Angler-Fishes.*

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THE fins of fishes are formed of a membrane supported by rays, which are generally flexible and jointed. But in one great group of fishes—the perch group—some of the fin-rays, and particularly the front rays of the fin on the back, are converted into strong, sharply pointed spines, weapons of attack and defence. It might be thought that these specialised structures would be end-products of evolution; but that is not so, for in various offshoots of the perch tribe the spines are modified for other purposes. In the flat-fishes, which swim by undulating movements of the body and the long marginal fins, the spines are reconverted into articulated rays—an example of reversible evolution. In the sucker-fishes, which attach themselves to sharks, turtles, and other marine animals, the spinous dorsal fin is transformed into a laminated adhesive disc placed on top of the head. In the angler-fishes the spinous rays of the dorsal fin have become slender and flexible, and the first is placed on the head, and forms a line and bait.

The angler-fish found in British seas has a large flat head, and a wide mouth furnished with sharp depressible teeth. The bait is a flap of skin—sometimes white in colour—placed at the end of the line, near the mouth. The angler lies on the bottom—and waves about the bait, which is perhaps better termed a lure, for it is not meant to be seized—and so entices other fishes near enough to be caught.

In the seas of other parts of the world there are other anglers more or less similar to ours. In some of these, as in *Lophiomus naresii* from New Guinea, the skinny flaps that look like weeds, and help to conceal the lurking fish, are much more developed than in the British species.

Another group of anglers includes a number of small fishes, compressed in form, and often brightly coloured and marked with patterns of stripes or spots. They are found in warm seas, many inhabiting the crevices of coral reefs. One lives among the *Sargassum* weed, where its coloration of mottled brown on yellow renders it inconspicuous.

The two groups of anglers so far described include fishes that live in the light; they have a coloration that harmonises with the ground on which they lie, or the rocks and weeds amongst which they rest, and their lure is a flap or a tassel at the end of the line. A third group includes the anglers that live out in the ocean, and deep down in the dark, generally from about 100 fathoms to 500 fathoms below the surface; not at the bottom, but in mid-water. These are uniformly coloured, generally blackish. Their lure is luminous, the swelling at the end containing a glandular sac with a luminous secretion; the sac is partly enclosed in a pigmented cup, lined inside by a peculiar membrane that acts as a reflector; the light shines

out through the mouth of the cup, and there is some evidence that it can be turned on or off at will. Generally the mouth is large, and the teeth are strong, sharp, and depressible inwards.

Another peculiarity of the oceanic anglers is the extraordinary distensibility of the stomach. In the depths of the ocean meals are scarce, and the angler does not want to refuse one because it is too big. There are several examples known of anglers that have swallowed fishes two or three times their own length and several times their own weight; two of these had just begun to digest the fish they had swallowed, and then took baits and were hooked and caught on lines! Others have been carried upwards by the struggles of their victims when these were first seized, and have been found at the surface of the ocean, alive but helpless. I believe that these could not have escaped their fate, for their teeth are so arranged that they hold the victim that is struggling to escape, but lie down and allow a little more of it to pass inside every time its efforts relax; so that eventually it is completely engulfed, and makes a considerable alteration to the figure of its captor.

In *Linophryne* the teeth are stronger than in any other angler. In *L. arborifer* the large luminous lure is carried by a short stout line, and below the chin is a large branched barbel, or beard. The use of this appendage is unknown; it may be luminous, or the little swellings on the terminal branches may be sensory organs, perhaps giving warning of the approach of other fishes. In other species of *Linophryne* the beard is different in structure, and the lure may have a series of filaments on each side of the bulb.

Edriolychnus has the skin translucent, although the stomach is pigmented; the luminous organ is sessile, without any line. *Gigantactis* is remarkable for the long fine line, in one species four times as long as the fish itself. One is reminded of a fly fisherman. The movements of the small lure may imitate the swimming movements of a small luminous animal.

The line is a fin-ray, and like other fin-rays is articulated to the end of a basal bone; this lies in a hollow on top of the head, but in *Gigantactis* its end projects. In *Dolopichthys* the basal bone projects more distinctly, and in some other anglers the whole of it may be permanently protruded, and it may increase in length, forming a rod.

Lasiognathus (Fig. 1) is a complete angler, for it has not only a rod and a line, but also a triangle of hooks, like those used by a pike-fisherman. In this extraordinary fish the upper jaw is connected to the head by a membrane; the prey, perhaps brought to the mouth by the hooks, must be completely enclosed by a downward movement of the upper jaw, when the membrane connecting it to the head forms the sides of a pouch; the teeth are bristle-like, of no use for piercing, but meeting across and closing the gap in front of the lower jaw,

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when the prey is inside the mouth. I suspect that this fish may feed on Pteropods, which are small enough to be taken in whole, and would offer a good hold for the hooks.

There is a considerable diversity among the anglers of the ocean. The lure differs greatly in size and form, and may be sessile on the head, or

FIG. 1.—*Lasiognathus saccoctoma*. Natural size.*

at the end of a short or a long line, and the line may or may not be connected with a rod; one fish even has hooks, as well as a rod and line. We can get some idea of the meaning of this diversity if we reflect that human anglers specialise; there are salmon fishermen, trout fishermen, pike fishermen, and roach fishermen, each using a different sort of rod, line, and bait or lure. Moreover, human anglers may use a variety of baits for the same fish; the trout fisherman, for example, may use artificial flies, spinning minnows, or worms, not to mention other methods. It would also be of advantage to the angler-fishes to display a variety of lures, for if all fished with the same bait, in the same way, the inhabitants of the ocean might come to look upon it as a danger signal.

The typical members of the group have a uniform coloration, a luminous lure, a large mouth, strong teeth, and a very distensible abdomen. This is an example of correlated adaptations; these characters are related to the habits and conditions of life of these fishes, and can scarcely have been evolved by accident, which is a modern theory of evolution that has some popularity.

Further correlated adaptations have developed within the group. In *Himantolophus* the lure is very complicated in structure, with numerous tentacles, ending in luminous tips. In young examples of this genus, about 2 inches long, the lure is simpler, and the mouth smaller, than in the adult. At a still earlier stage, as in all these anglers, there is no line or lure; it grows out from the head. These young fishes, with relatively small mouth and feeble teeth, and with the lure absent or little developed, live nearer the surface than the adults, and feed on minute organisms. But some retain these juvenile habits throughout

life; they never grow to more than two inches long, and the line and lure do not develop. *Lipac-tis* is very similar in structure to a young *Himantolophus*, but has no lure, somewhat larger eyes, and much larger nostrils, indicating that it seeks its food by smell and sight. The species of *Rhynchoceratias* differ in their pincer-like jaws, and some by still larger nostrils. The final stage in this series—*Aceratias*—differs from *Rhynchoceratias* in having the eyes directed forwards (Fig. 2); and the snout is shortened in relation to stereoscopic vision, as in man. This little fish differs considerably from the typical anglers of the ocean; but its modifications of structure are all related to the adoption of a new habit, search for food by smell and sight.

Neoceratias (Fig. 2) is probably related to *Gigantactis*; it has also lost the line and lure and developed the olfactory organ, but on a different plan, one nostril being at the end of a tube. This curious fish has teeth outside its mouth, on the surface of the head; each is long, slender, hooked at the end, and inserted in a muscular papilla, so that it is independently moveable. One may imagine the ends of two or three teeth coming together to catch something, and then passing it on to the other teeth, until it gets inside the mouth.

Now comes the most remarkable thing of all. All these free-swimming oceanic angler-fishes, black and mostly rather terrible in appearance, are females. The only males of this group known are

FIG. 2.—Above, *Aceratias macrorhinus* ($\times 2$); below, *Neoceratias spinifer* ($\times 3$).

dwarfs parasitic on the females. A pair of fishes was taken in a trawl to the south of Iceland; they belong to a genus—*Ceratias*—distinguished by the spiny skin, and by the very long rod and short line. The wife is 40 inches long; her husband is only 4 inches long, so that she is a thousand times his weight. He is attached to her in the mid-ventral line. The male (Fig. 3) has a general similarity to the female; but he has no line and bait, and no teeth. He is attached to her by

* The figures are taken from two sets of picture postcards issued by the British Museum (Natural History), entitled "Oceanic Angler-fishes", and sold at 6d. a set of five cards, with leaflet.

means of outgrowths in front of the snout and of the lower jaw, which meet in front of the mouth and unite with a prominence on the skin of the female. The union is so complete that it is difficult to say where one fish begins and the other ends; the connecting tissue is fibrous and full of blood-vessels, the general direction of which is from one fish to the other, and the male is a mere appendage, nourished by the continuity of his blood system with that of the female. He is quite incapable of feeding himself, for his mouth is closed in front and has no teeth, and his digestive system is reduced to a vestige. But he has a heart, and gills, so that he is able to breathe; water for respiration enters through the mouth. Another large female *Ceratias* was so fortunate as to possess two males, attached close together on the side of her abdomen.

arrangement, which has the advantage that the mouth has more room for the intake of water for respiration.

These fishes are unique amongst backboneed animals in having dwarfed and parasitic males, and unique among all animals in their method of parasitism, for in no other animal is there a union of the blood-systems of host and parasite. The nearest approach is the embryo of the placental mammals, where also parasite and host are of the same species.

Now if we consider the habits and conditions of life of these fishes we can understand the evolution of the dwarfed and parasitic males. The oceanic anglers are feeble swimmers; they float about waiting for their prey, and they are necessarily few in numbers as compared with the more active fishes that they attract with their luminous lure.

FIG. 3.—*Ceratias holboelli* (male). Natural size.

In these fishes the eggs are shed in the sea, and the males must be free when they are first hatched, and attach themselves if they find a female, first holding on by the mouth, and then becoming grown to her.

In *Photocorynus* a female three inches long has a male only $\frac{2}{5}$ of an inch long attached to the top of her head above the right eye. In *Edriolychnus* a female about 3 inches long has a fully adult male, $\frac{3}{8}$ of an inch long, attached under the spine of the præoperculum, and upside down. The attachment of the male *Photocorynus* is of the same type as in *Ceratias*, by means of outgrowths in front of the snout and the lower jaw, whereas in *Edriolychnus* the main attachment is inside the mouth, which is choked up. In both we must suppose that the male first nipped a piece of the skin of the female between his jaws, and that the ends of the lips fused with the papilla so formed. Then if the tongue pressed against and fused with this papilla inside the mouth, the *Edriolychnus* arrangement would result; but if it were pushed forward between the branches of the lower jaw to effect a union with the female below the mouth, subsequent growth would give the other

They live a solitary life, and they are in the dark. Imagine such a fish, out in the middle of the Atlantic, perhaps half a mile below the surface; How could it find a mate? But there may be thousands of males in a brood, hatched out at the same time from the eggs shed by a single female; and if these at once look for females, the chances of finding one are much greater than if they waited until later, when their numbers had diminished. If they are lucky enough to find one they unite with her and develop at her expense; if not, presumably they perish.

These extraordinary habits of the males have led to the degeneration of the organs they no longer need—the lure, the teeth, and the digestive system.

The males of these oceanic angler-fishes are another example of correlated adaptations, of several independent changes of structure related to new habits. These cannot be explained by the theory of evolution by accident—of changes of structure being due to changes in the germ-cells, that have no relation to habits and environment. They fit in better with the theory that the actions and reactions of the animals themselves result in modifications of structure that become hereditary.