

PLYMOUTH AQUARIUM



ILLUSTRATED GUIDE



by

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PLYMOUTH
MARINE BIOLOGICAL ASSOCIATION
OF THE UNITED KINGDOM

1951

THE MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE MARINE BIOLOGICAL ASSOCIATION was formed in 1884 for the purpose of promoting scientific research, and of increasing our knowledge of the food, habits, and conditions of life of sea fishes, and thereby aiding both the fishermen and the Government in taking measures to ensure to the nation the greatest possible supply of food from the sea.

With this object in view Plymouth was chosen as the site of a Marine Station, and the Laboratory was built and opened for work in 1888. The Laboratory stands in front of the Citadel on ground granted to the Association by the War Office, at a height of 95 feet above sea-level, and a distance of 60 yards from high-water mark. It comprises three main buildings, connected by passageways, namely the *south* or original building visible from the sea, the much newer *north* building behind it, and the new library block close to the west end of the north building.

THE AQUARIUM, *the only part of the buildings to which the public can be admitted*, is on the ground floor of the south block. The remainder and larger part of the buildings consist mainly of research laboratories, the library and a reference museum for the use of the scientific staff and visiting research workers. The latter are attracted to the Laboratory by the facilities it offers and by the reputation of its scientific work. They come from Universities and research institutions not only in this country but from all over the world.

The scientific laboratories, biological, chemical and physiological with their accompanying preparation rooms, workshops and darkrooms, are well equipped with the apparatus necessary for modern research. The library is one of the most complete of its kind in the country, containing thousands of books dealing with fish, fisheries and all aspects of marine biological science.

A special department is concerned with the supply of living and preserved specimens for teaching purposes in schools, universities and museums. From time to time living fishes and other marine animals are supplied to other aquaria in this country.

A research vessel and a motor boat, fitted with dredges, trawls, and nets of various kinds, are used for collecting the specimens required by the workers, and for the Aquarium.

The results of the investigations are published in the *Journal of the Marine Biological Association*, and in other scientific periodicals. It is the aim of the Association in its research work to build up the science of life in the sea from its foundations, beginning with the sea water and its constitution and properties, passing on to the minute plant life

[Continued on page 3 of cover]

GUIDE TO THE AQUARIUM

THE Aquarium consists of one exhibition hall in which large tanks are arranged along the north and south sides; down the middle is a row of lesser table tanks, in which are displayed many of the smaller animals. All the living specimens are from the seas off Devon and Cornwall—unless otherwise indicated on the labels—and they form the largest known collection of living marine animals taken in British waters. Most of them have been caught by the Association's own fishermen.

The animals are fed on the white uncooked flesh of the squid (*Loligo*) and on fish, shrimps, prawns, crabs and mussels two or three times a week when fresh food is available. It is not possible to have fixed days and hours for feeding.

Once established most of the animals live in the tanks for many years. Some kinds, which are naturally short-lived, are replaced from time to time at seasons when they are normally abundant in the sea.

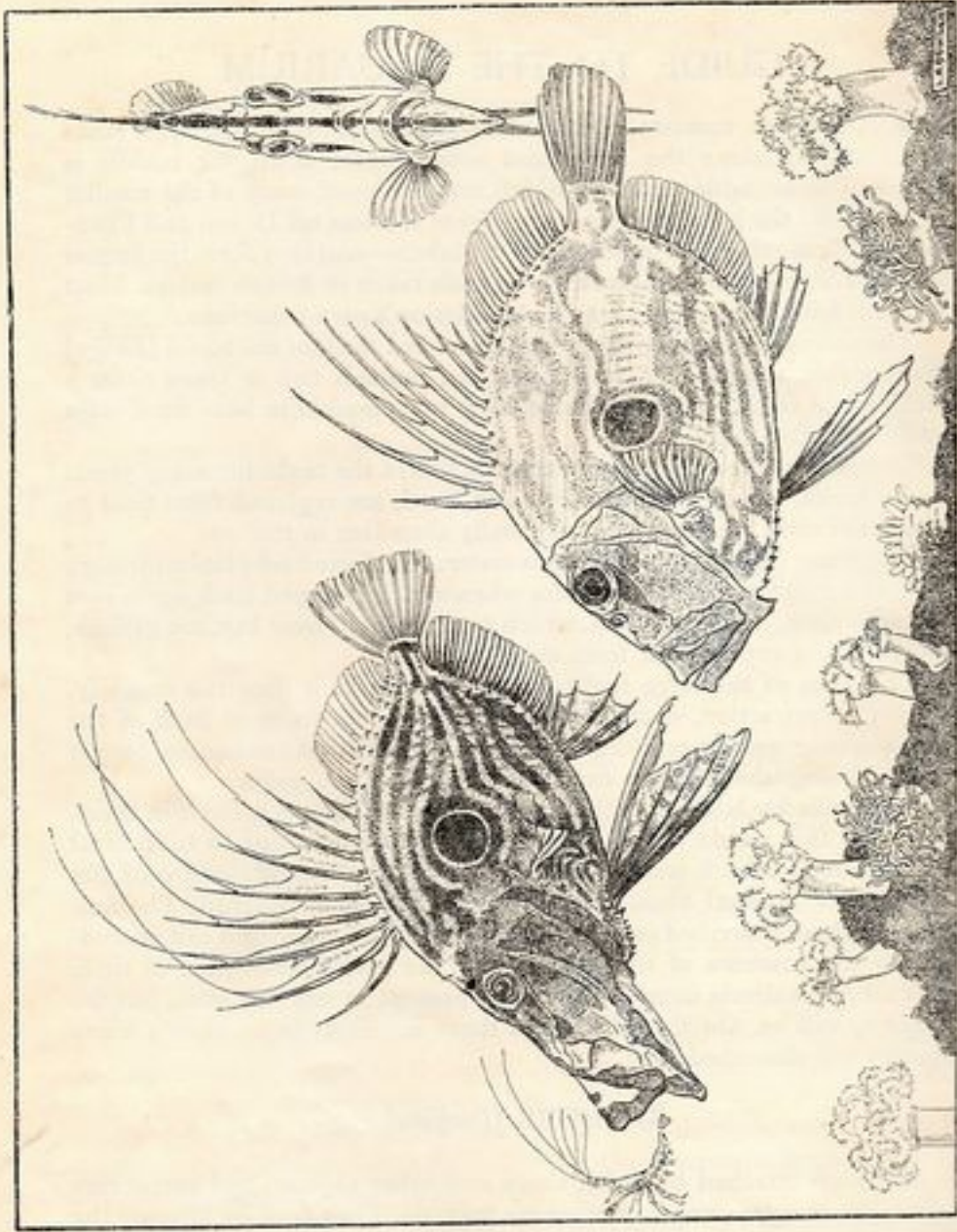
The water in the aquarium is sea water. It is forced into tanks through jets, and overflows into reservoirs whence it is pumped back again into the aquarium. The reservoirs, which together hold over 100,000 gallons, are regularly replenished from the sea.

The glass of the large tanks is one inch thick; it does not magnify. Owing to refraction, distances under water from front to back of the tanks appear greatly reduced. The largest tank (that containing conger eels and dogfishes), has a capacity of about 8,000 gallons.

The tanks are labelled with the names of the animals present in them. **In using this guide it will be found most convenient to turn first to the index which will direct the reader to a description of the particular animal about which information is desired.** The animals are here described in order of natural classification and not according to the contents of the tanks which are varied from time to time. Not all the animals mentioned will be present at any one time, but the majority will be. On the other hand there are likely to be shown many species not described here.

SPONGES (*Porifera*)

Although attached to rocks, shells and other objects, and sometimes plant-like in appearance, sponges are animals. They feed by filtering the water, drawing it in through minute pores all over the body and discharging it, after removal of all particles of food, through larger openings which are often conspicuous features on the surface of a sponge. Even a small sponge filters many gallons of water daily. To those familiar only

FIG. 1.—JOHN DORY (*Zenopsis*) AND SEA-ANEMONES

with life on land this may seem astonishing, but life under water is in many respects very different from life on land and the filtering of water to catch the microscopic swimming and floating animals and plants is a very usual method of feeding among marine and freshwater animals, large and small. The aquarium contains many other filtering animals besides sponges (see especially Tube-worms, Scallops, Sea-squirts).

Several kinds of sponges, some of them brightly coloured, are shown from time to time. Our British sponges have a supporting framework of limy or flinty needle-like spicules in their tissues and are therefore useless as toilet articles. The true bath sponges lack these sharp spicules having in their place a framework of a soft fibrous substance.

Of the sponges shown only one is described here, the **Boring Sponge** (*Cliona celata*), which on the sandstone rocks off the Mewstone outside Plymouth Sound grows into the large cheese-like yellow masses seen in the tanks. On limestone rocks and on oyster shells its habit is different; for it there excavates a network of galleries and tunnels under the surface of the rock or shell. In course of time the rock thus perforated crumbles away exposing deeper layers to the sponge's ravages. It occurs in the limestone blocks which form the Plymouth Breakwater thus helping in their destruction.

POLYPS, SEA-ANEMONES, CORALS (*Coelenterata*)

Hydroid polyps, Sea-anemones, Corals and Jellyfishes, although differing greatly from each other in appearance, are all essentially alike in structure. They are more highly developed than sponges in having definite mouths, and many can move from place to place.

The individual animal is called a *polyp*. A typical polyp has a cylindrical body, one end of which is fixed by an adhesive base to the surface on which it grows. The free end has a mouth, surrounded by one or more rows of tentacles. The body is hollow and the mouth opens directly into this digestive cavity, passing food in and discharging indigestible remains.

The body and especially the tentacles are armed with minute stinging capsules, each containing a poisonous liquid and a long coiled thread, often barbed. When suitably stimulated the thread is shot out, piercing the skin of any small animal which may have touched the tentacles. The struggling animal is stunned by the poison injected by the many threads discharged into it and the tentacles then convey it to the mouth.

Hydroids or Sea-firs

From time to time a number of the more beautiful species belonging to this group are shown, but as they do not live well under aquarium conditions they are not always on view. Most likely to be shown are the **Lobster's Antenna** (*Nemertesia antennina*), dredged from deep water, and the **Oaten-pipes Hydroid** (*Tubularia larynx*) which is com-

mon on harbour buoys and other floating structures. Both are clusters of polyps so connected that food caught by any one helps to nourish the whole colony. Much of their living tissue is protected and supported by a hard substance secreted around it in the form of ensheathing tubes.

Sea-anemones and Corals

These are very like hydroid polyps except that the mouth instead of opening directly into the digestive cavity leads first into a tube or gullet with radial attachments to the inside of the body wall. The coasts of Devon and Cornwall are especially rich in anemones of different kinds.

The commonest of all the British anemones is the **Beadlet** (*Actinia equina*), found everywhere between tide-marks. The column is short and very smooth with a blue line edging its base, and having a crown of about 200 tentacles arranged in 6 whorls. At the bases of the tentacles is the circle of shining blue beads, to which the name of Beadlet alludes. Each bead contains a battery of stinging cells. The colour is very variable; it may be dull red, green, olive, or brown, and either plain or spotted and streaked with green and yellow. A dark-red variety with greenish spots is known as the **Strawberry** from its resemblance to that fruit.

The **Dahlia Anemone** (*Tealia felina*) attaches itself to rocks between tide-marks, but although abundant it is difficult to find. Scattered over its body are numerous hollow warts or suckers; these hold on to small stones and shells so that when the anemone closes it becomes covered over and concealed by them. When expanded its colour is always striking but varies greatly in different specimens. The column is greenish, the warts grey, and the disc sometimes olive, sometimes crimson with conspicuous radial bands of scarlet. The stout tapering tentacles are almost transparent and are barred with purple or crimson and white. *Tealia* is a very voracious anemone and feeds on many quite large creatures such as shore-crabs, limpets, shrimps, small fishes, and even other anemones.

The **Plumose Anemone** (*Metridium senile*) has a smooth translucent column rising to a height of 5 to 6 inches and a large disc much expanded and deeply frilled, the frills curving outwards over the column like soft plumes (see Fig. 2). This feathery appearance is due to the surface being covered with numbers of delicate tentacles, long and scattered towards the centre of the disc, and short and densely crowded on the edges of the frills. The colour varies from pure white to dark brown, but is usually a pale rosy-pink, or primrose, with bands of white round the tentacles. The Plumose Anemone reproduces by division and also produces young from eggs. It is very hardy and will live for several years in captivity. In the tank it may often be seen moving about from one place to another by sliding very slowly over the rocks, and creeping up the side of the tank nearly to the surface.

The **Cactus-flower** (*Anemonia sulcata*), is also called the **Opelet** because of its habitually open disc, and the **Snakelocks** on account of

its long tentacles which twist and curve in all directions. There are two common varieties of this anemone both plentiful at Plymouth. The typical one is most beautifully coloured, with bands of pale brown and lilac round the column, and lustrous emerald-green tentacles tipped with rosy lilac. The other which is abundant in the Yealm estuary, has a brown column, and satiny ash-grey tentacles. The tentacles carry immense numbers of stinging-cells, especially in the bright-coloured tips, which are sometimes irritant enough to be felt by the human skin.

The **Daisy Anemone** (*Cereus pedunculatus*), is very common in the estuaries of the Yealm, Plym, and Tamar, living in crevices in the rock or in muddy ground attached to stones. It is very variable in colour, and usually about an inch to three inches high, but the height depends on the depth of the hole or crevice in which it dwells.

Parasitic and Cloak Anemones are described in the section dealing with their hosts, the hermit crabs.

True Corals are closely allied to sea-anemones. They can be regarded as sea-anemones which secrete a basal pedestal of lime. This is clearly seen in the little **Devonshire Cup Coral** (*Caryophyllia smithi*) which secretes a hard white basal cup on which it rises when expanded, and stretches out its tentacles for prey. The cups of this little British coral are solitary, but many allied species in the tropics are joined together in colonies and form large communal structures of hard lime which give rise to the well-known coral reefs of the Pacific and elsewhere.

The little brightly coloured **Jewel Anemone** (*Corynactis viridis*), also shown in the tanks, is regarded as being more closely related to the true corals than to the sea-anemones, although it lacks a limy base. It lives in colonies of many separate individuals, and is often brilliantly coloured, emerald green, rose, lilac, or other colours. Each little colony is generally all of the same colour.

Not very closely related to the true hard corals are the Soft and Flexible corals. The first are represented in the tanks by the **Sea-fingers** (*Alcyonium digitatum*), sometimes called Dead Men's Fingers. The polyps, each with eight frilled tentacles, make soft lobed masses and a colony may reach a length and breadth of several inches. The colour is white or pink, the polyps being of a glassy transparency. The latter are not always expanded, often they contract out of sight in the main spongy mass. The **Sea-fan** (*Eunicella verrucosa* - *Gorgonia verrucosa*), has polyps similar to those of the Sea-fingers but the colony forms a bright pink fan-shaped growth of branching stems. The stems have a supporting axis of a black horny substance which is covered over by the soft tissues in which the bases of the polyps are embedded. The contracted polyps are visible as nodules covering the branches, and when they expand, as they generally do at night, the whole colony becomes a thing of exquisite beauty. The Sea-fingers is found on rocks and shells from the lowest levels on shore into deep water but the Sea-fan is found only on rocky ground below about ten fathoms.

Jellyfishes

These are so rarely shown in the aquarium owing to their fragility and short life that it is not possible to devote space to them here.

SEA-WORMS (*Annelida*)

There are many kinds of worms living in the sea but most of them are rather small and inconspicuous and not very suitable for exhibiting. A few, however, are noteworthy and form one of the most attractive displays in the aquarium. These are the various Fan Worms to be seen in one of the smallest tanks. Generally three kinds are shown, the **Peacock Worm** (*Sabella pavonina*) which builds a tube of mud particles strongly cemented together, the **Fan Worm** (*Branchiomma vesiculosum*) with a tube of sand and rough particles, and the **Jelly-tube Worm** (*Myxicola infundibulum*) which secretes a thick walled tube of jelly around itself. Occasionally some other kinds are shown as well. The first three are found on muddy shores near low-water mark at Salcombe and the estuary of the River Yealm and the Peacock Worm is also sometimes taken in deep water. All are characterized by a large crown of feathery filaments on their heads. The filaments are protruded at the entrance to the tube; they serve for breathing and also for catching minute living organisms from the water for food. When danger threatens the crown is closed and pulled down the tube in a flash. These worms often live for many years in the aquarium.

Occasionally other sorts of worms are shown, notably the **Quill Worm** (*Hyalinoecia tubicola*) which forms around itself a transparent tube of stiff material looking rather like the quill of a feather. There are valves at each end so that when the worm is wholly inside it is protected from enemies. These worms come from deep water; unlike the Fan Worms they can crawl about dragging their tubes with them.

There are several worms which secrete white tubes of carbonate of lime, attached generally to rocks, shells or seaweed. Some of these are shown from time to time. They have brightly coloured feathery crowns on their heads in the manner of the Fan Worms. One kind, the **Filigree Worm** (*Filigrana implexa*) makes slender intertwining tubes in masses a few inches high. Another, very common on the shore, the **Keeled Tube Worm** (*Pomatoceros triqueter*) has a ridge along the top of its hard limy tube which is attached along its whole length to rocks or shells. It is provided with a stopper on a stalk with which the entrance to the tube can be closed when it has withdrawn within.

The **Sea-mouse** (*Aphrodite aculeata*), is a large broad worm, oval in shape. Its back is covered by a mouse-coloured felt of long thread-like hairs matted together. They spring from the feet of which there are about forty pairs. The feet are provided with strong bristles, they are arranged

along each side of the body and are clearly visible when the animal is turned on its back. When viewed from above, however, the feet are hidden by the most exquisite fringe of iridescent hairs which shine like the green and golden plumage of a humming bird. The Sea-mouse lives on muddy, sandy bottoms in deep water and is rarely to be found on the shore. It is carnivorous, feeding on smaller worms and other small animals.

LOBSTERS, CRABS, SHRIMPS & PRAWNS (*Crustacea*)

The Crustacea are a large group of animals of diverse shape, size and habit characterized by a hardened skin that is moulted from time to time to allow for growth. Immediately the old skin is cast, the animal swells to a larger size; the new skin then hardens, a process that may take several days to complete in large crabs and lobsters in which a heavy deposition of calcium carbonate (lime) produces a very strong protective armour. The armour is pliable at places where the skin remains soft; these joints are readily visible in the legs of a crab and the tail of a lobster.

Crabs and lobsters find their food largely by smell, the eyes being little used for this purpose.

All crustaceans possess the power of regenerating a new limb. If an animal is frightened and its leg is caught in such a way as to prevent escape, or if a leg is injured it can throw it off and grow a new one in its place; this it does so quickly that after a few moults the new leg is the same size and shape as the others. In the tanks lobsters and crabs may often be seen with one or both of their great claws missing, the loss being generally due to injuries received during their frequent battles.

The **Common Lobster** (*Homarus vulgaris*) has four pairs of walking-legs, and a pair of huge claws. The claws are not alike, the larger or crushing claw has blunt knobs on the inside of the "fingers" and is used to crush the shell of its victims, while the smaller or cutting claw has sharp saw-toothed edges on the inside of the fingers. The first two pairs of walking-legs end in small pincers.

On the tail are 6 pairs of swimming-feet or swimmerets, 5 pairs small and 1 pair, the last, spread out fan-wise to form with a small tail-piece (telson) the powerful tail-fan. The female lobster carries the eggs in masses on her swimmerets, fastened on by a kind of cement. The eggs, from 3,000 to 100,000 in number, take about ten months to hatch, and are kept aerated by the continual movement of the swimmerets.

Although the full-grown lobster is a creeping animal living near the bottom it can swim with great rapidity, springing backwards by powerful flaps of its strong tail.

The **Rock Lobster** (*Palinurus vulgaris*) is also known as the Spiny Lobster, the Sea Crawfish or Crayfish, and in France as the Langouste. It is a common species in the Mediterranean but in Britain it is only

found on the south and west coasts, where it is very abundant amongst the rocks in deep water.

The Rock Lobster reaches a length of 18 inches. It is larger than the Common Lobster, which it resembles in its general shape, though differing from it in several important details. The most noticeable differences are the absence of the huge claws, the thick covering of spines on the main body shield (carapace), and the spiny bases and great size and length of the second pair of feelers. It is a bright orange yellow or red colour, mottled with brown and white. Like the Common Lobster it is used for food.

The **Common Prawn** (*Leander serratus*) grows to about 4 inches in length. The shield or carapace is drawn out in front into a sort of pointed beak or horn (rostrum) curved upwards at the tip, and armed with sharp teeth like a saw (see Fig. 4). Both pairs of feelers are very long and delicate. The first and second pairs of legs end in small pincers. In life, the prawn is transparent with beautiful markings of red, blue and brown; when boiled, it changes to a bright pink.

The **Common Shrimp** (*Crangon vulgaris*) is sometimes visible in the tanks but the efficient way in which it buries itself out of sight and the manner in which its colouration matches the sandy bottom when it is not buried, make it very difficult to see. It is easily distinguished from the prawn. The horn (or rostrum) instead of being long and saw-edged is very short, and the first pair of feelers have noticeably large scales on their bases, which are used like shovels by the shrimp in burying itself in the sand.

The **Squat Lobsters** look like small, very short and broad lobsters. There is a pair of long flat claws covered with spines and three pairs of strong walking legs. Squat Lobsters swim backwards with great rapidity by powerful flaps of the strong muscular tail, which is normally kept folded up under the body. A large handsome deep water species the **Long-armed Squat Lobster** (*Munida bamffica* = *Munida rugosa*) is sometimes shown; it is pinkish-brown in colour.

Several kinds of **Hermit-crabs** are plentiful on these coasts. When first hatched a hermit-crab looks like a young prawn, but by the time it is half an inch in length it has altered its shape, and has to seek protection in an empty shell. Its tail is very soft and spirally twisted; it fits the coils of a spiral shell, where it is kept firmly wedged by special limbs at the end of the tail. Many hermits as they moult and increase in size find larger shells, and move into them, while others which inhabit shells on which grow sponges or anemones have no need to change, for the sponge or anemone in its growth not only absorbs and covers the shell, but grows around the body of the crab itself.

It is a curious fact that nearly all the hermit-crabs live in association with other animals, such as anemones, worms, hydroids, or sponges, and that each kind of hermit has its own special companions.

The **Large Hermit Crab** (*Eupagurus bernhardus*) when adult lives



FIG. 2.—PLUMOSE ANEMONES (*Metridium senile*) $\times \frac{1}{4}$



FIG. 3.—COMMON STARFISH (*Asterias rubens*) $\times \frac{1}{4}$

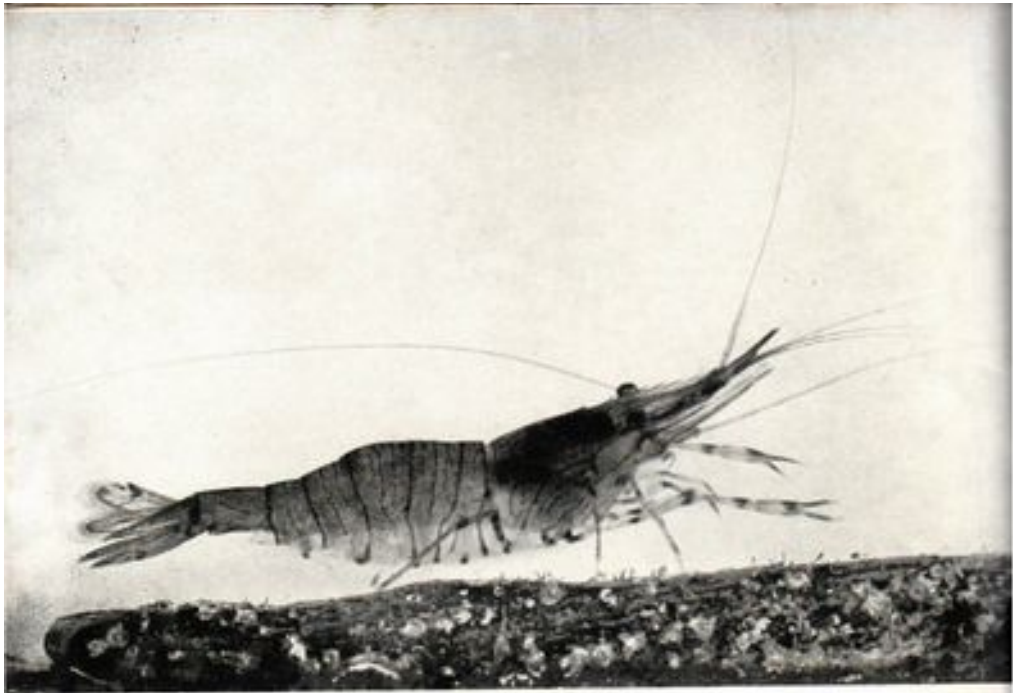


FIG. 4—COMMON PRAWN (*Leander serratus*) $\times 1$



FIG. 5—LARGE HERMIT CRAB (*Eupagurus bernhardus*) $\times \frac{1}{2}$

in the empty shell of a whelk (see Fig. 5). On its shell there are usually one or more **Parasitic Anemones** (*Calliactis parasitica*) and often in the upper coils of the shell there lives a particular kind of bristle worm (*Nereis fucata*). Both these guests share in the hermit's meals. To some extent they repay their host; the anemone by affording it some protection from enemies by reason of its stinging tentacles; the worm by creating a circulation of clean water through the shell. As the shell on which it sits is dragged along the anemone frequently bends over to apply its disc and tentacles to the ground, thereby catching many small creatures disturbed by the hermit in its clumsy progress.

The **Velvet Cloak Anemone** (*Adamsia palliata*) is associated with the **Little Hermit-crab** (*Eupagurus prideauxi*) which inhabits rather small shells. The anemone attaches itself to the inner lip of the shell, the base expands into two lobes, and these gradually increase in size to end by entirely surrounding the mouth of the shell. The mouth of the anemone and the tentacles surrounding it are directed downwards close behind the mouth of the hermit. They secure some of the food collected by the hermit and small worms, etc., disturbed by it as it crawls over the ground. The anemone grows as the crab grows and therefore this species of hermit has no need to change into larger shells as it gets bigger, the anemone covers it over and gives it protection. The Velvet Cloak is coloured white with rosy red spots.

In the true **Crabs** the tail is small and tucked forwards under the front part of the body which is often broader than it is long. Owing to the width of their bodies most crabs walk more easily sideways than forwards. As in lobsters there are four pairs of walking legs and one pair of large claws.

The **Edible Crab** (*Cancer pagurus*) is the best known of all the crabs, and the most important as an article of food. Young ones are common between tide-marks on rocky shores in the neighbourhood, but large specimens are seldom found above the low-water mark. They are caught in "crab-pots", which are traps made of wicker or iron wire baited with fish, and sunk in suitable places. Very large crabs weigh as much as 10 or 12 lb.

Swimming Crabs can swim easily through the water by using the hindermost pair of legs which are flattened like paddles. One of these, the **Cleanser Crab** (*Portunus depurator*), is the commonest crab on the trawling grounds in the neighbourhood of Plymouth. The swimming crabs are often beautifully marked and streaked with bright colours, especially on the legs and claws.

Numbers of different **Spider Crabs** occur in great abundance on the Devon and Cornish coasts. These crabs, with their long thin spidery legs and small rather triangular bodies, look like huge spiders. Their movements are slow, and the smaller ones would stand no chance of escaping their enemies were it not for the remarkable way in which they disguise themselves.

A spider crab intent on concealment collects pieces of seaweed, sponges, etc., and places these with its claws on its back and legs; the pieces, which are caught and held in place by the strong hooked bristles on the back, commence to grow and soon form a living coat of plants and animals, so that when the crab keeps still, as it does when alarmed, it is so masked by this covering that it cannot be distinguished from the weed-covered stones near by.

The **Spiny Spider Crab** (*Maia squinado*) is one of the largest of the British spider crabs, the body growing to about 8 inches in length and 6 inches in width and the legs spanning from 15 to 20 inches. As is often true of crabs generally the male is larger and has bigger claws than the female. When young this species attaches pieces of seaweed and other growths to the spines on its legs and back, or even balances pebbles thereon, as can sometimes be seen in the tank. When it grows larger, however, and better able to defend itself it no longer adopts these disguises.

Other species shown are the **Long-beaked Spider Crab** (*Macropodia longirostris*); and the **Scorpion Spider Crab** (*Inachus dorsettensis*).

MOLLUSCS (*Mollusca*)

The large group of Molluscs, or soft-bodied animals, includes such varied forms as the octopus and cuttle-fishes, whelks and limpets, snails and slugs, oysters, cockles and mussels.

They may be described as soft cold-blooded animals, which have no hard supporting skeleton inside. In the majority of species, however, the soft body is covered and protected from injury by a shell outside, which not only guards the vital parts, but serves also as a portable dwelling and a defence against enemies.

The shell is formed mainly of carbonate of lime which is secreted by a special area of the skin called the *mantle*. Usually the shell is of one piece, as in the whelk, periwinkles, etc., when the animal is called a univalve, or it has two pieces, or *valves*, joined by a hinge and is called a bivalve. Sometimes it consists of more than two pieces and in some molluscs, as in many slugs, is missing altogether.

Of the Bivalves shown in the aquarium the **Scallops** are well known for their beauty of shape and colour and for their food value. They can swim considerable distances in leaps, by rapidly opening and shutting the valves of their shells.

The **Scallop** (*Pecten maximus*) grows from 4 to 6 inches across the shell. In this species one valve is saucer-shaped and the other is flat, both are broadly ribbed or ridged, and they fit closely together when shut. The shell is usually a pale tint marked with shades of red, pink or brown. The animal itself is brightly coloured, parts of the body being orange or red; the mantle is pale buff and fringed with long white ten-

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tacles. It is beset with numbers of shining opalescent green or purple eyes in two rows along the margins.

The **Queen Scallop** (*Chlamys opercularis* = *Pecten opercularis*) is smaller, with the valves of the shell alike, ridged and rough. The colour is very variable, usually a rich pink, yellow or red-brown marked with white. It is an excellent swimmer and sometimes occurs in vast numbers on the fishing grounds. By some it is considered almost as great a delicacy as the oyster.

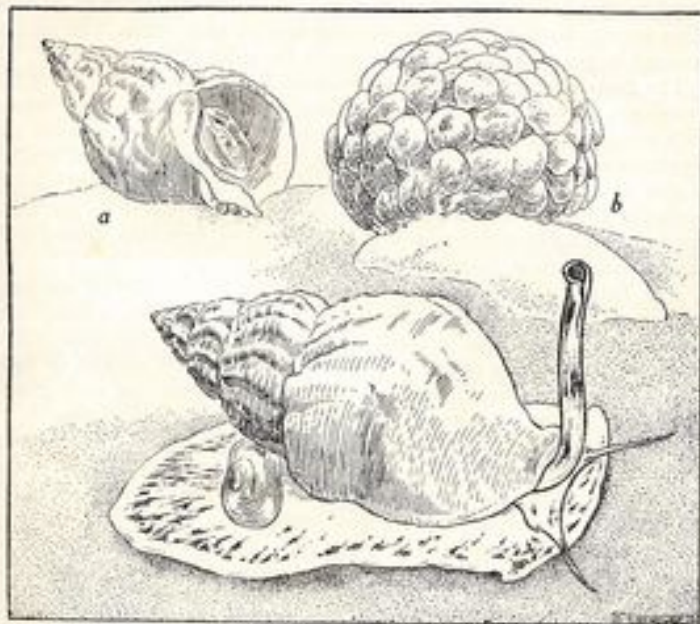


FIG. 6.—COMMON WHELK (*Buccinum undatum*) crawling
(a) The whelk drawn back into the shell, with the lid (operculum) closed.
(b) Egg cases of the whelk.

The Univalves, or sea-snails, include such forms as the common periwinkle of the seashore and a host of similar forms. Their largest representative in the aquarium is the **Common Whelk** (*Buccinum undatum*) which grows to as much as 6 inches in length. It feeds on scallops and other molluscs and is very voracious. Fig. 6 shows the animal as it looks when crawling, with the "siphon" or tube pushed out and turning about in all directions, the long muscular foot on which it creeps, extended, and the head with the eyes and feelers. On the foot is a horny lid or operculum which closes the entrance to the shell when the soft parts of the body are

withdrawn within (Fig. 6a). In Fig. 6b the egg-mass is represented. Each of the tough papery capsules contains about 500 to 600 eggs when laid, but only four or five young ones hatch out of all this number. These live in the capsule for several months, feeding on the other eggs and increasing in size, until they finally emerge in the spring with their shells formed. The empty cases are often found on the beach.

The **Boat Shell** (*Scaphander lignarius*) burrows in sand and mud, and feeds on other molluscs, swallowing them shell and all. It is able to grind up the shells by means of its muscular "gizzard" which is made of three strong, hard, limy plates working against each other. The animal is much larger than its shell, over which the sides of the body fold.

The **Sea-lemon** (*Archidoris britannica*—*Doris tuberculata*), one of the Sea-slugs, grows to about 3 inches long. It is bright yellow in colour with purplish patches, and looks very much like the half of a lemon cut lengthways. It has no shell when adult, but when tiny has one similar to that of any ordinary sea-snail. It casts it off while still very young. Both the gills at the hind end of the body and the feelers on the head can be extended or withdrawn at will. The tongue, or radula, armed with about 6,000 teeth is used for eating sponges.

The **Triton** (*Sphaerostoma hombergi*) is the largest British sea-slug, sometimes reaching a length of 7 or 8 inches. It has a series of branching feathery tufts, or "gills" around its body and when fully expanded is really handsome. The colour is variable, purple, cream, pinkish or light brown, often with purple markings. The tongue is provided with 36,000 teeth. The Triton feeds on the Sea-fingers (*Alcyonium digitatum*).

The **Octopus** and **Cuttle-fish** belong to a great group of molluscs called the Cephalopoda (head-footed). The long tentacles represent the muscular crawling foot of other molluscs which during the long course of evolution has surrounded the head and become drawn out into long curling arms. On the underside of the arms are rows of strong suckers. When these are applied to an object their centres are raised by muscular action so that a vacuum is formed. This enables them to cling with great force. The arms surround the mouth which has jaws like a parrot's beak and a rasping tongue armed with hooked teeth. Below the head a wide opening can be seen through which water enters bringing oxygen to the gills, and at the side, a short tube, the "funnel" or "siphon" out of which the water flows again. On watching the living animal, the funnel can be seen opening and shutting, alternating with the movements of the flap at the aperture. The funnel plays an important part in swimming and in defence. When the animal is disturbed or alarmed it shoots a stream of water out of this tube with sufficient force to drive itself backwards. At the same time it often discharges a black inky fluid which forms a dark cloud in the water to distract the attention of its pursuers.

Octopus crawl much more frequently than they swim. In our seas they are comparatively small and harmless to human beings.

The **Common Octopus** (*Octopus vulgaris*) has eight (see Fig. 8) arms

with two rows of suckers on each and it can cling with great tenacity to the rocks. The arms are long in proportion to the size of the body; in an animal measuring 6 inches in body length, for instance, the span of the arms would be about 4 feet. It lives in holes in the rocks from whence it sallies forth to seize crabs, its principal food.

The **Lesser Octopus** (*Eledone cirrosa*) differs from the Common Octopus in having smaller eyes, shorter arms in proportion to its body length and only one row of suckers on each arm. It is remarkable for its colour changes, the tints paling or flushing with great rapidity. The colouring is beautiful, reddish on the back, with the under surface a bird's-egg blue and the eyes orange with white lids. This species is frequently met with on the trawling grounds, and in lobster pots.

The **Common Cuttle-fish** (*Sepia officinalis*) grows to about a foot in length and has a broad body, oval and flattened, with fins along the sides (see Fig. 9). It is much more of a swimmer than the octopus. There are eight short arms each with four rows of suckers, and two very long arms, the tentacles, which can be stretched out to seize prey, but are at other times tucked away into pockets in the head. The eyes are black, very large and prominent. A shell or cuttle-bone is situated under the skin of the back; it is a broad curved plate about three-quarters the length of the body, made up of overlapping layers of a soft porous, limy material. The Cuttle discharges large quantities of ink when annoyed.

The Cuttle has many uses. It is eaten in Mediterranean countries, though not considered as good as the octopus. Its ink was used in ancient times for writing and painting and is still employed in the preparation of sepia paint. Its shell was made into "pounce" for rubbing on paper in order to prevent ink from spreading, it is used also for polishing wood, and by bird-fanciers for captive birds to sharpen their beaks on.

The colour of a Cuttle is purplish brown with white stripes, but the changes of tint are most striking, constant waves of colour passing over the body, and stripes and spots appearing and disappearing. The young, as soon as they are hatched can change colour in the same remarkable way.

The large black eggs are laid in grape-like clusters, attached to seaweeds. These "sea-grapes", as they are called, may be found in July and August when the cuttles come into the bays and estuaries to spawn.

The **Squid** (*Loligo forbesi*), which is much used by fishermen for bait, and also for feeding the animals in the aquarium, is similar in general appearance, and closely allied to the cuttle-fish. It swims in the sea in great shoals but unfortunately does not long survive capture. It has not proved possible to keep it alive in the tanks.

SEA-MATS (*Bryozoa*)

The Sea-mats are mostly small colonial animals of peculiar structure but the exceedingly brittle colonies of **Ross** (*Lepralia foliacea*) grow in

masses of great size; one recorded from off the Eddystone measured over 7 feet in circumference. The colony is built of two layers of cells, back to back, in the form of thin stiff folded and frilled plates formed together like a very open-meshed sponge. The individual animals, one to a cell, are minute; they feed by capturing microscopic floating animals and plants for food.

STARFISHES, SEA-URCHINS & SEA-CUCUMBERS

(Echinodermata)

The name "Echinoderm" is derived from the Greek words meaning "hedgehog skin" or "spiny-skin". It is applied to all these creatures because of the spines or prickles or spicules of carbonate of lime with which their skins are studded. Some, like the Feather-stars, Brittle-stars, and Sea-urchins, have complete skeletons formed of hard "plates" of lime; others, such as Starfishes, have a limy framework supporting a leathery skin; in others again, like the Sea-cucumbers, the body is soft, but the spicules, although scattered, are so numerous that the skin often feels rough to the touch.

The hard skeleton is frequently called a shell, but it is not a shell in the sense in which we use the term in speaking, say, of the shell of a limpet, which is outside the living parts of the animal. In the Echinoderms the shell, or "test", is formed *inside* the skin.

Another striking feature, also common to all, is the radiate structure, or star-like shape, the rays being generally five in number.

The most characteristic feature of these animals is the large number of tube-feet by which they can cling to rocks and pull themselves along. They are clearly visible on the underside of the arms of starfish clinging to the glass of a tank, or waving about around crawling sea-urchins. In the brittle-stars they are less conspicuous and play a smaller part in locomotion.

Most starfishes and brittle-stars readily grow arms again when they are broken off. Specimens with regenerating arms are often to be seen in the tanks.

Several kinds of Starfishes are shown. Those most frequently to be seen are the **Common Starfish** (*Asterias rubens*), the **Spiny Sea-star** (*Marthasterias glacialis*), the **Sun-star** (*Solaster papposus*), the **Cushion-star** (*Porania pulvillus*), but other kinds are also generally present as well. Most of them are caught in the trawl on the fishing grounds but a few, like the first two mentioned, are to be found on the seashore at extreme low-water mark, though the Common Starfish (see Fig. 3) is not as numerous on the shore at Plymouth as it is on some other parts of the British coast. Most starfishes eat bivalves, such as mussels and oysters, or even their own kind.

The **Brittle-stars** are disc-shaped with long fragile arms with which

they can crawl along quite fast. The **Common Brittle-star** (*Ophiothrix fragilis*) is often especially abundant, occurring in great numbers in favoured places in deep water. It is very variable in coloration, and it is rare to find two alike. It is generally spotted and banded with white, grey, pink and blue. A larger species, the **Black Brittle-star** (*Ophiocomina nigra*) is also often shown.

The **Rosy Feather-star** (*Antedon bifida*) differs from ordinary starfishes and brittle-stars in being provided with finger-like organs on the back of its disc, with which it clings, upside-down, to rocks in sheltered waters. It has ten long delicate arms fringed with short fine branches, like feathery plumes. It feeds on microscopic animals which it catches from the surrounding water.

Sea-urchins are almost spherical and studded with spines. The **Edible Sea-urchin** (*Echinus esculentus*), our largest species, is fished off the Portuguese coast and in the Mediterranean for its roe, or egg-mass; in the spring, when the animal is mature, these form five large sausage-shaped masses. It feeds on worms, barnacles, seaweeds, indeed almost anything it can crawl over. It has five large chewing teeth in its mouth; these can be seen in an urchin when it is crawling on the glass. A much smaller species the **Purple-tipped Sea-urchin** (*Psammechinus miliaris*) is common on rocky seashores. It is greenish in colour with purple-tipped spines. It has a habit of covering itself with bits of broken shell, seaweed or pebbles which it holds over itself with its tube-feet.

Sea-cucumbers, so called from their shape, have long bodies with the mouth at one end surrounded by tentacles. By far the largest kind kept in the aquarium is the **Cotton-spinner** (*Holothuria forskali* = *Holothuria nigra*) which is common on the trawling grounds. The skin is smooth and usually dark brown or deep black. It grows to a foot in length, with a diameter of 2 to 3 inches. When irritated, the animal shoots out tangles of sticky white threads, from which it gets the name of Cotton-spinner. The threads swell up enormously in water, and any lobster caught in these clinging coils is rendered completely helpless, until they decay after a lapse of some days.

SEA-SQUIRTS (*Tunicata*)

The Sea-squirts are very abundant, and are found either singly, or in large colonies. Most of them live fixed to rocks or stones, but some float in the open sea. They obtain their food by filtering the water for the minute particles of living matter which it contains. The name Sea-squirt refers to the habit of squirting water when disturbed.

Of those shown, the two largest are the **Tube Sea-squirt** (*Ciona intestinalis*) with its pale-green, semi-transparent body sometimes reaching a foot in length; and the grey-green **Knobbly Sea-squirt** (*Phallusia mammillata*), which rises erect to a height of several inches.

FISHES (*Pisces*)

Fishes differ from all the animals previously described in having backbones. According to the kind of backbone they possess they can be divided into two great classes, viz. those in which the backbone is soft like gristle (cartilaginous), as in the Shark, Dog-fish, Skate, and Ray, and those in which it is hard and bony, as in the Cod, Herring, and Sole. In the Shark and Ray family the body is armed with hard spines arranged in rows. Most of the bony fishes have the body protected by thin overlapping scales partly embedded in the skin, which, unlike the fixed scales of snakes and reptiles, are easily rubbed off. Others, like the Gurnards, carry hard bony plates, while the Eels have minute scales, not visible because they are buried in the skin.

The scales in some fishes show certain markings by means of which we are able to judge the age of the fish.

Fishes have teeth of different kinds, and use them for different purposes, for biting, cutting, or crushing the food, or for seizing and holding their prey. These occur not only on the jaws, but in many species on the top and sides of the mouth and throat, on the gill-arches, and even on the tongue.

Most fishes propel themselves forward by causing a regular series of waves to pass down their muscular bodies from head to tail. These waves are clearly discernible in the eels and some other elongated fishes. In fishes of more typical shape (e.g. bass, mullet, mackerel, pollack, etc.) the waves are not so obvious and it is the sweeping of the tail-fin from side to side that catches the attention. In these fishes the tail fin does to a large extent help to propel the fish along, rather like an oar sculled over the stern of a boat. Their other fins, the keel-like fins and the paired limb-like fins are used mainly for steering and balancing. In some other fishes, however, the paired fins are actually worked like paddles (this can be seen in wrasses and sticklebacks) and the tail-fin can then be used like a true rudder. John Dories, pipe-fishes, and some other types swim slowly by waving movements of portions of their keel-like fins and special lobes of these fins are also used by the wrasses in a similar way.

I. SHARKS, DOGFISHES, SKATES AND RAYS

As already mentioned these fishes have a soft flexible skeleton made of gristle (*cartilage*), not bone, and the skin is armed with spines, often minute, or limy "plates". The mouth is generally on the underside of the head, the snout projecting above it. Under the snout, in front of the mouth, are a pair of nostril-like pits, the smelling organs which are used to locate the food. At feeding time many of these fishes can be watched swimming actively about smelling for their food and not using their

eyes at all for the purpose. There are several separate gill slits on each side of the head and an opening, the spiracle, behind each eye, which like the gill-slits, communicates with the throat. In breathing, water enters the mouth and leaves through the gill-slits.

Nursehounds and **Dogfishes** can be regarded as small kinds of shark. Always on view in one of the tanks are numbers of the **Rough Dog** or **Small Spotted Dogfish** (*Scyllium canicula*—*Scyliorhinus caniculus*), and the **Nursehound** or **Large Spotted Dogfish** (*Scyllium catalus*—*Scyliorhinus stellaris*). The former is very common and grows to a length of 3 feet; it lives on the bottom. The head is broad and rather flat, the snout rounded, and the teeth small and pointed. In colour it is greyish fawn, with broad bands of dark brown and fine spots of brown and black. The Spotted Dog feeds on all kinds of creatures, fish, crustaceans, bristle worms, and shellfish such as whelks, and is most active at night. The eggs have yellow horny cases and are laid one or two at a time and fastened to sea-fans etc. by long tendrils at the corners.

The **Nursehound** is very like the species just described, except that it is larger, sometimes reaching 5 feet in length, the skin is rougher, and the spots fewer, but larger and darker. Its eggs are similar to those of the Small Spotted Dogfish but are larger and are often attached to seaweeds. Both are sometimes known as "mermaids' purses".

The **Spur Dogfish** (*Acanthias vulgaris*—*Squalus acanthias*) is sometimes shown. It has two strong sharp spines on its back, one in front of each of the two back fins. It is a strong active swimmer, hunting in shoals and preying on herrings, mackerel and pilchards. It reaches a length of four feet and gives birth to living young.

The **Angel-fish** (*Rhina squatina*), is known by many names; Angel-fish from its large breast-fins resembling wings; Monk from the shape of its head resembling a cowl; Fiddle-fish from the shape of its body; Buffoon and Puppy-fish. It belongs to the Shark family, has a broad flattened body something like the skates and rays in appearance, and very large expanded breast-fins; it swims by sculling with its tail. The mouth is well forward and the animal lies on the bottom ready to seize passing fishes for prey probably locating them by sight and not by smell. Its colour varies with the ground on which it lives, concealing it from enemies and from prey.

Rays are flattened from above downwards and are very broad with the pectoral or breast-fins of great size reaching nearly to the tip of the snout in front and to the hinder fins behind. The tail is long and whip-like, and not of much use in swimming, the fish moving by a gentle waving or flapping motion of its breast-fins. The peculiar shape of the ray's body is suited to lying on the ground at the bottom of the sea.

On top of the head behind the eyes are to be seen the spiracles, much larger than they are in the dogfish. The latter takes in water for breathing mainly through its mouth, but for a ray, with its mouth close against the ground, mouth breathing is not very practicable. Thus the spiracles

which in the dogfish send but little water to the gills are in the rays much enlarged and through them passes the main respiratory current. As a ray lies on the bottom the large spiracles can be watched opening and closing with the rhythm of the breathing movements.

When feeding rays rise over their victims, pinning them down with their broad bodies, and then devouring them. The eggs are large, with tough cases shaped like a pillow with a horn at each corner. These cases are also known as "mermaids' purses".

Long-snouted rays are known as Skates. Of several species the **Common Skate** (*Raia batis*) may be mentioned by name. It is a voracious animal, devouring great quantities of fish and crustaceans.

Of the short-snouted rays the commonest is the **Thornback Ray** (*Raia clavata*). The skin is rough and covered with spines of various sizes, many of them large, peculiarly shaped and curved. These are found on different parts of the body, on the snout, near the eyes, in rows on the tail, and one specially prominent row running down the back to the end of the tail gives this ray its name of Thornback.

Other rays are the **Homelyn** or **Spotted Ray** (*Raia maculata*), the **Blonde Ray** (*Raia brachyura*), rather like the Spotted Ray, but with a blunter snout, and the **Cuckoo Ray** (*Raia naevus*), which may be known at once by its remarkable coloration. The body is marked with wavy bands of sepia and spots and patches of a lighter shade. On each side in the middle of the wing is a very striking ringed spot like a large eye, consisting of a circle of cream colour with a blackish centre surrounded by a dark brown ring.

Three other species of ray occasionally landed at Plymouth are the **Small-eyed Ray** (*Raia microcellata*), the **Painted Ray** (*Raia undulata*), and the **Sandy Ray** (*Raia circularis*).

In the **Electric Ray** (*Torpedo nobilitiana*), specimens of which are occasionally exhibited, there are special organs on each side of the body for producing electricity. They are used to stun other fishes for prey and in large specimens are capable of giving an electric shock powerful enough to disable a man.

II. THE BONY FISHES

In these there is a skeleton of bone, the body is usually clothed with scales, and the gills are covered by a special plate, the gill-cover, behind which there is one slit only. The eggs are always small and generally very numerous and those of many species drift freely in the water.

THE EEL FAMILY

The body of an eel is very long and flexible, flattened at the tail-end and exceedingly muscular. The breast-fins are well developed but there

are no hinder paired fins. The back fin is continuous round the tail with the fin along the underside of the body.

One marine species of this family is common locally. It is the **Conger** (*Conger vulgaris*) which is most abundant in deep water and on rocky ground. It possesses great strength and is a formidable creature to handle in a small boat. It has large eyes, large gill-openings, upper jaw longer than the lower, no scales, very strong dangerous cutting teeth, and the back-fin commences close behind the head (see Fig. 11).

The female Conger grows to a length of 6 to 8 feet, and to a weight of 70 to 128 lb. The male is much smaller, not often exceeding 2 feet; it has a blunter snout and larger eyes than the female. The number of eggs is enormous; in one specimen the eggs were counted and found to number nearly eight million. The Conger can only spawn in deep water and goes out into the Atlantic to do so.

THE COD FAMILY

This family includes some fishes of great commercial importance, such as the Cod, Haddock, Whiting, Hake and Ling. They are fishes that feed generally on or near the bottom, devouring other fishes, crustaceans, molluscs and worms. Many are provided with a *barbel* or sensitive feeler on the lower jaw, with which they touch and feel along the ground. They also hunt by sight.

The **Cod** (*Gadus morrhua*), is not common near Plymouth though occasional specimens are obtained. It has a heavily built body reaching a length of 5 feet and 100 lb. in weight. The upper jaw is longer, and has stronger teeth than the lower, and the barbel on the chin is long. It feeds mainly on things picked up off the bottom. A single female lays from seven to nine million minute floating eggs.

The **Poor Cod** (*Gadus minutus*) is common locally in deep water. It is not more than 6 inches long. It is a beautiful warm brown with the margins of the delicate fins pale blue.

The **Pout** (*Gadus luscus*) is deeper in the body than the Poor Cod and grows larger. It is a bronze, or coppery colour, with broad upright bands of a darker shade. There is a black spot near the breast fin and a long barbel on the chin.

The **Whiting** (*Gadus merlangus*) is considered the most delicate in flavour of all the Cod family. Unlike the species just described it has only a very minute barbel on the chin, probably because it does not feed so closely on the bottom as they do, its food consisting chiefly of fish and shrimps. It is greenish grey or yellowish on the back, silver below, with yellow lines along the sides, and a black spot at the root of each breast-fin. Large specimens measure 21 inches in length, and weigh from 2 to 4 lb.

The Whiting is abundant in shallow water, and is especially plentiful

off Devon and Cornwall. A single female lays from 150,000 to 300,000 minute floating eggs.

The **Pollack** (*Gadus pollachius*) differs from the whiting in having the lower jaw markedly longer than the upper. It has no barbel on the chin, and probably takes little food off the bottom, feeding mainly on other fishes caught in mid-water. The colour is a dull green above, lighter below. A large Pollack is about 3 feet long, but the usual length is from 18 to 30 inches. It is a very common fish in Devon and Cornwall, almost always found near weed-covered rocks. It gives good sport with the line, the best bait being sand eels, worms, prawns, or artificial bait.

Other members of the Cod family often to be seen in the Aquarium are the **Three-bearded**, **Four-bearded** and **Five-bearded Rock-lings**. In these, the very narrow front fin on the back is sunk in a groove, and kept in frequent vibration during life.

THE SEA-PERCHES

The **Bass** (*Morone labrax*), is a silvery fish with strong spines in the first part of the back fin (see Fig. 10). It may reach a length of about 3 feet and 30 lb. in weight. It is a coastal fish swimming in shoals near the shore when small and often making its way up rivers. This fish is excellent for food and affords good sport to the angler who often takes it with rod and line from the shore on an incoming tide. It feeds on other fishes, shrimps, crabs, etc.

THE HORSE-MACKERELS

One species occurs locally sometimes in enormous shoals, the **Common Horse-mackerel** or **Scad** (*Caranx trachurus*). It has a row of overlapping bony plates along each side, those near the tail being keeled. It resembles the Mackerel in food and habits.

THE RED-MULLETS

The **Red Mullet** (*Mullus surmuletus*), can be recognized by the shape of the head, the brilliant red colour, and the two stiff barbels or feelers attached to the lower jaw. When feeding the barbels are used to stir the sand and gravel for worms, shrimps, and other small creatures; when not in use they are folded back into grooves on the lower jaws.

The Red Mullet reaches a length of about 15 inches. It has always been famed for its distinctive and delicate flavour.

THE SEA-BREAMS

The **Sea-Bream** or **Chad** (*Pagellus centrodontus*) has a plump deep body, a single long fin on the back with strong spines in front and soft fin-rays behind, long breast-fins and large scales. The colour is strik-

ing, orange-red on the back, silvery below, with a large black spot on each shoulder. The spot develops when the young are about 6 to 7 inches long. This fish is a bottom feeder, living on crustaceans and small fishes. It prefers the neighbourhood of weed-covered rocks near the shore.

THE WRASSES

The Wrasses have large thick lips, strong crushing teeth in the throat, most of the back fin spiny, and bright colours forming intricate patterns, bands and spots on their bodies.

The **Conner or Ballan Wrasse** (*Labrus bergylta*), is a heavily built fish common in shallow water; it sometimes reaches a length of 1½ feet and a weight of 7 to 8 lb. Its coloration is very striking in all shades of blue, green, yellow, brown, and orange, the tints varying in different proportion in different fishes and at different times of the year, being always brightest during the breeding season in the spring and early summer. The scales are often edged with a reddish orange and form a network pattern over the body. Spines and fin-rays also are reddish orange.

Ballan Wrasses build rough nests of seaweed in crevices in the rocks, both male and female assisting in the construction. Their food is chiefly crustaceans and molluscs, the hard shells of which they crush with the powerful throat-teeth. They are greedy, voracious creatures, attacking and devouring crabs of quite a large size, even hermit-crabs having no chance whatever against them.

The fish is eaten in many places, but it is not considered worth catching for the market, as its flesh is soft and insipid. It is used for baiting crab-pots.

The **Rock Wrasse** (*Ctenolabrus rupestris*), is a small species, 5 to 6 inches long, and of a reddish or golden colour, sometimes banded with a darker tint. A dark spot high up on the back at the root of the tail readily distinguishes it from other kinds. It lives in fairly deep water.

The **Corkwing** (*Cremilabrus melops*) is a small fish (see Fig. 7f), not more than 8 to 9 inches long, found frequenting rocks close inshore. The colour varies greatly in different specimens but three or four yellow bands across the cheeks and gill-covers are usually present, and the dark spot behind the eye, and the dark spot half-way up the body immediately in front of the tail-fin of the female are always distinct.

The male and female of the **Cuckoo Wrasse** (*Labrus mixtus*) are so different in appearance that they were long considered to be two distinct species. The male is brilliantly coloured, yellow or orange with long bright blue stripes running down the body, while the female is reddish and has three large black spots surrounded by light margins on the hinder part of the back. This species lives in deeper water than the Ballan Wrasse and rarely reaches more than a foot in length.

THE WEEVERS

The word Weever appears to have been derived from an old word *wivre*, a viper. We have two species of which the **Lesser Weever** or **Sting-fish** (*Trachinus vipera*), is more often met with owing to its habit of frequenting shallow sandy bays. The habit of the fish is to bury itself in the sand with only the top of the head and the tip of the back fin exposed, on the look out for prey. The spines of its first back fin, which is black in colour, and a long spine on each gill-cover are hollow and connect with poison glands. Intensely painful wounds can be caused by them, as when the fish is trodden on with bare feet.

THE PIPEFISHES

The Pipefishes have very long, slender roundish bodies and swim more or less upright with rapid flickering movements of their delicate dorsal fins, or rest with their long tails curled around seaweeds or other supports. There are no scales on the body, their place being taken by large bony plates or rings. The head is prolonged into a tube-like snout with a small toothless mouth at the tip. They feed on minute swimming animals which they suck in through their tiny mouths.

In the Pipefish family, as in the Sticklebacks, the males take charge of the eggs until they hatch, some carrying them in pouches, others fastening them on to the underpart of their bodies.

The **Great Pipefish** or **Needle-fish** (*Syngnathus acus*), is one of our most common species. It reaches a length of 16 to 18 inches. The male has a long pouch on the underside of its body, formed of two flaps of skin which fold over and completely cover the eggs. One specimen in the Aquarium hatched out 51 young, each of which measured just over an inch. Fig. 7a shows the female and the young just out of the pouch.

The green **Broad-nosed Pipefish** (*Siphonostoma typhle*), has a larger head and a much deeper snout than the Great Pipefish. A male with its pouch filled with eggs and a female are shown in Fig. 7b & c.

The **Ocean Pipefish** (*Nerophis aquoreus*) is longer than the two previous species, reaching a length of 1½ to 2 feet or more. The tail tapers to a point without any tail-fin (see Fig. 7d). It is sometimes called the Painted Sea-adder from its snake-like markings, and its habit of coiling round seaweed. It is yellow or yellowish green with narrow bluish bands nearly to the end of the tail, and a bright purple stripe running from the eye along the side of the snout. The male does not possess a pouch, but carries the eggs fixed or glued in rows in a groove on the underside of the body.

The **Worm Pipefish** (*Nerophis lumbriciformis*), is the smallest of the British Pipefishes, only 5 to 6 inches long and is found under stones on the shore near low-water mark.

The **Sea-Horse** (*Hippocampus guttulatus*), is well known to almost everyone by its quaint shape. Unfortunately it is rarely found near Plymouth.



FIG. 7.—Each letter is placed in line with the tip of the snout of the fish to which it refers

- (a) Great Pipefish (*Syngnathus acus*) female.
- (b) Broad-nosed Pipefish (*Siphonostoma typhle*) male.
- (c) Broad-nosed Pipefish (*Siphonostoma typhle*) female.
- (d) Ocean Pipefish (*Nerophis aquarum*).
- (e) Stickleback (*Spinachia vulgaris*).
- (f) Corkwing Wrasse (*Cremilabrus melops*).
- (g) Two-spot Goby (*Gobius rathbuniparrisi*).
- (h) Bullhead (*Cottus bubalis*).

THE STICKLEBACKS

Most people are familiar with some of the freshwater members of this family. There is one species which frequents salt water only, the **Fifteen-spined Stickleback** (*Spinachia vulgaris*). It is very common round Plymouth in shallow water, keeping near rocks or stones covered with seaweed into which it darts if alarmed. It grows to 6 or 7 inches in length, and is easily distinguished from all the other sticklebacks by its long body, the fifteen spines on its back and its long snout and small mouth (see Fig. 7 e). The male makes a nest in a tuft of growing seaweed. It spins a white silky thread from its body, and swims round and round the tuft, binding it together. After the eggs have been laid inside, the male guards the nest with great pugnacity until the young hatch out, attacking any creature that approaches. It also protects the small fry for some time until they are able to find food for themselves.

THE DRAGONETS

The **Dragonet** (*Callionymus lyra*), is a small fish very common on the trawling grounds. It rests on the bottom, often buried, and in conformity with this habit its lower surface is flattened. The head is large and the first ray of the back fin is very long, reaching as far back as the tail. In the breeding season the male is strikingly coloured, the body and fins bright yellow or orange, banded and spotted with sapphire-blue and lilac. In the spring the males can often be seen flaunting their bright colours before the duller females.

THE MACKEREL FAMILY

The members of this family, which includes the Tunny and Bonito as well as the Mackerel, are some of the swiftest and most active of all the fishes. They are migratory, associating in large shoals, and spawning in the open sea. Their blood is warmer than that of most fishes, and their muscles redder because of the larger supply of blood needed to maintain their constant activity. Even in the Aquarium tanks mackerel appear to swim day and night without stopping.

The **Mackerel** (*Scomber scombrus*), is noted for its beautiful colouring. The back is a rich greenish blue with wavy cross-bands of black, whilst the lower part of the body gleams like brilliant silver shot with opalescent tints, pink, blue and pale green. Mackerel feed on the minute floating life of the sea, on sprats and other small fishes.



FIG. 8.—COMMON OCTOPUS (*Octopus vulgaris*) X 1



FIG. 9.—CUTTLEFISH (*Sepia officinalis*) X 1



FIG. 10—BASS (*Morone labrax*) $\times \frac{1}{2}$

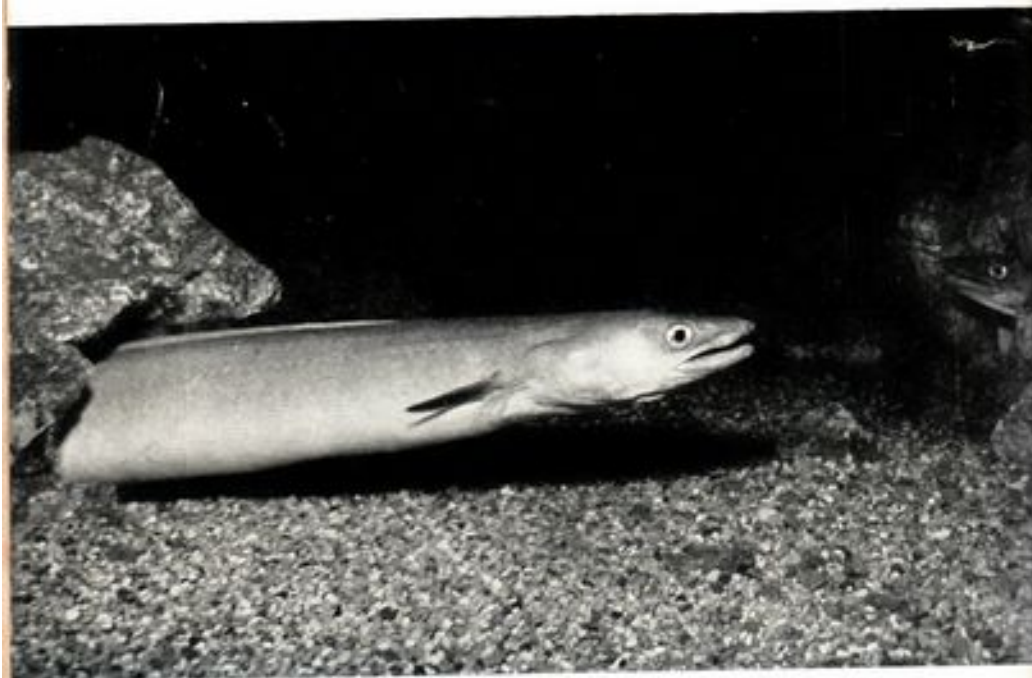


FIG. 11—CONGER EELS (*Conger vulgaris*) $\times \frac{1}{2}$

THE BLENNIES

Most of the Blennies found here are shore fishes and lurk under stones and seaweeds in shallow pools between tide-marks. The Common Blenny, Tompot and Butterfly Blenny, have long smooth slimy bodies without scales, and a long fin on the back notched near the middle.

The **Common Blenny** or **Shanny** (*Blennius pholis*), grows to 6 inches in length. It is a very active fish, climbing about on the rocks by means of its large fan-shaped breast-fins, and may often be seen peeping out of crevices, or crawling about out of the water. Its teeth are strong and sharp and can bite off acorn-barnacles and other hard-shelled animals.

The **Tompot** (*Blennius gattorugine*), is the largest of the British shore blennies, reaching a length of 9 inches. It has a fleshy fringed tentacle or feeler over each eye. In colour it is olive-grey or brown and yellow with blotches and bands of a darker tint. It lives in rather deeper water than the Shanny.

The **Butterfly Blenny** (*Blennius ocellaris*) is so called from the long fin on the back having a mark on it like the "eye-spot" on a butterfly's wing. The Butterfly Blenny is 7 or 8 inches long, with two fringed tentacles or feelers above the eyes. The eggs are generally laid inside an empty whelk shell and the male sits in the shell guarding the entrance. It lives in deep water.

THE GOBIES

The Gobies are small fishes, many of them common in shallow water and in rock-pools near the shore. The chief peculiarity of the Gobies is the "sucker", a cup-like sucking disc, formed by the union of the two hinder fins, which is used by the fish to fix itself firmly on to any surface.

The **Rock Goby** (*Gobius paganellus*), lives in rock pools and under stones between tide-marks, often being found high up on the shore in brackish water almost out of reach of the sea. It is about four inches long, and swims in short jerks.

The **Common or Sand Goby** (*Gobius minutus*), is abundant in shallow sandy bays and is often caught by children in their shrimping nets. It is speckled like the sand and difficult to see. It is much preyed on by other fishes.

The **Spotted or Two-spot Goby** (*Gobius rufescens*), prefers the neighbourhood of rocks and seaweed. It swims in shallow water and does not rest on the bottom like the gobies previously mentioned. The distinguishing spots which give the fish its name are large and velvety black with light edges, one on the body near the breast-fins, and one at the base of the tail-fin (see Fig. 7 g). It is abundant round Plymouth.

THE GREY MULLET

Grey Mulletts are lively active fishes which swim in shoals near the shore, coming in and out of estuaries with the tide. They are difficult to catch, for even when surrounded by the net they frequently spring over the head-lines and make their escape.

A **Grey Mullet** (*Mugil chelo*), has a small mouth, the jaws are fringed with small weak teeth. It browses on the green and brown plant growth that coats the stones and piles in the harbour. The stomach is adapted for this food and forms a strong gizzard something like that of a bird. The colour is silvery blue-grey above, white below, the sides marked with dusky bluish stripes running down the whole length of the body along the rows of scales.

THE GURNARDS

The Gurnards may be recognized by their large angular heads, strongly armoured with bony plates and spines, and by the three remarkable "fingers" on each side of the head. These are really three of the fin-rays of the breast-fin, separate from the others and movable, and are used by the fish as feelers when searching for food, and for walking. The Gurnards feed generally on the bottom of the sea on shrimps, crabs, and small fishes. They are all brilliantly coloured, red or brownish red or grey on the back, and dull white underneath.

The **Sapphirine Gurnard** (*Trigla hirundo*), also called Tub, or Latchet, is named Sapphirine from the beautiful azure colour on the upper surface of its long breast-fins. When spread out and so displaying the varied markings and tints of azure, pink, red and black, these fins look like the wings of some gorgeous butterfly. The general colour of the body is brownish red, with the back and tail-fins in red or purple tones. This is the largest of our Gurnards, growing to over 2 feet in length and 14 lb. in weight.

Other species are the **Red Gurnard** or **Cuckoo Gurnard** (*Trigla cuculus*) and the **Streaked Gurnard** or **Polperro Bulldog** (*Trigla lineata*), and the **Grey Gurnard** (*Trigla gurnardus*).

THE BULLHEADS

The Bullheads are so called from the shape of the curious fierce-looking head armed with backward-pointing spines. They are able to erect the spines and swell out the head to a great width when annoyed or attacked.

The **Father Lasher** or **Lucky Proach** (*Cottus bubalis*), lives in the sea near the shore and in rock-pools. Its large breast-fins (see Fig. 7 h) enable it to make short sharp dashes after prey. It often lays its egg-masses in the tank, in crevices of the rocks.

The **Pogge or Armed Bullhead** (*Agonus cataphractus*), is a small curious-looking fish rarely more than 6 inches long, with the head and body angular and covered with hard bony plates. On the mouth and chin are numerous small barbels or feelers. The body is yellowish grey, barred with four or five blackish bands.

THE FLATFISH FAMILY

The members of this family are amongst the most remarkable of the fishes in structure; they are all very much flattened, and always lie on one side at the bottom of the sea, with the upper surface coloured, and the lower or hidden surface white. Even more extraordinary is the position of the eyes in the adult, which are both on the same side of the head, the upper or coloured side, the white under-surface being called the "blind" side. When first hatched the young flatfish has one eye on each side of its head like an ordinary fish, and swims in the same way, but as it grows older the bones of the front part of the head become twisted so as to bring the two eyes close together on one side of the body. By the time the little fish is two or three months old, and from half an inch to an inch in length, the change is complete, both eyes are on the upper side and it has taken to lying on its underside on the ground.

The *Plaice*, *Flounder*, *Dab*, *Lemon Dab* have the right side uppermost and coloured, and in all the teeth are stronger and more developed on the lower or "blind" side. The *Turbot*, *Brill* and *Tophnots* have the left side uppermost, and the jaws and teeth equal on both sides.

All the British species of Soles have the right side uppermost, viz. the *Common Sole*, *Sand Sole*, *Thickback*, and *Solenette*, of which the first two are valuable food fishes. Teeth are present only on the lower side of the mouth.

The **Plaice** (*Pleuronectes platessa*), has bony knobs on its head, large prominent eyes, broad, straight-edged flat teeth in the jaws, and strong crushing teeth in the throat. Its colour is rich brown marked with large orange or red spots, the spots generally surrounded by a pale circle in old mature plaice. Plaice feed chiefly on shellfish, crushing the shells with the powerful throat teeth; mussels, cockles and other small bivalves are devoured, and also small crabs, worms, etc. A single female lays from 300,000 to 480,000 minute floating eggs.

The **Flounder, Butt or Fluke** (*Pleuronectes flesus*), has sharp chisel-shaped teeth in the jaws, and crushing teeth in the throat, small smooth scales on the body, and some curious larger scales projecting from the skin, and forming a row of rough spiny knobs along the bases of the fins. The colour varies with the ground they live on, sometimes greyish olive, mottled with brown, sometimes very dark brown or blackish without any definite markings.

This fish is abundant in estuaries and harbours, and often goes up river to fresh water. It buries itself in the sand or mud, working itself

down until only the eyes and mouth are above the surface. Although the flounder can live in fresh water and prefers dwelling in the brackish water of estuaries, it goes to the sea to spawn. A single female sheds more than a million floating eggs. The young flounders come inshore as they grow bigger, entering harbours, estuaries and rivers.

The **Common Dab** or **Sand Dab** (*Pleuronectes limanda*), is a small species, the average size at Plymouth being 8 to 9 inches. It may be known by the roughness of the skin, due to the spiny scales. In colour it is a light brown, with small dark spots arranged like the spots of the plaice. It feeds on hermit crabs and other crustaceans, starfishes, worms, etc.

The Dab is very common here, abundant in the sea and in estuaries but not ranging as far up the rivers as the flounder. A single female lays from 100,000 to 130,000 very small floating eggs.

The **Lemon Dab** (*Pleuronectes microcephalus*), is also known as the **Merry Sole** at Plymouth; and generally in the North Sea and in the London markets as **Lemon Sole**, although it is not a sole. It is oval in shape with a small head and mouth and large prominent eyes which can be twisted around independently of each other, often giving the fish a comical expression (see Fig. 12). The scales are small and smooth and the colour is bright brownish yellow with light and dark blotches. Lemon Dabs are found off Plymouth in 20 to 40 fathoms, the largest measuring from 16 to 17 inches. It is especially partial to worms and hermit crabs. A single female lays from 600,000 to 700,000 floating eggs.

The **Turbot** (*Rhombus maximus*—*Bothus maximus*), has a large body rhomboid or diamond-shaped, armed with scattered blunt bony knobs (tubercles) which are really modified scales. The colour is sandy-brown speckled all over the body and fins with lighter or darker shades varying according to its surroundings. It grows to a large size and weight, the males to 26 inches and the females to 28, some being recorded as 3 feet in length. It is a very prolific fish: a female 18 lb. in weight had over five and a half million eggs and another and larger one had over fourteen millions. The large Turbot feed almost entirely on other fishes.

The **Brill** (*Rhombus laevis*—*Bothus laevis*), resembles the turbot, except that the body is narrower in proportion to the length, and is covered all over with minute smooth scales slightly projecting from the skin. The colour is greyish brown speckled with reddish brown spots, or dark speckled with white spots, according to the ground on which it lies.

The **Common Sole** or **Dover Sole** (*Solea vulgaris*), is the most valuable of the Soles, and is noted for its delicate flavour. The colour is yellowish or greenish brown with rows of dark or black blotches down the middle of the body and along the bases of the fins; and a black spot also on the outer end of the breast-fin. It is more active by night, seeking its food by smell and touch; in the daytime it often lies concealed in the sand with only its eyes showing above the surface. A single female lays as many as 750,000 floating eggs.



FIG. 12.—MUMMICHOG OR MUMMICHOG (Fundulus heteroclitus).

The **Thickback** (*Solea variegata*), is known also as the **Banded Sole** from the five dark-coloured bands across the brownish red body. It has the mouth straighter and nearer the snout than in the other Soles, and very small breast-fins. It grows to 8 or 9 inches in length. Thickbacks are very abundant off Devon and Cornwall in water of over 20 fathoms in depth.

COLOUR-CHANGE IN FLATFISHES

When flatfishes lie on sand or mud they are hardly distinguishable from their surroundings, all the family possessing the power of changing their colour according to the ground they rest on, becoming lighter on a light ground, and darker, even black on a dark surface. This is demonstrated in a special tank where various flatfishes are kept on grounds of contrasting colour.

The colours are contained in colour-cells or *chromatophores* under the skin, yellow, orange, red, and black, and often beneath these there is a silvery reflecting layer. The chromatophores can be expanded or contracted; when they expand the colours are spread out and the fish darkens; when they contract the colours are concentrated into tiny specks and the fish looks pale.

THE BOARFISH

The **Boarfish** (*Capros aper*) is a little fish shaped like a John Dory, but orange red in colour, barred with a darker shade. It swims near the bottom, snapping up tiny creatures for food. The name refers to the pig-like snout and to a grunting noise which it can make.

THE JOHN DORY

The **John Dory** (*Zeus faber*), probably owes its name to its golden markings, *jaune dorée*. Another name, Peter-fish or St. Peter's Fish, recalls the tradition that this was the fish from which St. Peter took the tribute money, the spots on the sides being known as his "fingermarks". The same legend is also told of the haddock.

The body of the John Dory (see Fig. 1) is short, deep, and narrow from side to side. The large mouth is curiously constructed, opening by a sliding movement of the bones of the upper jaw, which causes it to protrude automatically in the form of a tube. The eyes are very brilliant, moving independently as if set on a swivel.

The front part of the back fin is supported by long stout spines. The hinder part has soft rays; this fin and that on the underside of the body below, propel the fish slowly along by wave-like movements. The John Dory catches little fishes by stalking them. Moving quietly along it is to them a scarcely visible thin upright object in the water and they are not alarmed. When it gets within striking distance the long mouth is suddenly shot out and the victim engulfed.

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which forms the food of the lower animals, and thence to the natural history of the fishes which feed on this lower life, working out all the stages of their growth and development. It is upon such knowledge that a right understanding of the problems affecting the sea-fishing industry must be based.

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All Correspondence should be addressed to—

THE DIRECTOR,
Marine Biological Laboratory,
Plymouth.

BOOKS

The following is a short list of recent and fairly recent books on marine biology which can be recommended to the general reader. A few are out of print but can usually be obtained from any good library.

1. THE SEAS by F. S. Russell and C. M. Yonge. Frederick Warne & Co.
2. LIFE BY THE SHORE AND SHALLOW SEA by Douglas P. Wilson. Ivor Nicholson & Watson.
3. SCIENCE OF THE SEA. Second Edition. Edited by E. J. Allen. The Clarendon Press, Oxford.
4. THEY LIVE IN THE SEA by Douglas P. Wilson. Collins.
5. LIFE BY THE SEASHORE by Marion Newbigin, revised by Richard Elmhirst. George Allen & Unwin, Ltd.
6. ANIMAL LIFE IN THE SEA by R. J. Daniel. The University Press of Liverpool, Ltd., Hodder & Stoughton, Ltd.
7. MARINE LIFE by C. M. Yonge. Britain in Pictures Series. Collins.
8. THE FISHES OF THE BRITISH ISLES by J. Travis Jenkins. Frederick Warne & Co., Ltd.
9. THE FISH GATE by Michael Graham. Faber & Faber.

Printed in Great Britain by
LATIMER, TREND & CO., LTD.
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