Limacina retroversa in Plymouth Waters.

By

Marie V. Lebour, D.Sc.,

Naturalist at the Plymouth Laboratory.

With Plates 1 and 2.

Limacina retroversa (Flem.) has been known in the Channel for over twenty-seven years and was several times recorded by Gough (1907) and Bygrave (1911) in the plankton reports (see Marine Biological Association, *Plymouth Marine Fauna*, 1931, p. 265), both from inshore and from outside. In recent years the more frequent collecting in the waters round Plymouth has shown that it may be present throughout the year, although much the most abundant in summer. Not only is it found in the outside waters but it is also often present in the Sound and even at the mouths of the estuaries.

It is very important from the food point of view as it is one of the commonest planktonic molluscs and much eaten by the plankton animals. In the North Sea and in other northern waters it is a favourite food of the herring, but as the herring is not usually at Plymouth when Limacina is most abundant this is of no great consequence with regard to the Plymouth herring. Mackerel probably eat it and certainly many invertebrates, amongst which are *Clione limacina* and Sagitta, both of which have actually been seen with Limacina inside them.

Hardy (1924, 1926) showed that it forms 2·17 per cent of the total year's food of the herring in the North Sea. In other parts it may be so largely eaten by the herring as to produce the condition known as "gut pouch."

In summer enormous swarms of Limacina may be taken in one haul of the ring-trawl, or even in a coarse tow-net, outside the Breakwater. In the smaller meshed nets the young may be taken and sometimes the egg masses.

Paulsen (1910) in his plankton résumé of the International Fisheries states that nothing is known of its breeding habits, and apparently no more has been added to this statement. He gives a good account of its distribution in the international area and this is quoted by Ostenfeld in his last summary (1931).

It is really quite easy to find out something about its breeding, for the

eggs are ripe for the greater part of the year and apparently each individual may have several broods. Especially in the summer almost every adult is laden with eggs and if left overnight in a finger-bowl will almost certainly have deposited some by the next morning. A further batch of eggs is usually seen inside after one batch has been extruded. Egg-bearing individuals have been seen in almost every month (January possibly excluded), and young of all ages also both inside and outside the Sound and as far out as the most southerly stations worked. The largest numbers are always outside the Sound. Many of all ages, including adults, were recorded in the summer from near Ushant in 1929 and 1930.

The fact that it is so abundant in these waters and also that it remains throughout the year makes Paulsen's (*op. cit.*) statement that it probably does not penetrate into the North Sea through the Channel rather doubtful. It is constantly present in the plankton in the northern and central North Sea (see Hardy *op. cit.*), and the more northerly of the North Sea stations and the more easterly stations of the Channel have been little worked. It seems more probable that *Limacina retroversa* will be found to have a greater range when further investigations are made.

As nothing so far is known of the eggs and life-history of the species, the following notes are not without interest.

The eggs of *Limacina retroversa* are planktonic, floating in small gelatinous strips with the eggs scattered and widely separated (Plate 1, Fig. 1). The form is similar to that of all pteropod eggs known and very like those of *Clione limacina*, but with the eggs fewer and further apart. Each strip may measure about 2 mm. in length and 0·64 mm. in breadth, but may be larger or smaller. Sometimes they are caught in some thread-like substance. The egg measures about 0·09 mm. to 0·10 mm. in length, and 0·06 to 0·07 mm. in breadth. Both matrix and eggs are perfectly colourless and glass-like in transparency. The embryos begin to develop at once and are moving about inside the egg envelope on the first day (Plate 1, Figs. 2–4). The second day they may hatch, but are very backward in development, and, unlike Clione, have no shell at first (Plate 1, Figs. 5–6). The cilia at first are round the body, then a circular velum appears which becomes bilobed when the shell forms, which is in a few days (Plate 1, Figs. 7–17). The shell is at first round, cap-like and perfectly symmetrical, measuring about 0·05 mm. across. By the fourth day it is asymmetrical and a good deal larger, the velum bilobed, the foot a small protuberance, ciliated on its surface. The shell is now about 0·10 mm. across its widest part and the width of the velum is about the same. The alimentary canal is forming from the apical mass. These early stages were obtained from the eggs, but unfortunately it was not possible to keep them alive. The other stages were all obtained from the plankton. When the shell measures about 0·13 mm. across the larva has

the usual veliger form ; the foot pulled out to a narrow tongue behind is ciliated all over with larger cilia at the tip and bears an operculum. Otoliths, eyes and mouth are present, the velum being about 0·15 mm. across with oval lobes of the usual structure with a row of long cilia round the margin and a second row of shorter cilia beneath, the two forming a groove to the mouth (Plate 1, Fig. 18). The whole shell and animal including the velum are perfectly colourless with the exception of the digestive gland which is coloured a brownish yellow, and the anal gland near the anus which is almost black. The shell now begins to be spiral with a sinistral twist, but whilst the shell is sinistral the animal is dextral. It is not necessary to describe the anatomy of this well-known mollusc. From now onwards the veliger may be recognised by its shell which gradually acquires more whorls (Plate 1, Fig. 19 ; Plate 2, Fig 1). When the shell measures about 0·32 mm. across two small lappets are seen developing from the sides of the foot at the base. These are the " wings " which grow quickly and are soon projecting beyond the shell (Plate 2, Fig. 2). As the " wings " grow the velum dwindles. Another organ, the " balancer," appears at the same time which projects from the base near the foot and is sometimes outstretched in swimming, sometimes pressed against the body whorl of the shell. The velum is dwindling fast when the shell measures 0·37 mm. across and the wings are nearly as long as the shell (Plate 2, Fig. 3), the foot changing its shape and very soon almost disappearing. The wings grow rapidly ; the velum disappears altogether and the Limacina is like the adult (Plate 2, Figs. 4–5). The oldest shells may have four or five whorls and measure about a millimetre or more in height. The wings may be twice as long as the shell or even more. They are covered with very minute cilia and are the only organs of locomotion, the animal swimming by strong flappings of its wings. There is a small amount of rose colour in the region of the mouth, the digestive gland is brownish yellow and the anal gland black ; otherwise the whole animal and shell are absolutely colourless and transparent. In very old individuals the operculum may fall off (Plate 2, Fig. 6).

When about three-parts grown the Limacina is able to lay eggs and it probably sends out many broods during its lifetime. We do not know how long they can live, but they appear to grow very quickly and it is probable that they reach their largest size in less than a year. In spite of their many enemies, there must be an enormous number continually breeding in spring or summer, and less so at other times of year, and they must play a very important part in the economics of the sea.

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EXPLANATION OF PLATES.

(Scale B is 6 times the scale of A, and scale C is twice the scale of A.)

PLATE 1.—(Fig. 1, scale A ; Figs. 2–20, scale B.)

FIG. 1.—Eggs of *Limacina retroversa*, laid 21/22.7.30.

FIGS. 2–4.—Eggs with developing embryos, 0·09–0·10 mm. long.

FIGS. 5–6.—Early larvæ, hatched in Laboratory.

FIG. 7.—Larva with young shell, hatched in Laboratory.

FIGS. 8–13.—Empty shells of young larvæ, hatched in Laboratory.

FIGS. 14–17.—Young larvæ with shells, hatched in Laboratory.

FIG. 18.—Larva 0·13 mm. across shell, from plankton.

FIG. 19.—Larva 0·18 mm. across shell, from plankton.

FIG. 20.—Larva 0·20 mm. across shell, from plankton.

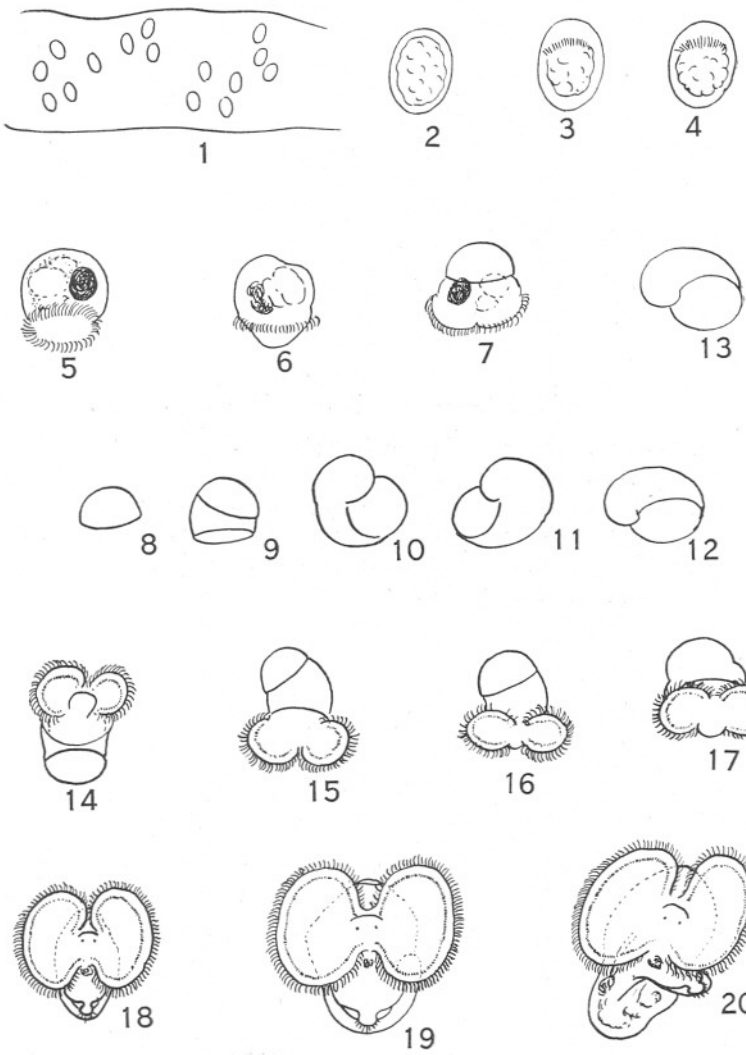
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PLATE 2.—(1–3 scale B, 4–5 scale C.)

Fig. 1.—Larva 0·25 mm. across shell, from plankton.

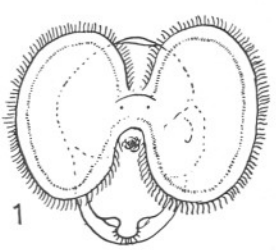
Fig. 2.—Larva 0·32 mm. across shell, from plankton.

Fig. 3.—Larva 0·37 mm. across shell, from plankton.

Fig. 4.—Limacina about three-parts grown, shell 0·72 high, from plankton.

Fig. 5.—Limacina with adult characters, 0·96 mm. high, from plankton.

Fig. 6.—Operculum of Limacina.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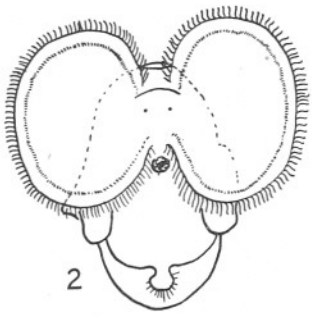
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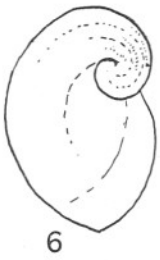
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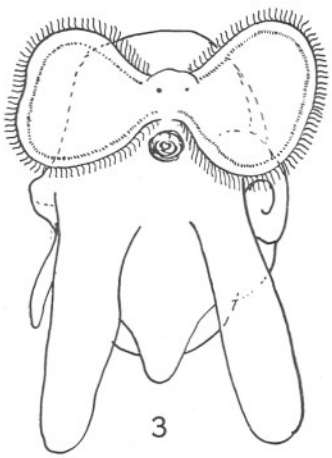
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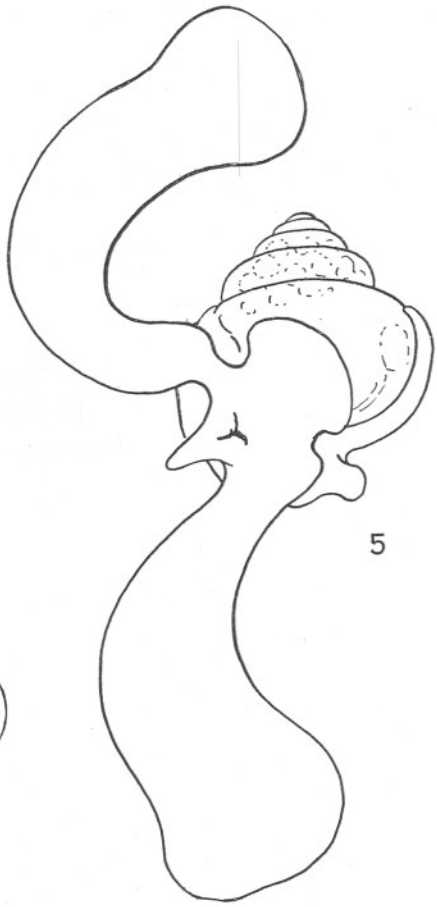
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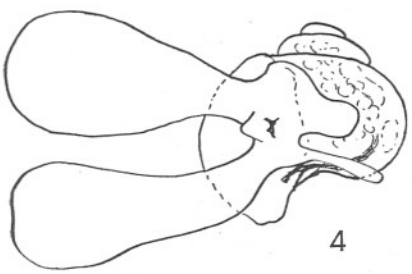
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