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ON THE EARLY DEVELOPMENT OF *PROTULA TUBULARIA* (MONTAGU)

(Family Serpulidae—Polychaeta)*

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THE growth of serpulid polychaetes inside marine aquaria and the consequent need for their frequent cleaning is a common experience. Ever since the experimental aquarium of the Central Marine Fisheries Research Station has been in operation, where unfiltered sea water is being circulated, a large number of serpulids were observed to grow either as solitary individuals or sometimes in clusters inside the concrete tanks, particularly in the less illuminated corners and grooves. These were carefully scrapped out from the substratum and were identified as *Protula tubularia* (Montagu), a species widely known from circummundane areas. Hewever, since Willey (1905) recorded this species from the Ceylon Pearl Oyster beds and described it as *Protula* (*Protulopsis*) *palliata* (but considered as a synonymy of *Protula tubularia* by Fauvel in 1953), there do not seem to be other collections from the Indian Ocean. The Indian Museum material includes only the anterior portion of a specimen of *Protula* from Andamans whose specific identity had not been ascertained (Fauvel, 1932). Owing to the hardy nature of the eggs and the ease with which they can be reared in the laboratory, serpulids have received comparatively greater attention among polychaetes as regards their development. For a review on the subject the reader is invited to the account on the development of *Pomatoceros triqueter* by Segrove (1941). It is apparent from literature that similar studies on tropical species are lacking and, therefore, a brief description of the early development in *Protula* is given below.

DEVELOPMENT OF THE EGG AND THE EARLY LARVA

Eggs were found at the bottom of the bowl in which freshly collected worms were kept. The fertilized egg (Fig. 1) is spherical with a diameter of 80-85 micra, including the egg membrane which is about 2 micra thick. The egg has a light pink coloured yolk as in the eggs of *Hydroides norvegica* (Paul, 1942), and numerous oil globules. The division of the egg started about an hour and a quarter after collection. The egg first divides horizontally into two unequal cells (Fig. 2) and within another fifteen minutes the 4-celled stage is formed. Out of the four cells thus produced one is comparatively large (Fig. 3) and this indicates the eventual posterior end of the larva. This cell more or less retains its relatively large size throughout the subsequent stages of division. Cell division is fairly rapid and the 16-celled stage (Fig. 4) is produced within an hour while subsequent stages have been difficult to follow owing to the opaque nature of the yolk. Within another two hours

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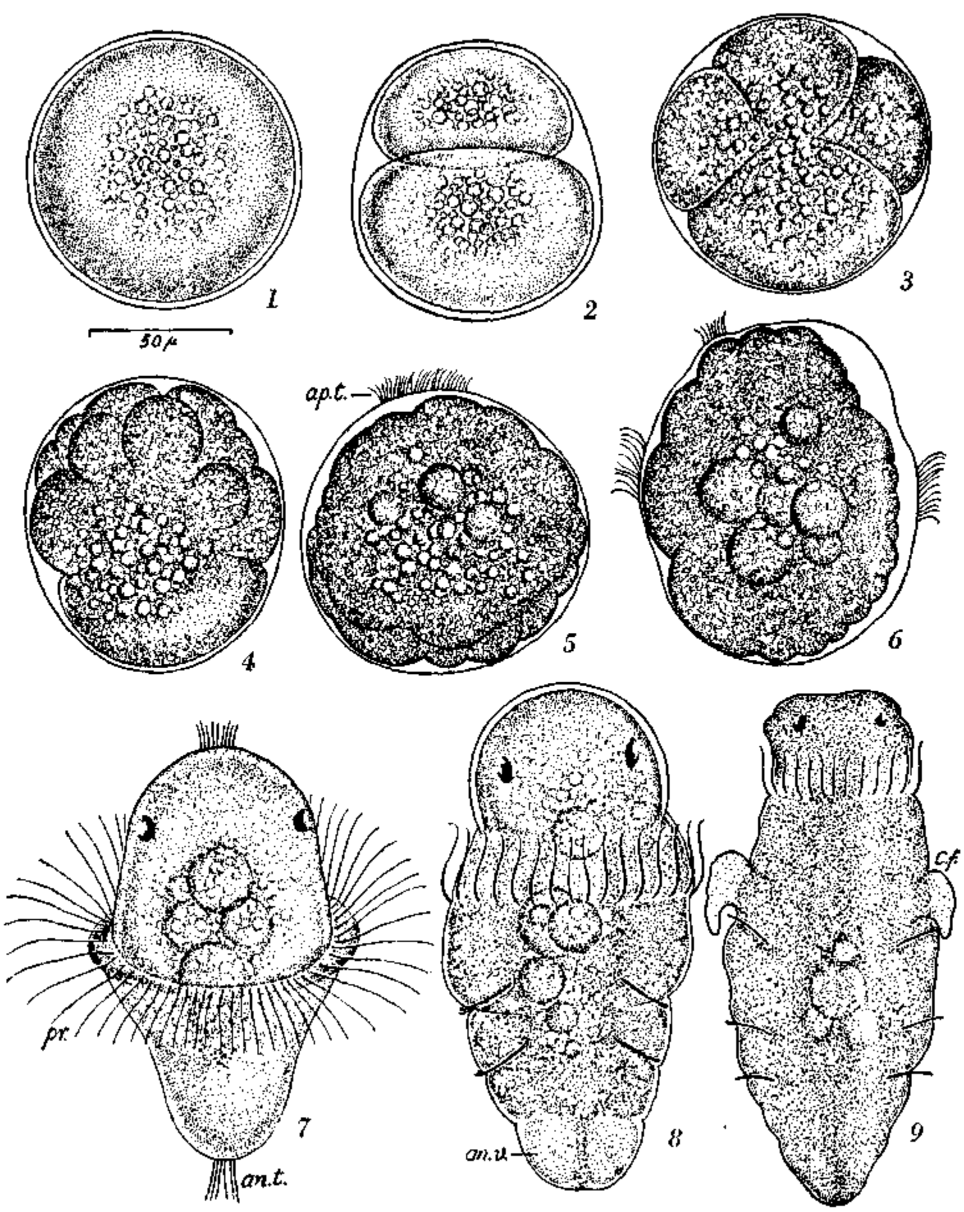
the gastrula is formed which soon develops an apical tuft of short cilia (Fig. 5, *ap.t.*) and the whole embryo starts a gentle revolving movement on its vertical axis. At this stage the oil globules begin to coalesce into larger and consequently fewer ones and the whole embryo loses its spherical shape. After about four hours since starting segmentation the indication of a protroch becomes evident in a horizontal plane around the embryo which begins to elongate (Fig. 6) and the spinning movement is accelerated. The number of oil globules is considerably reduced which show a maximum diameter of 20 micra. The egg membrane is never seen to be shed during the transformation of the egg into the embryo and, as in the case of many other polychaete development, the egg membrane is believed to be retained eventually to become the cuticle of the larva.

A free-swimming trochophore shown in (Fig. 7) has an average length of 150 micra excluding the apical ciliary tuft, has a well developed prototroch (*pr.*) of long cilia and also an anal tuft (*an.t.*). A ventral ciliary band or the neurotroch consisting of very short cilia is present which can be seen only from the side or in a ventral view. Two brownish eye spots are present near the anterior region. The yolk becomes more frothy and slightly translucent. (Fig. 8) shows the free-swimming larva on the second day. It has almost the same length as the trochophore but possesses a round head with slightly thicker cuticle than on the rest of the body and bears the two eyes spots. The apical and anal tufts have disappeared while the prototroch helps the larva to swim about actively near the surface of water. Two setigerous segments, each with a pair of simple setae, are present. Two anal vesicles (*an.v.*) can be distinctly seen at the posterior end of the larva.

Very little external changes in the larva are noticeable until about the third day of its free-swimming life except an increase in the swimming activity and a tendency for the post-trochal region to elongate. By about the fourth or fifth day (Fig. 9) distinct changes including a shrinkage of the head which becomes more square than round, a retrogression in the prototrochal cilia, disappearance of the neurotroch, formation of the rudiments of the collar fold (*c.f.*), appearance of the third setigerous segment and a further reduction in the number of oil globules. The anal vesicles are not clear and it is not certain whether they disappear completely at this stage or not. The whole larva is more transparent and the formation of the alimentary canal within can be seen through the body wall although it is doubtful if the digestive system becomes functional at this stage. Accompanying these external changes the larva also shows a tendency to rest occasionally at the bottom. Further observations of the larvae have not been possible as the larvae in this series did not survive under the conditions.

Discussion

Comparing the early development of this species with that of other serpulids from the temperate waters, it may be seen that while there is remarkable similarity in the general mode of development in the various species, the duration of the progressive changes in the early phase and in the free-swimming larval life in the present species is considerably abbreviated. Segrove (*op.cit.*) has discussed this point in his account on *Pomatoceros* development where the prolonged larval life and some of the morphological characters are attributed to the relatively small and poorly yolked egg. While the egg of *Protula* is rich in yolk, the size of the egg compares more or less in the two species. Both the trochophore and the early larva in *Pomatoceros*



Text-figure 1. The fertilized egg of *Protula tubularia*.
Text-figures 2, 3 & 4. Tne 2-celled, 4-celled and 16-celled stages, respectively.
Text-figures 5 & 6. Two stages in the spherical ciliated larva, the latter with the prototroch.
Text-figure 7. The free-swimming trochophore.
Text-figure 8. Larva on the second day.
Text-figure 9. Larva just before settling.

are much more organised than in the present form which lacks in a mouth, the feeding cilia and the alimentary canal during its free-swimming life which, as pointed out by Segrove, can be due to the complete dependence of the larva on its reserve yolk. Similarly, the larva of *Pomatoceros* possesses an additional circlet of metatrochal cilia and the advanced larva at the time of settling possesses four setigerous segments. The differences in the number of anal vesicle may not be very significant as this structure is known to vary in number in the different species of larval polychaetes.

Protracted embryonic development and larval life under colder conditions, both among the invertebrates and vertebrates, is well known. It may be pointed out here that the observations of Segrove on *Pomatoceros* has been carried out under 18°C. and the free-swimming larval life of the species is about 3 weeks while in the present instance where studies have been made at a water temperature of 26°C. the whole larval life is undergone in about 4 or 5 days when the larva begins to settle at the bottom. The absence of the digestive system and the complete dependence of the larva on its yolk reserve is also significant and a detailed study of the internal morphology will be of special interest. Paul (1942) while studying the growth and breeding of sedentary organisms in the Madras harbour has reported that *Hydroides norvegica*, a common serpulid, grows rapidly and attains maturity in a remarkably short time of 9 days after the larva settles down while the same species takes nearly 4 months to mature in the Plymouth waters (Orton, 1914) which, as Paul has discussed in detail, is possibly caused by the difference in temperature between the two regions. This perhaps indicates the effect of increased metabolic rate at higher temperatures.

Summary

The early larval development of *Protula tubularia* (Montagu), a serpulid polychaete, is briefly described. The salient features in the development are compared with that of allied species from temperate waters and their significance discussed.

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