The Life-history of the Pilchard.

By

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We have recently begun to receive from the French Ministère de la Marine a monthly journal entitled Pêches Maritimes, and published as a supplement to the Revue Maritime et Coloniale. The number for August of this journal commences with an article on *La biologie de la sardine,* by M. Paul Guéry. This article consists chiefly of summaries of the researches of four zoologists on the reproduction and life-history of the sardine. We have the summaries given under the following headings:

1. Le laboratoire de Concarneau. Opinion de M. le Professeur Pouchet.
2. Le laboratoire d'Endoume. Opinion de M. le Professeur Marion.
3. Laboratoire de Plymouth. Opinion de M. Cunningham.
4. Opinion de M. le Dr. Henneguy.

In the first section it is stated that in Professor Pouchet's opinion the sardine is a fish of the high seas, attracted to the coast neither by hunger nor the reproductive instinct, but whose migrations are determined by the wandering instinct characteristic of pelagic species, and are subject at most only to influences of temperature. It is pointed out that, according to M. Pouchet, we know nothing concerning the life-history of the sardine.

Then Prof. Marion's conclusions concerning the Mediterranean sardine are described with this difference, that, whereas no observations made by Prof. Pouchet are mentioned, some account is given of the observations of Prof. Marion on which his conclusions are founded. It cannot be said that full justice is done to these observations, no mention being made of the eggs found in the sea, and identified by Prof. Marion as those of the sardine, but we must make allowance for the restrictions of space.

No objection can be taken to the summary given of my own

observations, as published previously in our Journal, except that after they have been correctly quoted they are called *theories* which differ from those of Concarneau. M. Henneguy has studied the question whether any relation could be discovered between the varying abundance of sardines and variations in the abundance of any pelagic organisms which form their principal food. His results were negative.

The commentary by the writer of the article upon the publications which he has summarised is remarkable and surprising. He says the contradiction between the results reached on the one hand at Concarneau and on the other at Plymouth and Endoume is a matter for anxiety as to the reality of the progress made. One is obliged, he says, to accord the same degree of confidence to the statement of men who devote to the service of truth the same zeal, the same loyalty, and the same knowledge. And yet they contradict each other, and the conclusion drawn is that laboratory work is not adapted to solve the problem of the biology of the sardine. This, it seems to me, exemplifies the erroneous way in which scientific evidence is usually regarded by practical men, whether on boards of authority, commissions of inquiry, or in courts of justice. The opinion of one expert is weighed against that of another, and the only comparison by which they are judged is the reputation and authority of their respective authors. Therefore if two experts of equal reputation give contradictory opinions the result is zero. Now it is perfectly obvious that the reputation of a man should depend on the truth of his conclusions and not *vice versâ*, and that in a question of evidence the reputation of the witness is of no importance if he has no evidence to give. But the difficulty is that in the experience of men of affairs scientific methods and scientific knowledge are so completely excluded that they cannot give due weight to the facts on which opinions are based, and cannot therefore judge whether one opinion has more foundation than another. In the question of the reproduction of the sardine, which to anyone familiar with researches on the life-history of fishes is not so wonderfully complicated, the fact that Prof. Pouchet has not seen the ripe eggs of the fish, or the ripe fish themselves, does not in the least invalidate the observations of those who have seen them, namely, Prof. Marion and myself.

However, I have recently been able to add to the observations I have previously made on the reproduction and development of the pilchard. This year I have for the first time obtained artificially-fertilised eggs, and hatched the larvæ in the laboratory, and succeeded in rearing the larvæ for several days after hatching.

The eggs were taken from ripe fish obtained on the night of

September 5th, ten miles south of the Eddystone, by the crew of a Plymouth boat, to whom I had given bottles for carrying the eggs and instructions for dealing with them. Usually ripe pilchards are caught in mackerel nets, pilchard nets not being often used at a sufficient distance from land during the season when pilchards spawn, but in this case the boat was using pilchard nets and fishing for pilchards. The total catch amounted to 2,200 fish, but only a few of those were ripe. In the bottles when brought to me there were a considerable number of dead eggs at the bottom, but several thousands of living ones floating at the surface of the water. These were fertilised and developing, the blastoderm having extended already half round the yolk.

The characteristics of the eggs I have described in previous papers. In these, the divided yolk, single oil-globule, and large perivitelline space were present exactly as in the eggs obtained from the sea, or the unfertilised eggs taken on previous occasions from the fish. A drawing of one of these eggs actually taken from the pilchard and artificially fertilised, agrees in all respects with the figure which I published as the egg of the pilchard in Plate 5 of Vol. I of this Journal. But among these eggs I noticed one which presented an interesting variation or abnormality. This egg is represented in Fig. 1. It resembled the other eggs in all respects except one, namely, that instead of the normal large space between the envelope or

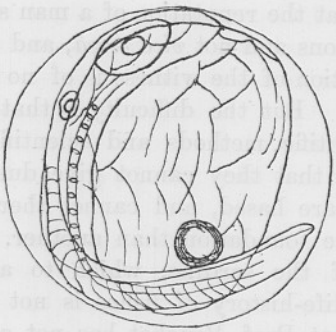

FIG. 1.—Abnormal, but healthy, egg of the pilchard, having small perivitelline space.

vitelline membrane and the egg proper, there was a narrow space as in the majority of other pelagic eggs, for instance the mackerel or plaice. I once found an egg showing this character among those taken from the sea by the tow-net, and thought it was the egg of some other species, its parentage being unknown. It is now clear that it represents an occasional variation in the egg of the pilchard. I kept this egg separate until it was hatched, and found the larva

hatched from it differed in no respect from those hatched from normal eggs.

These pilchard eggs were placed in a glass hatching jar in one of the laboratory tanks, and treated in the way described in my Treatise on the Sole. The temperature of the water was 17° C., and its density, 1026·5. The eggs all hatched on September 7th, only three days after fertilization. The newly-hatched larvæ agreed exactly with Fig. 30, plate 5 of Vol. I of this Journal. The larva is 3·8 mm. in length. Fig. 2 shows the appearance of the living larva seen from above in its natural position, floating with the yolk-sac uppermost. In this position little protuberances are seen on each side of the body; these are larval sense organs, such as are seen in the larvæ of fishes generally, and from them are derived the sense organs of the lateral line, but in the adult pilchard these sense organs are wanting, so that the larval sense organs evidently disappear during development.

When the larva is first hatched the yolk is large, the mouth not open, and there is no pigment, except a few black chromatophores along the dorsal region of the body. The yolk diminished on the second day, September 8th, and on the third day, September 9th, the mouth was found to be open as a wide rhomboidal aperture on the under surface of the head. A little yellow pigment and reflecting substance was now present in the eye.

On the 10th, by the growth of the lower jaw and under parts of the head, the mouth had become terminal; the eyes were black and opaque, and there were black chromatophores along the sides of the body ventrally. The yolk was reduced to a very small remnant, and with the absorption of the yolk the head region had become much shorter in comparison with the rest of the body. On this day I tried to feed the larvæ with minute particles obtained from minced worms, but they took none of it.

On the 11th I gave them some of the minute organisms obtained by the tow-net, and also a little more of the worm food, and, on examining some of the larvæ, saw some of the food in the intestine. The food was particles of worm.

On the 12th, when the larvæ were five days old, they were 5·5 mm. in length, the yolk was all gone, and they continued to feed on the particles of worm. Although I had the finest tow-net used, and put the produce into the jar containing the larvæ, none of it was ever found in their intestines. The tow-net produce included minute Peridiniidæ, diatoms, worm larvæ, &c., which I thought probably formed the natural food of the larvæ, but they did not feed on it. On the 14th there was evidently a diminution in the number of the larvæ, and I found that some had died and fallen to the bottom of the jar. During

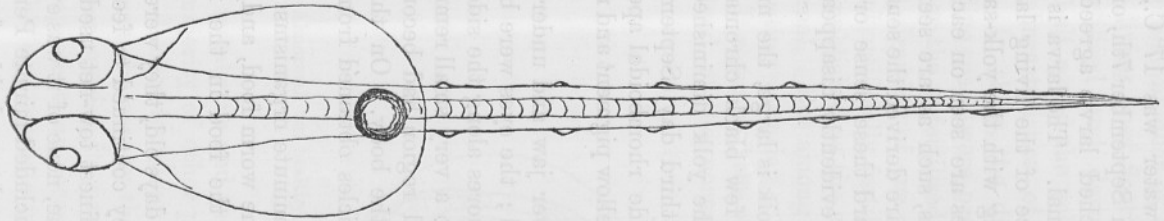

FIG. 2.—Newly-hatched larva of the pilchard, with ventral surface uppermost, showing sensory papillæ.

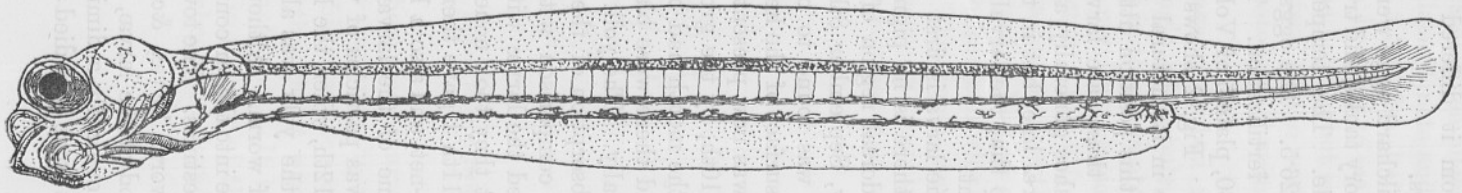

FIG. 3.—Larva of pilchard, nine days old.

the days that they were feeding they were seen to "peck" at the particles of food suspended in the water, and the food was seen in the intestine as a white opaque mass contrasting with the transparency of the body. On the 15th there were few left alive, and on the 17th only one was left, which I took out and mounted. Thus, the longest time any were kept alive was ten days. In the oldest larvæ no great advance in development had taken place; no indication of the permanent fin-rays had appeared, but radiating lines in the larval fin in the caudal region indicated the commencement of the primitive fin-rays. The oldest larvæ did not exceed 5·5 mm. in length in the preserved condition, and very little shrinkage took place in the process of preservation. Fig. 3 shows the condition of one of the larva killed and preserved on September 16th, when nine days old.

In September I found that the Saltash men were fishing with large seines for sprats, in the Hamoaze on the west shore, between St. John's Lake and Millbrook Lake. Besides abundance of adult sprats there were taken numbers of small fish of the character of whitebait, and miscellaneous fish of other kinds, including a few small mackerel, small bream, and *Belone acus*. On examining a sample of the small clupeoids I found they consisted chiefly of young sprats from $2\frac{1}{8}$ to $3\frac{1}{2}$ inches in length, evidently the produce of the preceding spawning season in the early part of the year. But there was also a small proportion of young pilchards, $2\frac{3}{4}$ to $4\frac{5}{8}$ inches in length. These must be derived from the spawn shed in the same year in the early part of the spawning period, that is to say in the months of May and June. It has long been known that sprats and herrings are found in estuaries at this age and size, but pilchards have not hitherto been recorded in such localities in England, nor I believe elsewhere on the Atlantic coast. Young pilchards of this age are taken regularly, as described by Professor Marion in the Annales du Musée de Marseille, 1890 and 1891, in the Gulf of Marseilles by seines and other engines worked from or close to the shore.