Preliminary Inquiries at Plymouth into the Marine Fauna and the Ova of Fishes.

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ALTHOUGH the Plymouth Laboratory was opened only on June 30th, investigations have been carried on by the Association for the last two years. These inquiries have necessarily been of a general and preliminary character, but they have resulted in the acquisition of definite precise information on several subjects, in which previously only conjecture or complete ignorance prevailed. This information includes discoveries of some value and completeness in themselves, but its chief importance lies in the fact that it shows in what directions and by what means the instruments of inquiry supplied by the Plymouth Laboratory, and its organisation, can be applied without delay to fruitful work. It was with just this object in view that the Council instituted these preliminary inquiries; without them, when the apparatus of the Laboratory was ready for action, the staff would have had to make tentative experiments before they knew what problems the neighbourhood of Plymouth gave the material for solving. With them the fisheries and the marine Fauna of Plymouth are mapped out, and problems to be worked out are definitely proposed, so that the tanks and the powers of the zoologists can be fully occupied without loss of time.

I will shortly describe the inquiries carried on since the beginning of August, 1887, into the local marine Fauna, and the natural history of food-fishes.

In the autumn of last year the Sound inside the Breakwater, and the neighbourhood of the coast on either side east and west, were explored generally by the dredge and small trawl. In this way it was ascertained that some

interesting forms were abundantly to be found at certain localities. Thus the Feather-star (*Antedon rosaceus*), the most interesting of British Echinodermata, lives in large numbers between the Mallard and the Cobbler Buoys, right at the door, so to speak, of the Laboratory, for the spot is but a few hundred yards from the building. A dredge put down there for two or three minutes came up half full of these beautiful and delicate creatures. Anyone wishing to pursue the study of this animal's development and physiology, subjects by no means yet exhausted, has to take very little trouble in order to procure specimens.

In other parts of the Sound only occasional specimens of the Feather-star are met with. Sponges of various species occur abundantly in the Sound, one curious species wellknown to naturalists is somewhat common ; it has usually a globular or nearly globular form ; it reaches a large size, some specimens being as big as a child's head. It has a hard rind, which presents a regular reticulation on the surface. This rounded mass (Raphyrus Griffithsii, Bowbuk) would be taken by everyone at first sight for a sea-worn stone, and there is little doubt that it is a perfect example of what is technically called mimicry; the shape and appearance of a rounded stone having been acquired by the sponge just because it is then mistaken by predaceous animals for one of the stones among which it lies on the sea-bottom. In the interior of this sponge is always found an inorganic body, usually a piece of shell, which served as its foundation when it began to grow.

The curious pipe-fishes, which look like grotesque fishes carved out of a piece of walking stick, are also common in the Sound. These are among the very few fishes which take care of their eggs; the male receives these when they are shed into a pouch formed by the skin beneath his tail, and there they remain while the young fish are developing, and until they are hatched and escape. Thus the male in this order has the same peculiar method of guarding his progeny as the female kangaroo in Australia.

A great number of species of marine worms live on the shores of the Sound and its estuaries. In the latter, digging

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for them is unpleasant, as the mud is so soft that a man sinks in over his ankles; but there is one place in Jennycliff Bay where there is a patch of hard sand, from which they can be dug without difficulty, and many other kinds are found under the stones on the east shore of Drake's Island.

Crustacea are abundant and varied; they include the common shrimp, the red shrimp, the prawn, and many less familiar species. The development of these is being studied systematically in detail, as well as that of the lobster, crab, and "crayfish," by Mr. W. F. R. Weldon.

In Sutton Pool eels are taken at certain times of the year, and efforts are being made to throw some light on the reproduction of these, a problem whose complete solution has evaded the researches of naturalists for the last two centuries.

Passing now beyond the Sound, the thickest marine population occurs in the neighbourhood of the Mewstone. Here have been dredged numbers of large Holothurians, animals with somewhat the appearance of black puddings, a foot in length, and belonging to the same class as starfishes and feather-stars, namely, the Echinodermata. Also beautiful sponges, feather-stars themselves, great coral-like masses of a colonial animal called *Lepralia foliacea*, in the cavities of which the feather-stars creep about, large ascidians or sea-squirts, and the pretty red fans or "sea-trees," as they are called by the fishermen, formed by the Gorgonia, one of the coral order.

On the sands off Whitsand Bay are trawled young flatfishes and a variety of shell-fish or molluscs, including small Cephalopods, allied to the cuttle-fish. On the shores of the bay the rocks which project above the sand are covered with masses of agglomerated sand grains formed by the tubes of a small worm (Sabellaria). These masses are in many cases yards in diameter, and a foot thick, and remind one almost of coral reefs, though the mode of formation is quite different.

The food-fishes have been studied by means of excursions on fishing boats, and by the help of the fishermen. The eggs of nearly all our food-fishes except the herring are buoyant and transparent when they are ripe. The immature

eggs in the ovary are opaque, white grains, but by the time they are shed they become as transparent as glass. These ova as soon as they are shed are fertilized by milt in the water supplied by male fish in the neighbourhood, and then they rise towards the surface of the sea; in calm weather only do they actually reach the surface, because being but slightly lighter than the water agitation causes them to be uniformly distributed throughout the depth affected by the wave-motion. A fine net made of muslin, or similar material, drawn gently through the water at almost any season of the year, collects numbers of these buoyant eggs, which can be taken ashore and examined with the microscope. But as these eggs are of many different kinds, and show constant differences of structure, it is necessary to know what species of fish each kind belongs to. One way of doing this is to trace the development of the young fish after it is hatched, until it reaches an age at which it can be recognised as a whiting, sole, turbot, or other particular species. But this, although easy enough to propose, is exceedingly difficult in practice, and when followed usually leads to serious errors. There is a more certain method, and that is to take the fish when its ova are ripe, and by gentle pressure expel these into a bottle of sea-water, then to add some milt from a male of the same species, and keep the ova so obtained in healthy conditions while they develop. This process of obtaining ova is called artificial fertilization.

A number of species have been subjected by various observers in different places to this process, and the structure of the egg and young stages have been described in published papers. Thus I myself published drawings and descriptions of the ova of the cod, haddock, whiting, gurnard, smelt (Osmerus eperlanus), plaice, common flounder, dab, and pole flounder. But many species remained to be examined. The first ova which I artificially fertilized after arriving at Plymouth were those of Capros aper, a small fish with very spiny fins, known sometimes as the boar-fish, but always spoken of by Plymouth trawlers as the cuckoo. This fish is taken in the trawl occasionally at all seasons of the year, but in the latter part of summer, especially in August and

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September, it is taken in the neighbourhood of the Eddystone in hundreds and thousands, so that it becomes a pest to the fishermen, as there is no market for it.

No attempt was made to follow out the development of these ova, because suitable arrangements were not available. At that time the building was in a very early stage of construction; the stairs had not yet been made, and the plasterers were everywhere at work, so that it was impossible for me to take possession of any room in which to carry on my work. I was occupying a small room in the fishermen's quarter, which I had hired a day or two after my arrival in Plymouth. This room was a short distance from the fish quay, usually known as the Barbican, and this position was its sole recommendation. It had a single window, from which the sky was invisible, as it looked into a narrow court only a few yards wide, on the other side of which were house walls pierced by other small windows.

In this room I kept alive ova of the cuckoo-fish, which I fertilized on board a trawler on August 15th, for three days, and made a few drawings of the successive stages of development. These ova belong to a type which is common to a large number of species of sea-fish. They are spherical, with a transparent, structureless yolk, in which is a single globule of oily matter. The egg-envelope is separated by only a small space from the egg itself.

At the beginning of November the Laboratory was sufficiently advanced that a room in the west wing could be so far finished that I could use it as a temporary work-room, and accordingly it was supplied with some trestle tables, and I occupied it from that time until a week before the formal opening of the building.

In November, December, and January some attention was paid to the herring. At that season there is a regular herring fishery at Plymouth, which consists of two branches, a fishery inside the Sound, which is carried on by open rowing boats working only two or three drift-nets each, and a fishery outside along the coast as far as Bolt Head, carried on by larger boats working complete "fleets" of nets. On clear, quiet, dark nights, when the herring are plentiful,

there are a very large number of small boats fishing in the Sound after sunset, and as each carries a somewhat brilliant light to prevent vessels under weigh running her down, the sight from the Hoe is very pretty, and reminds one of a Venetian fête. The herring taken are all full, *i.e.* in mature spawning condition, till towards the end of the season, when large numbers of spent fish are taken. In Cawsand Bay, on the west side of the Sound, moored nets are used to catch herring; these are of the same kind as drift nets, but are fixed by means of anchors at each end, instead of being allowed to drift with the tide.

As both full and spent herring are taken inside the Sound, it is natural to conclude that the spawn is actually deposited within that area. It is well known that herring spawn is adhesive, and attaches itself to stones and weed at the bottom of the water. Systematic dredging was therefore carried on all over the Sound in January with a view of finding some of the spawn, and so ascertaining at which spots it was deposited. But the search was entirely unsuccessful, circumstances did not allow of similar researches being carried on outside the Sound, and the question of the exact locality where the herring deposit their spawn in the neighbourhood of Plymouth remains to be answered in future seasons. Herring ova have so often been studied and described, that no special study of them was made, and no arrangements were available for hatching any. Young herring were frequently taken in the tow-nets in the months of February and March.

The ova of the common sole had, at the beginning of the present year, never been examined or described. It had been thought by some that male soles were very rarely caught, but on dissection of specimens procured from the fish-quay I found that this was not correct, and in subsequent work on the species I never had difficulty in procuring specimens of the male sex. After the beginning of February I went out frequently in trawlers on their ordinary trips for the express purpose of examining soles in a sexually ripe condition, and artificially fertilizing samples of the ova. On February 6th, I made my first examination of living soles about ten miles

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west by south of the Eddystone. There were not many in the trawl, and although I got a few ripe ova, I could not press any milt from any of the fish. Accordingly, when I got ashore again I found the ova were unfertilized. Nearly all the trawlers after this time went to fish off the Wolf Rock, about thirty to forty miles west of the Lizard, remaining at sea a week on each trip. In order to pursue the study of soles' ova, I went several times with one of them in March, April, and May to this fishing ground, where soles are very much more abundant than off Plymouth. But although I frequently obtained ripe ova in considerable numbers, I could never press out ripe milt from a male. I therefore cut out the testes and cut them in pieces and placed them in the water with the ova, hoping that fertilization could be effected by this method. The expedient succeeded, but only to a slight degree, as only about a dozen ova were fertilized on each occasion out of several hundreds. These few were sufficient to show the normal character of the fertilized ova. The ovum of the sole was thus found to have several marked peculiarities; which enable it to be recognised with certainty when taken in the tow-net. It is of considerable size, and spherical in shape ; instead of having a single oil globule it has a large number of very minute size, which are irregularly distributed in groups of different sizes over the surface of the ovum. The vitellus is homogeneous in the centre, but when the embryo is formed has a superficial layer of separate vitelline masses.

The ova of the merry-sole, *Pleuronectes microcephalus*, were obtained with great ease in large numbers and fertilized without difficulty. Numbers of these were hatched, although they were kept in small bottles, in which the water was changed only once a day. If it were worth while to propagate so abundant and cheap a form, it would be a simple matter to hatch millions of young merry-soles from the eggs of the parent fish caught for the market.

The eggs of two species of gurnard, *Trigla gurnardus* and *Trigla cuculus* were also fertilized, and the young fish hatched; but these were not so hardy as those of the merry-sole.

The ova of the mackerel are at present under observation.

They can be obtained and fertilized with the greatest ease, as in June and July a large proportion of every catch are ripe fish of both sexes. After explaining to Mr. F. Johns, the skipper of a mackerel boat, the necessary operations, and promising him payment for his trouble, I found he could bring me mackerel ova properly fertilized and in good condition whenever he shot his nets. The mackerel is another species which could be artificially propagated to any desired extent. The eggs of the mackerel are closely similar to those of the cuckoo-fish; they have a single oil globule and an otherwise homogeneous yolk; they are buoyant and transparent.

Pilchard ova have not yet been obtained. In the case of mackerel and herring the fishing season and the spawning season coincide; in the case of the pilchard there is no fishery in the spawning season. The pilchard leaves the shore when spawning, and at that time, June and July, no shoals are met with. But spawning specimens are caught occasionally in small numbers in the mackerel nets, and it is from some so taken that I expect before long to get some fertilized ova. Now that the supply of salt water in the Laboratory is at last available, the examination and the hatching of the eggs of fish becomes comparatively easy, and it may reasonably be hoped that these preliminary results will be rapidly extended.