

Notes on the postembryonic development of the ovary in *Argulus japonicus* (Crustacea: Branchiura)

Kyosuke IKUTA and Toshiki MAKIOKA

Institute of Biological Sciences, University of Tsukuba, Tsukuba, Ibaraki 305, Japan

The adult female of branchiuran crustacean, *Argulus japonicus*, has a single sac-like ovary above the alimentary canal, occupying the most part of the thorax. A pair of long lateral oviducts runs backward along both sides of the ovary. Either of the oviducts is connected with a female gonopore at the hind end of the thorax, but the other ends blindly (Ikuta and Makioka, 1992). We ascertained that the growing oocytes are protruded outward from the ovarian wall into the hemocoel, not included in the ovarian lumen (Ikuta and Makioka, 1993). The features in the ovarian structure and oogenetic mode of *A. japonicus* seem similar to those in many chelicerates (Makioka, 1988) and pentastomids (Nørrevang, 1983) rather than to those in other crustaceans at least in the adult stage. In the present study, we examined the postembryonic development of the ovary of *A. japonicus* in order to throw light on their origins.

Larvae of *A. japonicus* were obtained from the body surfaces of mirror carps kept in the Ibaraki Prefectural Freshwater Fisheries Experimental Station. We fixed the larvae with Bouin's solution, decided their postembryonic stages according to Tokioka (1936), and then made them into serial paraffin sections in 5 μ m thickness. These sections were stained with Mayer's hematoxylin and eosin, Heidenhain's azan or Gomori's one-step trichrome staining.

All the seven postembryonic stages (Tokioka, 1936) were distinguished in the larvae.

In the first larval stage, a small bilobed ovary or oogonial cluster is located medianly between the dorsal wall of the thorax and the alimentary canal, but the oviducts have not yet been observed (Fig. 1).

In the second larval stage, a larger monolobed ovary or a cluster of oogonia and very early previtellogenic oocytes is slightly biased left or right from the dorsomedian line of the alimentary canal (Fig. 2, ov). A pair of lateral oviducts runs along both sides of the ovary. The oviduct on either side opposite the biased ovary is larger than that on the other side (Fig. 2, od).

In the third larval stage, a narrow ovarian lumen is found, surrounded laterally and ventrally by the ovarian epithelium and dorsally by the young germ cell cluster or germarium (Fig. 3, g, oe, ol). Some larger previtellogenic oocytes are found to be protruded outward from the ovarian epithelium near the germarium (Fig. 3, oc).

During the fourth and fifth larval stages, the oocytes protruded outward from the ovarian epithelium increase in number and advance to the lateral surfaces of the ovary, but not still attain the ventral surface (Fig. 4). The larger lateral oviduct, lying on the opposite side of the slightly biased ovary, reaches the gonopore at the end of the thorax (Fig. 5, od).

By the sixth larval stage, the slightly biased ovary is gradually shifted to the final position on the median line of the thorax (Fig. 6). The ovarian epithelium becomes folded deeply at the lateral and ventral surfaces, and the larger oocytes are located on the ventral folds.

In the seventh larval stage, the ovary is mostly similar to that of the adult stage, but vitellogenic oocytes have not yet been observed.

The postembryonic development of *A. japonicus* ovary was described for the first time in the branchiurans. The ovary has already been located above the alimentary canal in the thorax at the early first larval stage. It is a single bilobed median oogonial cluster, developing later into a single sac-like ovary with a germarium in the

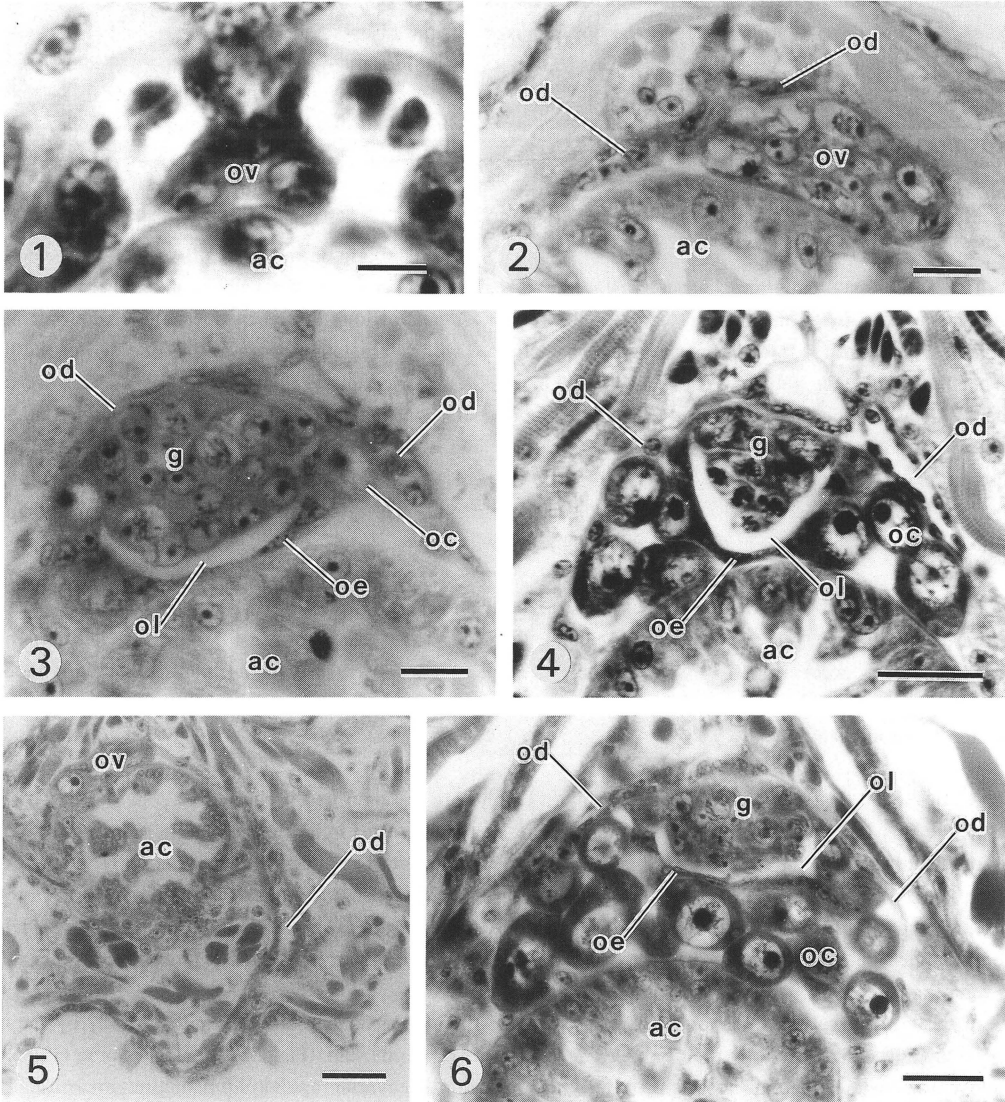


Fig. 1 Ovary of *Argulus japonicus* in the first larval stage. Transverse section. One-step trichrome staining. Scale = $5\mu\text{m}$.

Fig. 2 Ovary in the second larval stage. Transverse section. Hematoxylin-eosin (H-E). Scale = $10\mu\text{m}$.

Fig. 3 Ovary in the third larval stage. Transverse section. H-E. Scale = $10\mu\text{m}$.

Fig. 4 Ovary in the fourth larval stage. Transverse section. One-step trichrome. Scale = $20\mu\text{m}$.

Fig. 5 Lateral oviduct near the gonopore in the fourth larval stage. Transverse section. One-step trichrome. Scale = $20\mu\text{m}$.

Fig. 6 Ovary in the sixth larval stage. Transverse section. One-step trichrome. Scale = $20\mu\text{m}$.

ac: alimentary canal, g: germarium, oc: oocyte, od: oviduct, oe: ovarian epithelium, ol: ovarian lumen, ov: ovary.

dorsomedian ovarian wall. The growing oocytes never enter the ovarian lumen, but instead stay on the outer surface of the ovarian wall, shifted gradually from the dorsal to the ventral, possibly by an outflow of new ovarian epithelial cells from the germarium. We regard these ovarian characteristics as basic in the branchiurans and unique among the crustaceans. The long question whether the branchiuran ovary is originally single or has become secondarily single (see Martin, 1932) has not yet been solved in the present study. However, the bilobed oogonial cluster in the first larval stage and slightly biased position of the ovary seen from the second to the fifth larval stage may suggest a paired origin of the ancestral branchiuran ovary.

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