. They further differ from the brown shrimps in having the carapace rounded, not depressed, and in being provided with a long, saw-like rostrum. The largest British prawns belong to the genus *Leander* and attain

FIG. 39.—SHRIMP (*CRANGON VULGARIS*).

a length of four and a half inches. In this genus the first two pairs of walking-legs have pincers of the ordinary type. The various species frequent rocky parts of the coast, and small specimens are found in abundance in rock-pools. *L. serratus*, the commonest species, is grey, spotted and banded with dark purplish brown (Fig. 40).

Pandalus annulicornis, almost equally abundant, is distinguished from the preceding by the conformation of the walking-legs; the pincers are minute and the second pair of legs filiform and curiously asymmetrical, one being considerably longer than the other. It is particularly common on the East Coast, rarely exceeding three inches in length.

FIG. 40.—PRAWN (*LEANDER SERRATUS*).

The coloration resembles that of *Leander*, but the markings are of a rather more reddish tint. Closely allied to the edible species is a little shrimp called *Hippolyte varians*. Too small to be of any economic value, as it rarely exceeds three-quarters of an inch in length, it is one of the most common forms in rock-pools on the South Coast, found clinging to weeds of different kinds. It is easily recognised by the shape of the abdomen, abruptly bent downwards at the third segment, producing the peculiar appearance which has given rise to the name of hump-backed shrimp often applied to it. Special interest attaches to this little creature, owing to its changes in coloration. The name *variens* is most appropriate, as this shrimp harmonises most accurately with the weeds upon which it rests, sometimes assuming the dark brown colour of a fucus, sometimes the bright red or vivid green of other algæ. The coloration varies not only in different individuals, but each one seems able to assimilate to almost any shade offered by its surroundings.

No group of Crustaceans arouses more the interest of the seaside visitor than the different kinds of crabs. The Brachyura, or "short tails," as the crabs are called, show a striking contrast to the Macrura, or "long tails," like the lobster. The carapace is flattened and broad, the eyes are sunk in the orbits, the

FIG. 41.—1, SHORE CRAB; 2, EDIBLE CRAB; 3, SWIMMING CRAB.

FIG. 42.—SPIDER-CRAB COVERED WITH WEEDS.

abdomen, popularly but erroneously regarded as the tail, is reduced in length, without expanded tail-flap, and permanently flexed, while the appendages of this region of the body are considerably modified. The most common with us is the shore crab (*Carcinus mænas*), and it is also the most conspicuous as it has the power of remaining for a considerable time out of water and is seen running at low tide on the sand or on the mud-flats of estuaries. It is dark green above, reddish below in adult specimens, green, mottled with white and black, in the young. The carapace, or shield protecting the body, is slightly broader than long, with the margin deeply toothed in front. Much eaten by the poorer people on the coast, it does not often find its way to the London market. The edible crab (*Cancer pagurus*) is the most esteemed for the table, occasionally measuring as much as eleven inches in width, and weighing up to twelve pounds (Fig. 41). The carapace is much broader than long, with smooth anterior margin, pale reddish-brown above, sometimes with a purplish tinge, and the big claws are tipped with black. The edible crab is far more aquatic than the shore crab, and soon dies when removed from the water. The adults are only found at some distance from the shore, but young specimens are occasionally met with nestling under stones in rock-pools. In such situations we may come across another crab which bears a strong resemblance to the shore crab in the shape of the carapace—the swimming crab (*Portunus puber*), readily distinguished by the shape of the last pair of legs, with the terminal joints flattened and paddle-shaped, for the purpose of swimming and digging in the sand.

In the three species considered so far the carapace is broad and truncate in front. In the spider crabs it is almost triangular, tapering anteriorly into a prominent rostrum. The spiny spider crab (*Maia squinado*) is commonly found in shallow water about tidal rocks. Next to the edible crab it is the largest of the British Brachyura, reaching a length of eight inches. The carapace is studded with spines and the rostrum is forked. This crab is usually overgrown with seaweeds and zoophytes, which render it highly inconspicuous in its natural surroundings (Fig. 42). This growth is not entirely due to the sluggish habits of the crab, as formerly believed; it has been observed to deliberately insert the weeds on its dorsal surface, to the rugosities of which they readily adhere. The spiny spider-crab (Fig. 43) is only eaten by the poorer classes in England, but it finds a ready sale on the markets in the North of France. Several other spider-crabs occur more or less frequently on our coasts,

FIG. 43.—SPINOUS SPIDER-CRAB (AFTER BELL).

and among these we may mention the scorpion spider-crab (*Inachus dorsettensis*) similar to *Maia*, but much smaller and with a smooth carapace (Fig. 44).

In crabs, as in nearly all Decapod (ten-footed) Crustaceans, the eggs are carried by the mother, attached to the swimmerets

FIG. 44.—SCORPION SPIDER-CRAB (AFTER BELL).

on the ventral side of the abdomen, crabs in this condition being said by fishmongers to be "in berry." Since the abdomen of the Brachyura has ceased to assist in locomotion, this is its only function, and the organ is therefore much better developed

in the female than in the male, in which it is very narrow and with the swimmerets much reduced in number. The majority of marine Decapods are not hatched from the egg in the form of the adult, but pass through a number of larval stages, which are of great interest as affording, in many cases, a clue to the ancestry of the different forms (Fig. 45). These larvæ vary considerably according to the genera, but the following short account of the development of the common shore crab will give a general idea of the transformations to which a Crustacean is subject in the course of its life.

The young leaves the egg as a tiny transparent larva, just visible under a strong lens. From this

FIG. 45.—LARVÆ OF *CARCINUS MOENAS* (AFTER BELL).

early stage the crustacean characters are already apparent, carapace and abdomen are well developed, but the eyes are sessile, not stalked or pedunculated, and the walking-legs and swimmerets are absent, locomotion being effected by the more anterior appendages which, later in life, function as mouth parts. This little larva, known as *Zoëa*, swims about the surface of the sea, feeding voraciously and undergoing a series of moults, in the course of which the hinder appendages of the carapace and abdomen gradually appear. Later on the eyes acquire stalks and the carapace broadens, the larva reaching the stage known

as *Megalopa*, similar to a little crab, except for the abdomen, which is carried extended. In this last condition the larva swims actively for a little time, and then sinks to the bottom, where, after one more moult, the perfect form is attained. The crab is then about the size of a lentil, and grows larger and larger at each successive moult.

The development of such a typical Brachyurous form suggests that the crabs are derived from "long-tailed" ancestors, and, as

FIG. 46.—SCALY GALATHEA (AFTER BELL).

last pair of walking-legs. One very common representative of this group, the Squat-Lobster (*Galathea squamifera*), is often found under stones at low tide (Fig. 46). It is about three inches long, of a dark greenish brown colour, and has somewhat the appearance of a little lobster, the carapace and abdomen being almost equally developed, the latter ending in a fan-like tail. Its position among the Anomura is indicated by the very small size of the last pair of legs and by the way in which the abdomen

a matter of fact, forms filling the gaps between the two extremes exist in Nature. Such intermediate types, which cannot find a place either among the Macrura or among the Brachyura, are assigned to a separate division, Anomura (irregular tails), the members of which differ widely from one another, some being suggestive of lobsters, others of crabs; yet all agree in having the abdomen modified to some extent, the essential characteristic being the reduction in size of the

is carried bent below the carapace, although not fitting into a groove as in the Brachyura. Other forms of this group bear a strong resemblance to the true crabs. On lifting up stones on a rocky coast we cannot fail to come across the little creatures known as Porcelain Crabs (*Porcellana platycheles*) in which the appearance is absolutely Brachyurous (Fig. 47); yet, if the abdomen be spread out, it will be found to terminate in a tail-fan as in the Macrura, and the peculiar reduction of the fifth pair of legs is carried so far as to convey the impression, at first sight, that only three pairs of legs are present in addition to the large flattened pincers. The porcelain crab exhibits very well the phenomenon known as self-mutilation or autotomy, which is common to many Crustaceans. When disturbed it takes up a quite pugnacious attitude, raising its pincers; if, however, one of these be seized, it is promptly cast off while the crab, thus re-

FIG. 47.—PORCELLANA PLATYCHELES (AFTER BELL).

FIG. 48.—COMMON HERMIT CRAB (AFTER BELL).

leased, makes its escape, and, in the course of time, regenerates the voluntarily amputated limb. When the limb of a crab is injured at some point it is cast off by a sudden jerk, to provide

for its regeneration from the base, the tissues of which are conformed for the purpose.

The most interesting members of the Anomura are undoubtedly the Hermit Crabs, represented by several species on our coasts (Fig. 48). *Eupagurus bernhardus* is the largest and commonest. The abdomen is imperfectly segmented and devoid

FIG. 49.—OPOSSUM SHRIMP (AFTER BELL).

of armour, thus necessitating protection, for which purpose the empty shell of a mollusc is selected. The appendages of the abdomen are in a reduced condition, and the last pair, instead of forming a tail-fin, is modified into a special organ which helps the animal to fasten itself to the deeper recess of the shell. The last two pairs of walking-legs are reduced, but the pincers are well developed and of unequal size, the right being the larger and serving as an operculum to cover the mouth of the shell when the hermit withdraws into his dwelling, as shown on the right hand of Fig. 50. *Eupagurus bernhardus* grows to a length of about five inches, and, in the adult state, requires the shell of a whelk; younger specimens, most frequently met with in rock-pools, select smaller shells, such as those of the winkle, the *Trochus* or the screw-shell.

Although the Decapods include the more conspicuous forms, members of this division represent but a very small proportion of the Crustaceans of our shores. The representatives of the less highly organised divisions are for the most part of very small size and, therefore, escape attention from the more superficial observer. The Crustaceans which come nearest to the Decapods are those known as Schizopoda, of which *Mysis flexuosa*, the Opossum Shrimp, is a common representative, found in abundance in sandy pools at low tide (Fig. 49). *Mysis* has the general appearance of a small shrimp, but is easily recognised by the number and structure of the appendages below the carapace; there are no walking-legs, their place being taken by seven pairs of biramous swimming legs. During the breeding season, the females carry their eggs in a kind of brood-pouch

FIG 50.—HERMIT CRAES.

below the carapace, a feature to which the popular English name is due. Like the little shrimp (*Hippolyte*) previously mentioned, the opossum shrimp can make itself almost invisible by assimilating to the colour of its surroundings, passing from light grey to dark brown, or even black, within the space of less than half an hour. As in the decapods, the eyes of *Mysis* and its allies are stalked, the majority of the lower crustaceans having these organs sessile and almost flush with the surface of the head.

Everyone who has walked or sat on a sandy beach at low tide is familiar with the little Sand-hoppers (*Talitrus saltator*)

FIG. 51.—SAND-HOPPER (AFTER SARS).

which appear in thousands, leaping and skipping about with extraordinary agility (Fig. 51). The Sand-hopper belongs to a division of sessile-eyed Crustaceans known as Amphipods, in which a conspicuous carapace is absent, nearly the whole of the much-compressed body being ringed or segmented. The peculiar jumping movements are produced by the sudden straightening out of the muscular abdomen, the last three segments of which are provided with special rod-like appendages modified for the purpose; the remainder of the appendages of the body consist of pincers, walking-legs and swimmerets. The Sand-hoppers have

taken to an almost terrestrial existence, yet keeping to the immediate vicinity of the sea ; but the closely related *Gammarus* (Fig. 52) is entirely aquatic, although often found under stones

FIG. 52.—*GAMMARUS LOCUSTA* (AFTER SARS).

on the wet beach, its peculiar way of wriggling along on the side accounting for the popular name, "scud," often applied to it. Other types are to be found in tufts of seaweeds, and among them the extraordinary skeleton shrimps, *Phtisica* and *Caprella* (Fig. 53), representatives of another family of Amphipods. With their slender, elongate body, long antennæ and walking-legs, they are the stick-insects of Crustaceans, and their tenuity renders them almost invisible when clambering among the delicately branched seaweeds and zoophytes. As adaptations to a terrestrial existence, the sand-hoppers are even surpassed by some of the Isopoda, resembling the Amphipods in their

FIG. 53.—*CAPRELLA LINEARIS* (AFTER SPENCE BATE).

sessile eyes and ringed body, which is, however, depressed instead of compressed ; the seven pairs of walking-legs are similar to one another, at least in the typical forms. The Sea-slater

FIG. 54.—ACORN-BARNACLES ON ROCK.

FIG 55 BUNCH OF GOOSE BARNACLES.

(*Ligia oceanica*) is one of the largest British Isopods, found running on rocks (Fig. 56). Although essentially terrestrial, the sea-slater never occurs far from the sea, thus differing from its near relatives, the wood-lice and pill-bugs. Most Isopods are aquatic, and many species of small size occur among weeds in rock-pools. The little *Euridice pulchra*, only two lines long, is a thoroughly aquatic Isopod, found swimming in puddles on the sandy beach, as well as in the sea, where it is said to bite people bathing.

The Crustaceans dealt with so far are free-living and exhibit the full characteristics of the group. But a large number of

FIG. 56.—SEA-SLATER (AFTER SARS).

forms, belonging to nearly all the principal divisions, have become adapted to a very different mode of existence, have lost the power of locomotion, and live attached to stones, boats or larger animals. Such fixed Crustaceans are for the most part curiously degenerate, and their position in the zoological system could only be ascertained by a knowledge of their development. The most familiar of these forms are undoubtedly the Cirripedes or Barnacles. We all know the acorn barnacles, or acorn-shells (*Balanus*), which cover rocks and stonework washed by the tides, to the inconvenience of bathers and bare-footed investigators of the rock-pools (Fig. 54). When seen attached to a rock at low tide, a barnacle shows no signs of life, the body being enclosed in a

hard shell consisting of many pieces, some of which form valve-like plates which completely close its orifice.

FIG. 57.—CYPRIS LARVA OF SACCULINA, SIDE VIEW (AFTER DELAGE).

When the rock is washed by the sea, these plates gape apart and expose six pairs of fringed appendages, by means of which floating organic particles are captured and used as food. The goose-

barnacle (*Lepas anatifera*) is provided with long stalks which form bunches attached to floating timber and boats, and, after storms, these bunches are sometimes washed ashore (Fig. 55). Like most fixed animals, the majority of Cirripedes are hermaphrodite. The larval stages, as we have said, fix the position of these curious creatures in the classification. The young leaves the egg as a microscopic pear-shaped creature with three pairs of appendages only; such a larva is known as a *Nauplius*, and is characteristic of many divisions of the Crustaceans (Fig. 58). The *Nauplius* passes after a series of moults into a second larval form, the *Cypris* (Fig. 57), which has the whole body enclosed in a large, loose carapace, with eyes and feelers, as well as six pairs of biramous limbs. After a short free-swimming existence, the *Cypris* fixes itself, head downwards, to some solid object by means of its feelers; the eyes disappear, and calcareous plates are developed in the carapace, thus forming the hard shell of the adult.

FIG. 58.—NAUPLIUS LARVA OF SACCULINA, LOWER VIEW (AFTER DELAGE).

FIG. 50. —CRAB WITH PARASITE (SACCULINA).

FIG. 60. —PRAWN WITH PARASITE (BOPYRUS).

The true barnacles are occasionally attached to other animals, without deriving from their hosts any greater benefit than that of support. Many Crustaceans, however, are, strictly speaking, parasites, living entirely at the expense of other aquatic animals, often of their own class. These parasitic forms are for the most part extremely degenerate, and, as in the barnacles, the clue to their systematic position is afforded by their larval stages. A good example is offered by a near relative of the barnacles (*Sacculina carcini*) appearing as an oval, cushion-like body attached to the under-surface of the abdomen of many individuals of the shore crab, and also of other crabs. The parasite shows no indication of its crustacean nature, all locomotory and masticatory organs are absent, food being drawn from the host by means of long branched filaments which ramify throughout the body of the crab. We know that the *Sacculina* is a Crustacean, and must be placed among the Cirripedes, because its early life-history is almost identical with that of a barnacle, the development including the Nauplius and Cypris stages, after which the larva introduces itself into the body of its future host (Fig. 59). Similar degeneration in connexion with parasitic habits occurs in many of the other divisions of the Crustaceans. Among the Isopods, species of *Bopyrus* are common parasites living under the carapace of shrimps and prawns, causing the peculiar swellings so often noticeable on the sides of these animals (Fig. 60).

The Arachnids are nearly related to the Crustaceans. In addition to microscopic Acarians (Mites), they are represented on our rocky shores by two or three species of Pseudo-scorpions of the genus *Obisium*, tiny creatures about a line in length, half-way between Spiders and Scorpions, living among stones overgrown with fucus, which keep them damp when the tide withdraws. The original figure of *Obisium maritimum* (Fig. 61) is reproduced here. The Myriopods are represented by two species of Chilopod Millipedes: *Geophilus maritimus* (Fig. 62), first discovered at Polperro in Cornwall and since found in Devonshire, Brittany, Normandy and Scandinavia; and *G. submarinus*, originally described from near St. Malo and since obtained on Jersey and at Polperro. They live in fissures in rocks and under stones and seaweeds washed by the sea at high tide. These are yellowish-brown in colour and measure a little over an inch in length.

Even the class of insects, or Hexapods (six-legged), must be mentioned before dismissing the Arthropods, for, many

of our readers may be surprised to hear, several essentially marine representatives occur on our coasts, forming rare exceptions in this by far the most numerous of all groups of animals. The five principal will be mentioned here. Three belong to the order Coleoptera, or Beetles, in which (normally) a pair of membranous wings folds when at rest under a pair of hard sheaths known as elytra. One of these is called *Aëpus marinus* or *fulvescens* (Fig. 63); yellowish-brown in colour, one and a-half to two lines in length, with the elytra nearly entirely covering the abdomen as in the Ground-beetles (*Carabidæ*), to which it is related; the eyes are minute, partly covered by a shield; wings are absent. The second, *Aëpus robini* or *brachelytra*, is distinguished by shorter elytra. The third, *Micralymma brevipenne*, is slightly larger and has the elytra still more reduced, the abdomen being nearly entirely exposed above and covered with hard transverse lamellæ; its nearest ally is the common black Cock-tail (Rove-beetles, *Staphylinidæ*). These tiny beetles hide under stones that are covered by the sea for several hours every day, or even, at neap-tides, for several days in succession. As their respiratory organs do not differ from those of other insects, they probably have to suspend respiration, unless enough air remains in form of bubbles attached to the hairs of the body; but *Aëpus* is provided with a pair of air-sacs in the abdomen, affording, no doubt, a reserve of air for prolonged submersion. The fourth marine insect to be mentioned is *Anurida maritima* (Fig. 64), of the group *Collembola* (order *Aptera*), small wingless creatures undergoing no metamorphoses (contrary to the general rule in insects), the more typical forms being called "Spiny-tails," from their habit of leaping by means of a forked appendage to the abdomen, appearing as a pair of bristles. This appendage is, however, absent in *Anurida* (a name meaning "tailless"), a minute black insect only one line in length, found creeping about rocks and under stones, or floating on the surface of small rock-pools, and retreating into narrow fissures or empty barnacle-shells when the tide rises; in such a shelter, whence it cannot be dislodged by the waves, it may remain hours under water. The fifth example, *Machilis maritima*, belongs to another group of *Aptera*, the *Thysanura* or Bristle-tails, and measures a quarter of an inch in length: it is distinguished from *Anurida* by the three long bristles in which its abdomen terminates, the median being nearly as long as the body; the antennæ are also very long. This insect is found about rocks, sometimes under stones, sometimes on the sides of a rock-pool, running along swiftly or leaping when

FIG. 61.—OBISIUM MARI-
TIMUM (AFTER LEACH),
MUCH ENLARGED.

FIG. 62.—GEOPHILUS MARITIMUS (AFTER LEACH),
MUCH ENLARGED.

FIG. 63.—AEPUS MARINUS (AFTER
DU VAL), MUCH ENLARGED.

FIG. 64.—ANURIDA MARI-
TIMA (AFTER LABOUL-
BENE), MUCH ENLARGED.

disturbed. Other small insects are common on the beach, burrowing in wet sand or hiding under stranded seaweeds, either in the perfect condition or as maggots, and usually undergoing a short daily immersion. Some larvæ of Diptera (two-winged insects like the flies) normally live in the sea, which they only leave as perfect insects.

V.—WORMS.

WORMS, in the wide sense, is the name usually given to a large assemblage of animals, comprising a great variety of forms, some commending themselves to the lover of beautiful things in Nature, and quite unlike the miserable creatures which the name suggests to the popular mind. The rambler on the seashore cannot fail to come across a few at least of the more conspicuous representatives of this division, and, in the case of some, he may be surprised to hear they are classed as worms. As a matter of fact, the division is incapable of a simple definition. All we can say is, that Worms include lowly forms of life with bilateral symmetry that can be assigned neither to the Molluscs nor to the Arthropods, which, as we have said in the preceding chapter, include the Crustaceans. The higher worms, with which we shall start, approach the Centipedes and Crustaceans in the ringed or segmented nature of the body, differing chiefly from them in the structure of the

FIG. 65.—A POLYCHÆTE WORM, *NEREIS PELAGICA* (AFTER JOHNSTON).

appendages or limbs, which are quite different from the Arthropod type. These higher forms are grouped as Annelids, with reference to the rings into which their body is divided. The majority are characterised by the possession of peculiar tough bristles, called chetæ, which are particularly numerous in a multitude of marine types termed, for this reason, Polychætes (many bristles). These worms are to be found abundantly between tide-marks, and many are of a certain economic importance as affording most valuable bait to fishermen. One of the commonest of British Polychætes is *Nereis cultrifera*, a slender worm, some six to twelve inches long, found below stones and in crevices of rocks (Fig. 65). It is of a greenish colour, with a thin red line along the middle

FIG. 66.—PADDLE-WORM (PHYLLODOCE PARETTI), FLAT-WORM (LEPTOPLANA TREMELLARIS), AND
NEMERTINE LONG-WORM (BORLASIA TRILINEATA).

of the back, marking the position of one of the main blood-vessels; the lower surface is lighter, often beautifully iridescent. The body is composed of a large number of segments, the first and last of which are modified to form the head and tail respectively. As in the Crustaceans, each segment bears a pair of locomotory appendages or feet, which, however, are not jointed, each being provided with two bundles of bristles and with a pair of little finger-shaped sensory organs, termed cirri; these feet are used for walking and swimming. Bristles are absent from the head segment, but the cirri are enlarged on that region, forming a number of sensory tentacles which, in all probability, are put to the same use as the feelers of insects and crustaceans. The head also bears two pairs of small eyes. A pair of cirri are present on the tail. *Nereis* is carnivorous, and when feeding, chiefly on other annelids and crustaceans, protrudes a muscular proboscis armed with strong jaws. The sexes are separate, and the breeding individuals undergo a peculiar seasonal transformation, the eyes increasing in size and the feet of the hinder part of the body acquiring a paddle shape, modifications of structure which go hand in hand with a marked change in the habits, the worms in this condition displaying an increased activity, swimming great distances and often appearing at the surface of the sea. Many species are found in the same situations. *N. pelagica* is a little smaller than *N. cultrifera*, and reddish brown in colour.

Many common Polychætes have the feet permanently modified for swimming, the cirri being transformed into leaf-like expansions, as in the Paddle-worm (*Phyllodoce lamelligera*), which may attain a length of two feet (Fig. 66). This is one of the most beautiful of our littoral worms, the body being of an iridescent blue, with the feet olive-green or brown. While the slender and elongate form prevails in many of our marine Annelids, not a few of them are less typically worm-like. On lifting up stones at low water we may often come across the little *Polynoë squamata* (Fig. 67), characterised by a very short and broad, much flattened body an inch and a half long, with two rows of large, overlapping scales, these scales being expansions of the feet. Still less

FIG. 67.—POLYNOË SQUAMATA (AFTER JOHNSTON).

like a worm, looking more like a hairy slug, is the larger ally of *Polynoë*, the Sea-mouse (*Aphrodite aculeata*), one of our most extraordinary Polychætes (Fig. 69). Oval in shape and three to six inches in length, this animal is distinguished by the enormous development of the bristles, some of which are highly iridescent and occupy the sides of the body, while others are long and hair-like and woven into a kind of felt protecting the whole dorsal surface. If this coating of hair-like bristles be removed, fifteen pairs of scales, similar to those of *Polynoë*, will be found to cover the body. The Sea-mouse lives in fairly deep water, but specimens are frequently washed ashore after storms.

The Lug-worm, *Arenicola marina* (Fig. 68), so much sought for as bait for fishing, is very different in its mode of life from the forms just mentioned; it is a burrower, and occupies much the same position in the sea as the earth-worms on land, its shape as well as its brownish colour being highly suggestive of those well-known creatures. It is, however, by no means closely related to the earth-worms, being a Polychæte, with the feet much reduced in accordance with the burrowing habit; on the front segments of the body these organs are represented by a few bristles only, while further back they are somewhat better developed, and bear, in addition, branching filaments, modified cirri, which act as gills. Everyone who has walked along the sea-shore must be familiar with the curious castings or sand-ropes

FIG. 68.—LUG-WORM (*ARENICOLA MARINA*).

made by the Lug-worm burrowing in muddy sand; the worm swallows great quantities of sand in order to assimilate the small organic particles mixed with it, and passes through the vent the indigestible residue, which is heaped up on the surface in

FIG. 69.—SEA-MOUSE. SEEN FROM ABOVE AND BELOW.

FIG. 70. TUBICOLOUS WORM *PECTINARIA BELGICA*).

vermiform coils; the whole underground burrow is U-shaped, and a small, funnel-like hole in the sand, at some distance from the casting, indicates the position of the animal's head. The walls of the burrow are to some extent strengthened by a sticky secretion from the body of the worm, but many Polychætes go further and construct definite tubes, in which they dwell. As an example of a tube made exclusively of mud and slime, we may mention that of the common *Amphitrite johnstoni*; in other worms the tube may be strengthened by the addition of grains

FIG. 71.—ANTERIOR EXTREMITY OF AMPHITRITE JOHNSTONI (AFTER CUNNINGHAM AND RAMAGE).

of sand, bits of shells, or even calcareous matter secreted by the animal itself. On turning over stones in muddy places the presence of *Amphitrite* (Fig. 71) is often revealed, not by the tube, which is sunk in the mud, but by the head of the worm, furnished with a large number of long, slender, reddish filaments, the movements of which attract attention. The first few segments of the body bear gills, somewhat similar to those of the Lug-worm. The Sand-mason Worm, *Terebella conchilega*, is similar to the preceding, but protects itself by a rudely constructed tube of sand-grains and shell débris, cemented together by a special secretion. The tube is easily detected on the beach at low tide on account of the peculiar fringe surrounding its anterior opening.

Pectinaria belgica (Fig. 70) produces, with the same materials, a much more neatly finished structure, and the tube is almost cylindrical. The name *Pectinaria* (from *pecten*, a comb) refers to the beautiful crown of stiff golden bristles which protects the head, forming a sort of cover to the anterior, slightly wider opening of the tube. The most perfected tube-dwellers among the Polychætes are undoubtedly those which are grouped

together under the name of Serpulids ; in them, not only is the tube formed of hard calcareous matter, but the whole organisation of the animal is modified to subserve a tubicolous existence ; the head, for instance, has been transformed into a collar-like structure provided with a crown of long gill-filaments. The tubular, shell-like tubes of *Serpula* (Fig. 72) and its near relatives have a circular aperture which can be closed by one of the gill-filaments, enlarged to form an operculum. The tubes so often found on empty shells of various molluscs belong to the allied genus *Pomatoceros* ; these differ from those of *Serpula* in having a longitudinal, keel-like ridge. *Spirorbis borealis* (Fig. 73) secretes a spiral tube very similar to the shell of a gastropod mollusc ; such "shells," measuring less than an eighth of an inch across, are commonly found attached to stones or other hard objects, or to the fronds of sea-weeds. The head of the worm is similar to that of *Serpula*, but the operculum formed by one of the gill-filaments is hollow, and performs the unexpected function of a brood-pouch, receiving and storing the eggs during the breeding season.

On some parts of our coasts tubicolous Annelids are sufficiently abundant to form quite a characteristic feature of the landscape. At Whitsand Bay, near Plymouth, as well as at other places, especially on the South Coast, the sandy tubes of *Sabellaria alveolata* constitute thick, rock-like masses several feet in diameter, the animals being gregarious, and building their tubes in close contact, like the pipes of an organ. *Sabellaria* is peculiar in bending its body in two so as to bring the much-narrowed posterior extremity to open close to the mouth of the tube.

On lifting up stones or examining the tangled roots of Laminarian seaweeds examples of a quite different type of worms are often met with, remarkable for their great tenuity and the absence of any trace of segmentation, of feet, bristles or other kinds of appendages. Such worms belong to the group of Long Worms or Nemerteans, of which *Lineus marinus* is a good example. Only from one to four lines in breadth, this species has a length of fifteen to thirty feet when fully developed, a length which is, however, not apparent owing to the close, twisted coils into which the body is thrown. There is no distinct head, the anterior, blunted extremity of the soft body carrying the mouth, through which a thin, trunk-like proboscis can be protruded. *Lineus* contracts to an extraordinary extent ; a specimen several yards in length may shrink to as many inches, and the changes in width are equally striking. Professor

FIG 72.—SERPULA ; INDIVIDUALS
OF SEVERAL SPECIES CLUSTERING
TOGETHER (AFTER QUATREFAGES).

FIG. 73.—SPIROBIS BOREALIS, ON LICHEN FROND, WITH
ENLARGED VIEW OF WORM AND TUBE.

McIntosh remarks that the bodies of several of the elongated forms resemble a semi-fluid substance that can be drawn through any aperture, bent round any angle, and looped, coiled or twisted in the most elaborate manner. These worms are of great fragility, a feature which is compensated by an equally great power of regeneration. All the Nemerteans secrete much mucus, and, like land snails and slugs, leave a slimy trail behind them when progressing on a rock.

The best method of collecting the smaller Nemerteans is to place a number of stones overgrown with algæ and zoophytes in a basin of water; after a short time a number of small creatures will emerge and crawl to the water-line, among them Nemerteans, small Molluscs and Annelids, and probably also examples of the peculiar group of worms known as Flat Worms or Planarians. These represent some of the most lowly-organised forms of the animal kingdom. As in the Nemerteans, the body is naked, unsegmented and without appendages, but it differs in being greatly flattened, almost leaf like, and also in being devoid of a posterior opening to the gut, a small aperture on the lower surface serving both for the ingress of food and the expulsion of undigested matter.

The majority of British marine Flat Worms are oval in outline and of small size, only a few species growing to a length of more than an inch. *Leptoplana tremellaris* is one of our largest species; it is sometimes found in rock-pools on the under surface of stones, especially on such as are coated with colonial Ascidians, *Botryllus* for instance, but difficult to detect unless betraying itself by its movements. The colour of this worm is very variable, white to grey or reddish brown, with the anterior, broader end of the body marked with two little groups of black dots which function as eyes. The usual method of progression in Planarians is by a peculiar gliding motion, but swimming can also be effected by the flapping action of the thin edges of the body.

We will conclude this chapter on worms by referring to the peculiar division known as Polyzoa, of which the Sea-mat (*Flustra foliacea*) is an extremely common example (Fig. 74). Nothing could be less worm-like than the Sea-mat; the uninitiated mistake it for a seaweed, and, as such, dried specimens are often mounted in albums. If, however, one of the leaf-like fronds be examined with a pocket-lens it will be seen to be made up of a large number of tiny oblong cells, arranged like those of a honeycomb; each of these cells contains an animal, which in spite of its size is quite highly organised, possessing a distinct

alimentary tube with mouth and vent, the former being surrounded by a crown of tentacles. This comparatively high organisation of the individual animals distinguishes the Polyzoa from the Hydroid Zoophytes, with which they are often confounded, and which will be described in the last chapter. The Sea-mat is the most conspicuous of our Polyzoa on account of the frequency with which the dried colonies are washed ashore; examination of rock-pools will, however, disclose many other forms, some of which are most delicately branched. In some members of the group the colonies are not ramified but encrusting, as, for instance in the Lace-coralline, *Membranipora*

FIG. 74.—SEA-MAT (FLUSTRA FOLIACEA).

pilosa, which frequently covers seaweeds with the most delicate lace-like tracery.

Having thus briefly reviewed the principal worms and their allies which are large enough to attract attention, we pass on to other forms which differ by the lack of bilateral symmetry, at least in their more typical representatives.

VI.—STARFISHES AND URCHINS.

THESE animals are known scientifically as Echinoderms, a name which means "spiny skin," from the fact that the skin contains calcareous matter deposited in the form of plates or of spicules (a term which has been defined above, page 28), often with spines. They are also called radiate animals, because they present a radial instead of a bilateral symmetry, *i.e.*, their body is not divisible into two equal halves, but is made up of several rays; the body shows no trace of the segmentation which is so characteristic a feature of the Crustaceans and the Annelid worms.

The Common Starfish, *Asterias rubens* (frontispiece) affords a good example of an Echinoderm. The body is enclosed in a tough but flexible skin, supported by plates, and consists of a central disc, from which five finger-shaped arms radiate. The plates of the skin are particularly well developed on the lower side of the arms, where they are oblong and arranged in two rows, meeting at an angle so as to give rise to deep grooves, bordered by spines. The mouth is on the ventral side, and the vent nearly in the middle on the dorsal side of the disc. Locomotion is effected by means of peculiar tubules ending in sucker-like discs, which, arranged in a double row in each groove of the arm, function as feet. These little feet are hollow, and their interior is in communication with a number of canals conveying sea-water, which enters the system through minute holes pierced in a single plate situated on the upper surface of the disc between the bases of two arms. The position of this plate, which occurs in the majority of Echinoderms, tends to show that the radial symmetry of these animals is more apparent than real. When the starfish moves, the tubular feet are protruded and adhere to any surface by means of the sucker-like discs with which they are furnished. The arms are hollow, and contain prolongations of the gut and other organs. *Asterias rubens* has an average span of eight inches; the colour varies much, some specimens being brownish red, others orange, some even violet. The much smaller starfish, *Asterina gibbosa* (frontispiece) is often met with, and may be easily recognised by the lesser

development of the arms, which are scarcely defined from the disc, the whole animal being of an almost pentagonal shape. When alive this starfish is usually of a greenish yellow, sometimes tinged with red.

Solaster papposus is an inhabitant of deeper water, but is sometimes cast ashore; it differs from the forms already mentioned in having an increased number of arms, viz., twelve to fifteen (frontispiece).

Starfishes are omnivorous creatures with distinct predaceous tendencies, and their partiality to bivalve molluscs is only too well known to oyster-growers, whole beds of these valuable shellfish having been destroyed in one night by an invasion of *Asterias*. The suctorial feet are the chief instrument used to open bivalve shells; the finger-like arms embrace the shell, and the suckers exert a steady pull on both valves until the muscle of the mollusc relaxes, when the contents are engulfed by the sac-like stomach, which the starfish is able to evert through its mouth. Starfishes are endowed with remarkable powers of self-mutilation and regeneration; one or more of the arms can be cast off and regrown, and this accounts for specimens being often found with the arms of unequal size. Even a detached arm is capable of producing buds which grow into a complete individual. While probably originally a device for escaping from enemies, like the fragile tail of lizards, this self-mutilation has become, in some forms, a second mode of reproduction, supplementing the normal, which is by eggs. Most starfishes have separate sexes.

The Brittle-stars (Ophiurids) bear a certain resemblance to the starfishes, but this resemblance is very superficial; they belong to a quite different group of Echinoderms. The body is likewise divisible into disc and arms, the latter, however, being narrow and perfectly distinct from the circular disc; they are, moreover, solid, not containing any part of the gut, and lack the suctorial feet, the flexible arms themselves being the locomotory organs. The vent, as distinct from the mouth, is absent, another important difference as compared with true starfishes. A considerable number of different kinds of Brittle-stars occur on our coasts; one is here figured (frontispiece) as a characteristic example, *Ophiothrix fragilis*.

In the Echinoderms known as Sea-urchins or Sea-eggs, the plates of the skin attain their highest development. Large and thick and interlocking with one another, they constitute a continuous and rigid box or shell, which, it may be mentioned, has nothing in common with the shell of a mollusc, being a part

FIG. 75.—SEA-URCHIN (*ECHINUS ESCULENTUS*) WITHOUT THE SPINES.

FIG. 76 SEA-URCHIN *ECHINUS ESCULENTUS*, WITH THE SPINES

of the body itself, as is the carapace of a crab (Figs. 75 and 76). This carapace, or test, to use a more correct term, is covered with erectile spines. The urchins, like most starfishes, are five-rayed, but the rays are not free. Let us examine the large *Echinus esculentus*, a common urchin on our coasts. Its test would be perfectly spherical but for a slight flattening of the lower pole, in the middle of which the mouth is situated. It is entirely covered with movable spines, attached by muscle to knobs or tubercles, the larger spines, stout and pointed, intermixed with others of more slender shape, each of the latter ending in little pincers. These pincers, no doubt, serve to capture small prey, but their main function is to keep the surface of the urchin clean, these creatures never becoming overgrown with weeds or zoophytes, as is the case in so many sedentary or slow-moving marine animals. As already mentioned, the mouth is below. It is provided with a complicated masticatory apparatus, bearing five strong teeth protruding through the aperture. The vent is in the centre of the upper pole, and close to it we find the perforated water-plate which we have mentioned in the starfish. These apertures are best seen on a specimen the spines of which have been removed, or lost after death through decomposition of the soft tissues, as on empty tests thrown up on the beach. We can then follow the arrangement of the plates, in ten meridional zones, each with two rows of plates, alternate zones consisting of plates bearing small apertures, through which long tubular feet protruded when the animal was alive, locomotion in the urchins being effected in the same manner as in the starfishes. The sexes are separate, and the roes of mature examples are very large, affording an article of food in certain countries, especially in Italy. *Echinus esculentus* is of a brownish red, sometimes inclining to violet, and grows to the size of a large orange or grape-fruit. *E. miliaris* is a smaller species, with a more flattened body about two inches in diameter. The spines are relatively larger than in the edible species and of an olive green with pinkish tips. *Strongylocentrotus lividus*, often of a deep purple, occurs in great numbers in some localities, in hollows made by them in limestone and other rocks, often to a depth of ten inches. The excavations are probably the result of mechanical action, and possibly due to the constant movement of the spines, the ends of which may be seen in many cases to be considerably worn. Our Sea-urchins, of which there are a number of species besides those here mentioned, are mostly inhabitants of deepish water near the

coast, but small specimens are not infrequently found in rock-pools, while the more or less damaged tests of adults may be picked up on the shore.

The Heart-urchin, *Echinocardium cordatum* (Fig. 77), derives its name from the heart-shaped test, which has acquired a bilateral symmetry, in accordance with which both mouth and vent have shifted their position as compared to that of typical urchins. The former is on the lower surface near the broad end, the latter almost at the very extremity of the other end. The test is covered with spines of a yellowish colour, harmonising with the sand, more flexible than in other urchins, and more hair-like. The Heart-urchin burrows deep in the sand, at some distance from the shore, and, like the Lug-worm, subsists on the small organic particles extracted from the sand as it passes through the gut.

Although not often met with close to the shore, the Sea-Cucumbers, *e.g.*, *Cucumaria* and *Holothuria*, must be mentioned here in order to call attention to a type of Echinoderms departing very strikingly from the normal. These creatures, belonging to the group called Holothurians, are almost vermiform in shape, the body being elongate and nearly naked (Fig. 78). Mouth and vent open at both ends of the body, and the former is surrounded by a crown of branched tentacles, perhaps respiratory in function. The systematic position of *Cucumaria* is revealed by the characteristic tubular feet, arranged in five double rows equidistant from one another and running in more or less regular series parallel to the length of the cylindrical body. *Cucumaria pentacles* grows to a length of six inches; in

FIG. 77.—HEART-URCHIN.

(*Echinocardium cordatum*.)

C. frondosa, which may measure a foot, one side of the body, the upper, as the animal lies on the sand, is reddish brown, the other pinkish white. The tubular feet are wart-like and irregularly scattered on the lower surface in *Holothuria nigra*, the Cotton-spinner, so called by the Cornish fishermen from its habit of throwing out, through the anal aperture, long sticky, thread-like tubes which they compare to cotton. Another Holothurian, *Synapta inhærens*, only two inches long, is sometimes found in shallow water in Devonshire and Cornwall as well as on the West Coast of Scotland, and may be dug out of its burrows

FIG. 78.—HOLOTHURIANS, SEA-CUCUMBERS: *HOLOTHURIA NIGRA*, *CUCUMARIA PENTACTES*, *SYNAPTA DIGITATA*.

in the sand at low tide. The allied species here figured, *S. digitata*, occurs only in deeper water (ten to twenty fathoms). The body is very elongate and the feet are absent or quite vestigial. With its fringe of tentacles round the mouth *Synapta* might well be taken for a worm, and without entering into lengthly anatomical details, which would surely be out of place in this book, we are unable to demonstrate that it is not a worm, but a highly degraded Echinoderm

VII.—POLYPS, JELLY-FISHES AND SPONGES.

THIS last chapter deals with a number of lowly organised animals, which, on account of their radial symmetry, were once grouped together with the Echinoderms in the large division Radiata. They are now placed in two separate divisions, the Coelenterates (Polyps and Jelly-fishes) and the Porifera (Sponges). All these forms differ from the Echinoderms, and the representatives of the other higher groups, in not having a specialised alimentary tube, the single cavity contained within them subserving all the functions and acting as gut, circulatory system, etc.; sometimes even as a brood pouch. The most familiar Polyps are undoubtedly the Sea-anemones, also the largest and, owing to their great beauty of form and their vivid and varied tints, among the most attractive of our seashore animals.

Commonest on all parts of our coasts is the Smooth Anemone or Beadlet, *Actinia mesembryanthemum* (Fig. 79), which furnishes a good example for study. The organisation is of a very simple type, the animal, when expanded, presenting the form of a cylinder, attached at the base and containing a cavity which communicates with the exterior by an oval mouth opening in the centre of the free extremity. Surrounding the latter are the mobile tentacles, used for the capture of food, and provided with peculiar stinging or urticating organs which, like those of the jelly-fishes, form a powerful offensive and defensive apparatus. The tentacles can be completely retracted, and the animal, when molested, or when exposed out of the water at low tide, can contract to such an extent as to form an inconspicuous, fleshy knob. This anemone is very variable in colour; although usually dark red, green and brown varieties occur; the tentacles are of a lighter tint than the body. The species can be recognised by the smoothness of the body and by the presence of a ring of bright blue, bead-like tubercles below the whorls of tentacles.

The allied *Anthea cereus* (the Opelet), common in deep rock-pools, also has a smooth body, but differs from the Beadlet

FIG. 79. BEADLET ANEMONE (AFTER MULLEGGER, WOCHENSCHR. F. AQUAR. U. TERR. 1912).

FIGS. 80 AND 81.—PLUMOSE ANEMONE AND WARTLET ANEMONE
(AFTER MULLEGER, WOCHENSCHR. F. AQUAR. U. TERR. 1912).

in the tentacles not being retractile. The colour is normally olive green, with the tentacles beautifully tipped with violet ; a variety also occurs in which the animal is of a uniform slate-grey tint. The Wartlet, *Tealia crassicornis* (Fig. 81) has a much tougher body, covered with wart-like tubercles, and variegated in colour, bright red and green ; the short retractile tentacles are red, banded with pink. This species is usually found on sand or gravel at the bottom of pools, where it often lies half buried and concealed by adherent sand-grains or shell fragments. The most beautiful, as well as the largest, of the British forms is the Plumose Anemone, *Actinoloba dianthus* (Fig. 80), the sea-pink (See-Nelke) of the German naturalists, and a great favourite in salt-water aquaria. It frequents rather deeper water than the species we have just mentioned, but is sometimes found on rocks or attached to the wooden piles of piers at extreme low tide. The pale yellow or pink body reaches a length of six inches ; the oral extremity is deeply lobed, each lobe bearing a multitude of small tentacles.

A number of common sea-anemones are remarkable on account of their constant association with other marine animals ; for instance, *Sagartia parasitica* is always found attached, either singly or in small groups, to a whelk-shell inhabited by the hermit crab (*Eupagurus bernhardus*). The advantages of such an association are pretty obvious ; the crustacean is concealed by the polyp and also protected by means of its stinging cells, while the anemone benefits by the increased aeration of its tissues, due to change of position, and also obtains its food largely from the *débris* of the hermit crab's meals. The term commensalism is used to denote such associations leading to mutual advantage. More than two different animals may be concerned in this partnership ; thus, in the case just mentioned, the hermit crab, in addition to carrying commensal anemones, frequently shelters a bristle-worm (*Nereis fucata*), which lives in the uppermost whorls of the whelk-shell, and is only visible at meal-times, when its anterior extremity may be seen protruding from the mouth of the shell in readiness to seize its share of the food roughly torn up by the pincers of the crustacean. *Adamsia palliata* is another species of anemone commensal of a smaller hermit crab (*Eupagurus prideauxi*). In this case the association is even more intimate, for the body of the anemone, instead of being cylindrical, is spread out like a cloak, closely covering the shell, and the mouth and tentacles are situated on the lower surface in close proximity to the mouth parts of the crab, in the best possible position for securing

food-fragments. Although usually attached by means of a sticky secretion from the base of the body to rocks, shells, etc., sea-anemones have the power of shifting their position by slow, gliding movements of the basal extremity; more rarely locomotion is effected by means of the tentacles, which are then used as little feet. They feed almost entirely on living animals; any small fish or crustacean coming within reach is seized by the tentacles, the urticating organs of which have a paralysing effect, soon putting an end to its struggles, after which it is swallowed entire.

The Sea-anemones have the sexes separate; in a few forms the eggs are discharged through the mouth, and undergo their development in the sea; in the majority, however, some part of the development takes place within the body of the parent; in the Wartlet, for instance, the young reach their full develop-

ment in this position. A few forms, e.g., the Plumose Anemone, are known to be capable of reproducing themselves by an asexual process, small buds being formed from the base of the animal.

FIG. 82.—CUP-CORAL.

As we have seen, the anemones have the body quite naked, and trust to their stinging organs for protection from predaceous animals; allied polyps are, however, known, which secrete hard, calcareous skeletons. These are the Madrecore Corals, also known as Stone-corals. A few are solitary, like the sea-anemones, but in the majority continuous budding has led to the formation of enormous aggregations of individuals, which participate in a common life, and form what are known as colonies. Madrecore colonies are particularly abundant in the warmer oceans, where they build coral reefs of great size. The only British representative is a solitary form, the little Cup-coral, *Caryophyllia smithi* (Fig. 82), which occurs in the Channel, and is sometimes not uncommon at low water, under boulders or in the crevices of rocks. The living animal has the appearance of a little anemone, for the skeleton is completely concealed, and when dried presents the form of a little cup, the inside of which is divided up by a number of radially arranged, stony partitions.

The Madrecores are not the only colonial polyps to which the name "coral" is given; thus the precious coral of

FIG. 83.—DEAD MAN'S FINGERS (*ALCYONIUM DIGITATUM*).

FIG 84.—*OBELIA GENICULATA* IN THE ZOOPHYTE AND JELLY-FISH STAGES (MICROPHOTOGRAPHS).

commerce belongs to a quite different, although allied, division. Here the coral polyyps differ from those of the Madrepores and from the sea-anemones in having the tentacles branched and limited to a constant number—eight.

The precious coral is an inhabitant of the Mediterranean and other warm seas, but an ally occurs in our fauna, *Alcyonium digitatum*, popularly known as Dead Man's Fingers (Fig. 83). Colonies of this form are often washed up on the beach, and when seen in such a situation appear as dirty yellow, almost shapeless masses of a leathery texture, provided with blunt finger-shaped processes. Nothing could be more unattractive to the eye, yet in the living, expanded condition these colonies are objects of great beauty, and are seen to consist of innumerable little white polyyps bound together by a gelatinous-looking semi-transparent substance, which acts as a kind of skeleton. The polyyps of *Alcyonium* have eight delicately branched tentacles, and their tissues, as well as the gelatinous skeleton, are strengthened by little sharp spicules, slender rods of a hard matter, which are possibly of use in rendering the tempting-looking colonies unpalatable to predaceous animals, which would otherwise devour them.

Although, on account of their plant-like appearance, often mistaken for seaweeds, the delicately branched Zoophytes

are also colonies composed of numerous little polyyps, often so small as to be visible only under the microscope. It is, indeed, to one of these that the term polyp was first applied, on account of a fanciful resemblance between this little animal and a diminutive Octopus (*Polypus* of the Greek). These Zoophytes, also called Hydroids, are extremely abundant, and occur in many different situations; in rock-pools they usually form merely fir-like growths on stones or shells; but the deeper water species, the colonies of which are often cast up on the beach, may attain a height of several feet, and branch most luxuriantly.

A typical Zoophyte is the common *Obelia geniculata* (Figs. 84 and 85) so often found growing on the broad fronds of laminarian weeds. The colony here consists of a number of branched filaments, about the thickness of ordinary sewing-thread, which are encased in a skeletal tube composed of a flexible, horny substance,

FIG. 85.—*OBELIA GENICULATA*
(AFTER HINCKS).

which investment expands at the tip of each branch into a little cup, where a polyp is lodged. Examination with a strong lens will show that these tiny polyps, although of a somewhat simpler structure, are similar in most respects to those which we have described above; they feed actively on minute organisms, seized with their tentacles, and the digested products are distributed through the colony, the cavities of all the individuals being in communication through the hollow stem. Further examination of the *Obelia* colony reveals the fact that, in addition to bearing polyps, the branches also carry groups of peculiar little circular buds, which develop into saucer-shaped individuals; these in course of time break away and swim off as tiny jelly-fishes, leading an

FIG. 86.—*TUBULARIA BELLIS* AND ENLARGED POLYP OF
T. LARYNX (AFTER HINCKS).

independent existence. When liberated they are no larger than a pin's head; they are, however, active feeders, and soon grow up, reaching a diameter of about a third of an inch. In *Obelia*, therefore, we meet with a colony bearing two kinds of individuals, polyps and jelly-fishes, the former merely nutritive in function, the latter reproductive, alone bearing the eggs which it is their duty to distribute as widely as possible. In some Zoophytes the jelly-fish stage has been done away with, as in the Sea-firs, *Sertularia*, and the handsome *Tubularia indivisa* (Figs. 86 and 87); in the latter the polyps are of

FIG. 87.—*SERTULARIA ABIETINA* (AFTER HINCKS).

FIG. 88—CHRYSAORA ISOSCELES.

considerable size, and differ from those of *Obelia* in not being contained in cup-like, skeletal structures.

On account of their small size, the Jelly-fishes produced from Zoophyte colonies are not very conspicuous objects. At

certain times of the year, however, they are very abundant on the surface of the sea, and can be collected in enormous quantities by means of a fine net. Although varying in shape, jelly-fishes are pretty constant in structure. The main organ, bell-shaped or saucer-shaped, and of great transparency, is usually referred to as the "bell"; by the pulsation of this bell locomotion is effected. From the centre of the under-

FIG. 89.—RHIZOSTOMA PULMO.

surface is given off a little stomach-tube, carrying the mouth at its extremity, the latter leading into a central cavity from which a number of fine canals lead to the more outlying parts of the body. The edge of the bell is provided with a varying number of tentacles, which, like those of a polyp, carry a stinging apparatus, used both for the capture of food and for defence. The large Jelly-fishes which often attract the attention of visitors to the seaside, usually found as inanimate lumps of jelly left behind by a receding tide, are of a similar nature, but show a greater complexity in their structure. Like the smaller forms, they

usually have a polyp stage in their life-history, although it is frequently much reduced. Only a few forms are at all abundant on our coasts. The commonest is undoubtedly *Aurelia aurita*, easily recognised by its flat, saucer-shaped bell, the margin of which is fringed with innumerable small tentacles. The mouth of this, as well as most other species, is produced at the corners into four large lips. *Aurelia* reaches

a diameter of six inches or more ; its colour is usually pale blue or pale green. This Jelly-fish is quite harmless, as its stinging-cells are not sufficiently powerful to pierce the human skins. The allied *Chrysaora isosceles* (Fig. 88), capable of inflicting a most painful sting, can be recognised by its larger oral lips and by the twenty-four stout tentacles which depend from the bell margin and replace the fringe of small tentacles which occurs in *Aurelia*. The yellow and blue species of *Cyanæa*, *C. capillata* and *C. lamarcki* are also forms with powerful stinging organs ; in these the bell margin is deeply lobed and the long, slender tentacles are grouped in eight tufts on the ventral surface.

Rhizostoma pulmo (Fig. 89) is a common Jelly-fish in the English Channel ; it is peculiar in having the large oral lips fused over the mouth in such a way that this opening is almost obliterated, being reduced to a number of minute apertures arranged along the lines of suture, and capable of taking in only the tiniest food-particles. This is a large, handsome form, the deep bell of which may attain a diameter of two feet, and is not provided with marginal tentacles. The colour is pale green or blue, with a deep blue or purple edge. Like the common *Aurelia*, this *Rhizostoma* may be handled with impunity.

As in this chapter we have continually referred to the stinging or urticating powers of polyyps and jelly-fishes, a short explanation as to how this is produced may be of interest. In the tissues of all these forms very highly modified cells, known as stinging-cells, are to be found, either scattered over the surface of the body or tentacles, or, more commonly, grouped in clusters or batteries. Each cell contains an oval capsule filled with a poisonous fluid, as well as a coiled thread provided with small barbs ; on appropriate stimulation these threads are shot out with great violence, and penetrate the bodies of any organisms with which they come into contact. When once discharged, the stinging-cell cannot be used again, and is cast off, being replaced by a new one, ready to take up its position at the surface of the body. While the sting of the average polyp or jelly-fish is not very formidable, it is sufficiently powerful to render these creatures distasteful to the majority of predaceous animals. They are also singularly free from parasites, although many small animals associate with them in a less intimate manner ; thus, several large jelly-fishes are constantly accompanied by shoals of shrimps or small fishes, which, when disturbed, seek shelter in the area protected by the long stinging tentacles. There are no jelly-fishes of real economic value,

although, curiously enough, some belonging to various species are articles of food for man in different parts of the world. Borlase, in his "Natural History of Cornwall" (published in 1758), stated that *Rhizostoma pulmo* was frequently eaten in that county.

With the exception of the minute, unicellular organisms known as Protists, the Sponges occupy the lowest position in the animal kingdom, and, indeed, not until the nineteenth century was their animal nature definitely recognised. Their great variety of shape, together with the absence of organs of sufficient size to be visible to the naked eye, render them almost incapable of any simple definition. The scientific name of the group, Porifera, refers to the fact that the surface of a sponge is perforated by myriads of little pores through which water is taken in and caused

FIG. 90.—SYCON COMPRESSUM (PURSE-SPONGE) AND S. CILIATUM.

to circulate through the body, being finally expelled through larger exhalent orifices, which are often of considerable size. This water current conveys the food, and also affords a means of respiration for the animal. Only a few of our native Sponges are sufficiently characteristic sea-shore organisms to find place in a review which is not intended for the professional zoologist. Perhaps the most striking is the little Purse-sponge, *Sycon compressum* (Fig. 90), so common at low tide in most rocky localities. This Sponge is approximately vase-shaped, but much

FIG. 91.—*SIPHOCHALINA OCULATA*, A SPONGE OFTEN WASHEI
ASHORE AFTER STORMS

compressed, and its free extremity is provided with a large opening; its general appearance is, therefore, not unlike that of a polyp without tentacles, but we must note, however, that the opening is not a mouth—no food passes in through it; on the contrary, it is an exhalent aperture for the exit of the water current taken in through the tiny surface pores, which are only to be seen under strong magnification. The allied *Sycon ciliatum* is also abundant, but prefers deeper water, and is only occasionally found between tide-marks. It differs from *S. compressum* in being perfectly cylindrical in shape. The bodies of these two sponges are supported by a complicated skeleton composed of little calcareous spicules, or hard rods, which give them their characteristic felt-like texture; spicules too small to be seen with the naked eye, except in the neighbourhood of the exhalent opening, where, especially in *S. ciliatum*, they are enlarged and form a conspicuous little tuft. These two examples are among the simplest members of the group. Most of our other common sponges do not show any such definite structure, but form irregular masses, often encrusting rocks, shells, or other appropriate objects. A sponge of the latter type is the common *Hali-chondria panicea*, the Bread-crumble Sponge, forming brown or orange-coloured sheets which adhere closely to rocks exposed at low tide. Its consistency is approximately that of a piece of bread, and the surface is studded with numerous crater-like orifices, each of which corresponds to the single opening at the free end of a sycon. Like this Sponge, the Bread-crumble Sponge has a skeleton of spicules, but among the members of the group there is a considerable diversity in the nature and composition of the skeleton; in many, e.g., the familiar Bath-sponge (a native of the Mediterranean and other warm seas), spicules are absent and replaced by a meshwork of a flexible horny substance.

The Sponge figured in Fig. 91 (*Siphochalina oculata*), which occurs only in deep water, but is often washed ashore after storms, differs from the commoner littoral species by its handsome arborescent habit.

The only other Sponge we will mention is *Cliona celata*, interesting because it is able to bore into rocks and shells, with a marked partiality for oyster-shells, which are often found perforated by this creature. It is considered as a serious pest by the oyster-growers.

Although microscopic organisms are outside the scope of this work, we cannot conclude without a word as to those which

cause one of the most striking phenomena to be witnessed on a hot summer night—the phosphorescence of the sea. This phosphorescence is caused by many different organisms belonging to various divisions, minute jelly-fish and the microscopic crustaceans which form so great a proportion of the surface fauna contributing largely to the phenomenon. On our coasts, however, the luminosity of the sea is due in most cases to an animalcule appropriately termed *Noctiluca miliaris*, a unicellular organism, myriads of which are at times floating at the surface. *Noctiluca*, which is just large enough to be visible to the naked eye, being one-twenty-fifth of an inch in diameter, is a little gelatinous creature of approximately globular shape; when seen singly it appears almost colourless, but masses of the animalcule appear of a reddish-brown tint, hence the discoloration of the water near the shore which so frequently occurs after a night of magnificent phosphorescence. The cause of the luminosity of these creatures is not known; the light, however, always shows best when the water containing them is disturbed, as by waves or ripples, the action of a boat, or some animal swimming on the surface.

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