On the Early Development of the Nemertine, *Lineus torquatus* Coe[1]

By

Fumio Iwata

(Akkeshi Marine Biological Station, Akkeshi, Hokkaido)

(*With 2 Text-figures*)

Thanks to Metschnikoff's (1869, 1882) and Wilson's (1900) works on *Cerebratulus lacteus* and Coe's (1899) report on *C. leidyi*, *C. marginatus* and *Micrura caeca*, the early development of nemerteans to the pilidium has been described in detail. In the present report the early development of *Lineus torquatus* Coe has been dealt with.

Before proceeding further the writer wishes to express his grateful thanks to Professor Tohru Uchida for his guidance and reading the manuscript. Acknowledgement is also due to Professor Katsuma Dan of the Tokyo Metropolitan University for his helpful advice.

Observations on the spawning habit and the spiral cleavage were made on August 6th, 1953 and on August 4th, 1954, and the eggs liberated artificially on August 4th, 1956 were used for the study of the later development to the pilidium.

The adult worm is commonly found under stones between the tide marks at Akkeshi. The breeding season of this species lasts during July and August. A great number of the eggs escaped simultaneously through the ducts leading from the gonads to the exterior. The eggs immediately after liberation from the ovary are irregularly oval in shape, transparent, and surrounded by the egg-membrane, while the ones removed from the female for the purpose of making an artificial fertilization are destitute of the egg-membrane round them. In most of the eggs there exists a conspicuous conical protuberance which was reported at first by Wilson (1900). The germinal vesicle which is demarcated from the cytoplasm as a clear zone is situated opposite the protuberance. About 30 minutes later the ovum has become round in shape after the protuberance was nipped off as a droplet of the cytoplasm. The separation of the protuberance was not observed in the eggs liberated artificially. The round ovum measures about 0.1 mm in diameter and the egg-membrane is about 0.015 mm in thickness. The sperm is a nematosperm, composed of a head, a middle piece and a tail, the tail being about 0.05 mm long and the remnant about 0.005 mm long.

The eggs after fertilization show succeedingly break-down of the germinal vesicle, formation of the polar bodies and the spiral cleavage as is found in *C.*

1) Contributions from the Akkeshi Marine Biological Station, No. 93.

Jour. Fac. Sci. Hokkaido Univ. Ser. VI, Zool. 13, 1957 (Prof. T. Uchida Jubilee Volume).

lacteus. Four equal macromeres are resulted from the first two cleavages, which take place at a right angle to each other. A crossed portion of the two constrictions resulting lies beneath the polar bodies. A quartet of the first four micromeres is budded off dexiotropically from the macromere (Fig. 1, 4). Each micromere is larger in size than the macromere. At the fourth cleavage the micromere is divided obliqually downwards to the right, while the macromere

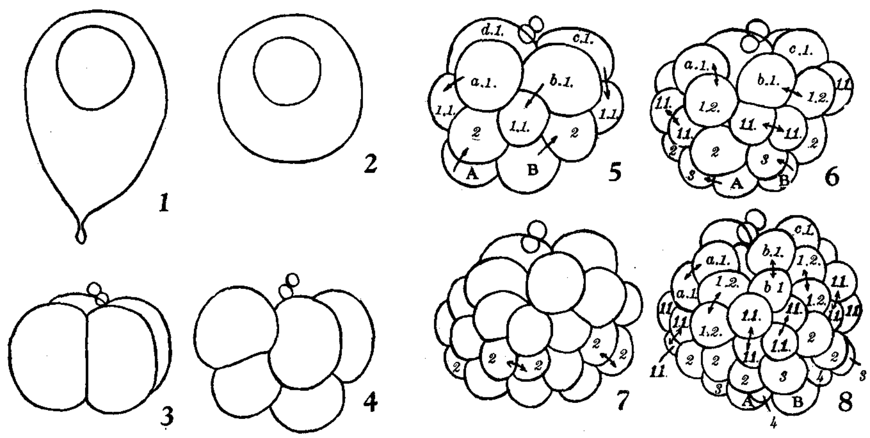

Fig. 1. 1, The egg immediately after liberation from the ovary. 2, The egg of 30 minutes after liberation from the ovary. 3, 4 cell stage. 4, 8 cell stage. 5, 16 cell stage. 6, 28 cell stage. 7, 32 cell stage. 8, 52 cell stage. × 210.

is divided obliqually upwards to the left (Fig. 1, 5). This cleavage occurs laeotropically. There intervenes the twenty-eight cell stage at which no cleavage takes place yet in the second four micromeres (Fig. 1, 6). The fifth cleavage is dexiotropic and the sixth is laeotropic. About 15 hours after fertilization the blastocoel has been clearly formed in the embryo, and the vegitable pole has become wider than the animal one. The embryo provided with numerous fine cilia begins to revolve at the blastula stage. At 24th hour the embryo becomes flattened on the vegitable pole and arched on the opposite. The apical portion of the embryo becomes to be equipped with a long apical tuft and the endoderm invaginates upwards into the blastocoel from the base. Two days later the larva begins to show a bilateral symmetry in shape. It elongates axially, and the endoderm bends horizontally towards a lateral side of the body (Fig. 2, 3). This horizontal axis will become the future antero-posterior axis of the larva. According to Coe who observed experimentally the movement of food-material in the digestive canal, it is possible that the opening of the endoderm is situated at the anterior of the body. The apical plate is distinguishable as a concave thick

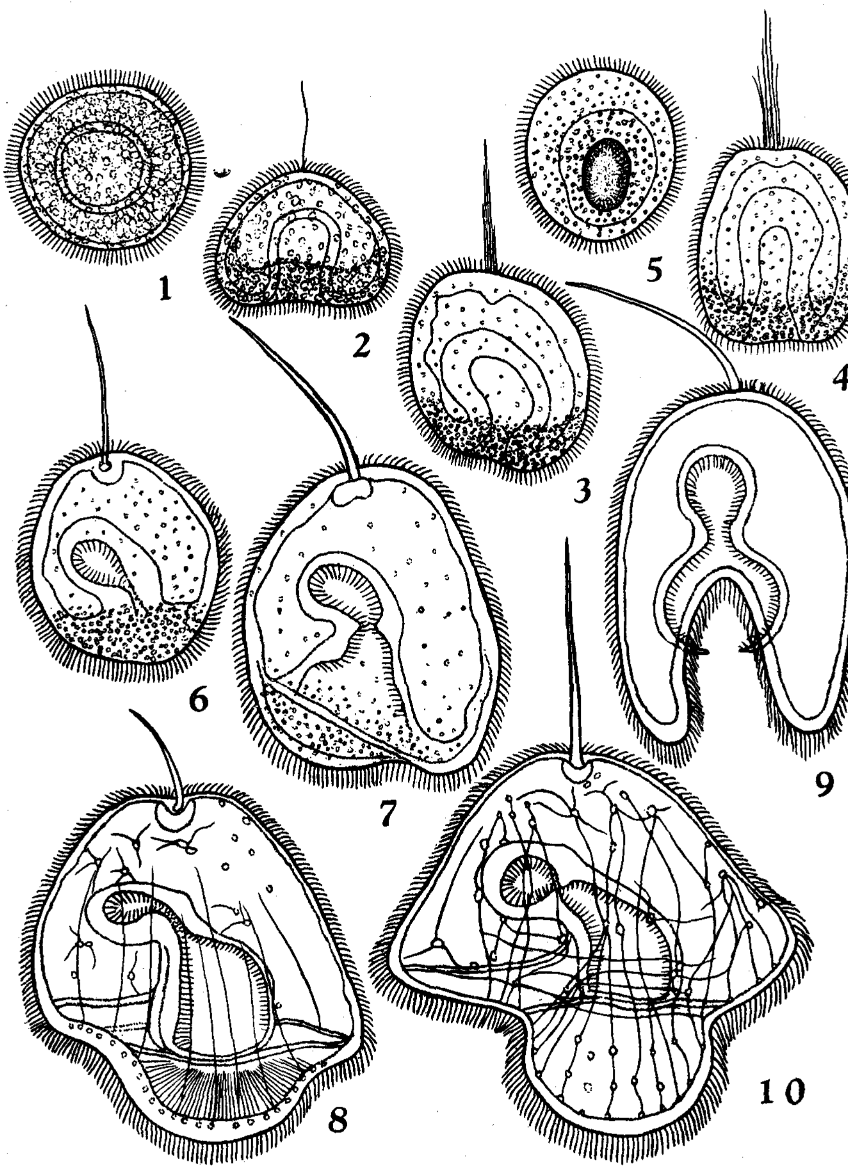

Fig. 2. 1 and 2, The young larva of one day from the dorsal (1) and from the lateral (2) view. 3, 4, and 5., The larva of 2 days from the lateral (3), from the frontal (4), and from the ventral (5) view. 6, The larva of 3 days from the lateral view. 7. The larva of 4 days from the lateral view. 8 and 9, The larva of 5 days from the lateral (8) and from the frontal (9) view. 10, The larva of 6 days from the lateral view. × 200.

portion on the animal pole, and the long cilia of the apical tuft increase in number. Three days later the endodermal canal provided with cilia is divided into the archenteron which later forms the intestine, and the stomodaeum which transforms into the oesophagus of the adult worm (Coe, 1899). The blastopore opens at the end of the archenteron. The apical plate sank down in the blastocoel as a thick and round portion. Three to four days after fertilization the body grows in size markedly, the stomodaeum increasing its depth and width in the body as a result of the process of invagination and the lateral lappets characteristic of the pilidium begining to show their shape at the posterior corner of the ventral side. The mouth of the larva opening between the lateral lappets is first apparent in this stage. From the lateral view of the larva it is represented as a pair of the narrow bands of the epithelium which are formed by the thickened folds of the stomodaeum on the sides of the mouth. One of these bands ranging on the dorsal side of the lateral lappet is shown in Fig. 2, 7. This band is movable dorsoventrally, and becomes thicker and shorter if travels upwards. The larva become angular on the anterior corner of the ventral side. The larva at the age of five days indicates completely the shape characteristic of the pilidium. Two lateral lappets expand vertically downwards on both sides of the stomodaeum (Fig. 2, 8). On the ventral wall of the posterior portion of the body a deep furrow directed upwards is formed through which the undigested food-material from the mouth escapes externally, while the ventral wall of the anterior portion is flat in shape. On the ventral margin of the larva there are a considerable number of the muscle cells differentiated, which send off numerous short fibres to each lateral lappet and several long ones running dorsoventrally to the portion near the apical plate. A small number of these cells provided with a few short fibres are scattered on the inner wall of the body and on the digestive canal. The cilia arranged on the ventral margin of the body are closely set and longer than those on the dorsal side. Fig. 2, 9 shows the situation of the digestive canal and the lateral lappets from the postero-frontal view. Six days later the adult pilidium measures 0.26 mm in length on the horizontal basal portion and 0.24 mm in height. The apical tuft measures 0.14 mm in length. About a dozen of the muscle cells arranged on each lateral lappet send off the muscle fibres. These fibres are anastomosed with those grouped near the apical plate and with the intermediate ones between them. Several muscles running dorsoventrally are also found between the dorsal wall and the ventral one except the portion of the lappet. A few muscles run horizontally along the basal portion above the lateral lappets in addition to those extending dorsoventrally. If irritated artificially the pilidium opens the lateral lappets externally by the elastic movement of the muscles attached to the body wall.

References

Coe, W.R. 1899. Trans. Connect. Acad. 10 : 235-262.
Metschnikoff, E. 1869. Mem. de l'Acad. Sci. St. Pétersb. 14 : 1-73.
——— 1882. Zeit. wiss. Zool. 37 : 286-313.
Wilson, C.B. 1900. Quart. Jour. Micr. Sci. 43 : 97-198.
Wilson, E.B. 1903. Arch. Entm. 16 : 411-460.