

Structure of the adult ovary in a cirriped, *Lepas anatifera* (Crustacea: Thecostraca)

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Abstract

We describe some structural features of the adult ovary of the pedunculate barnacle, *Lepas anatifera*, to compare them with those of some other crustaceans. A pair of ovaries repeatedly branched into several hundreds of fine ovariole tubules are located in the upper portion of the peduncle. Germaria or patch-shaped small clusters of young germ cells are located in the ovarian epithelium, scattering through the ovaries. The early previtellogenic oocytes leave the germaria to fall into the ovarian lumen, in which they grow up simultaneously. These structural and oogenetic features of *L. anatifera* ovary are similar to those in many other crustaceans but different from those in the branchiuran, *Argulus japonicus*, and some myodocopid ostracods such as *Vargula hilgendorfi*.

Introduction

In many crustaceans, as in the other mandibulate arthropods, the oocytes grow in the ovarian lumen, although in the chelicerate arthropods, they grow on the outer surface of the ovary, protruding into the hemocoel (Makioka, 1988). Among the maxillopod crustaceans, the ovaries of some copepods can be regarded as those of the "mandibulate type" (Makioka, 1988), but the branchiurans and myodocopid ostracods seem to have those of the "chelicerate type" (Ikuta and Makioka, 1993, 1994a, b, 1995). Thus, morphological features of the ovaries seem to be remarkably diversified in the maxillopods among the arthropod classes. Further studies on the comparative morphology of the maxillopod ovaries should provide some useful markers to discuss the evolution of the ovary, not only in the maxillopods, but also more extensively in the crustaceans, furthermore, among arthropod classes.

Cirripedia is a large maxillopod group. The structure of the ovaries has been described in some cirripeds by several authors (Iwaki, 1975; Fyhn and Costlow, 1977; Lepore *et al.*, 1993; Molares *et al.*, 1994), but more detailed descriptions are necessary to compare structural features of their ovaries with those in other maxillopod or crustacean groups. In the present paper, we report some structural features in detail of the ovary in a pedunculate barnacle, *Lepas anatifera*.

Materials and Methods

Adults of the goose barnacle or pedunculate barnacle, *Lepas anatifera* L., attaching colonially on the outer surfaces of the floats for an experimental seaweed cultivation station on the Nabeta Bay (Shimoda, Izu Peninsula, Central Japan) were collected. The whole bodies and ovaries removed from the peduncles were fixed with Bouin's solution and embedded in Paraplast[®] (Monoject Scientific Co.). Serial sections 5–10 μm thick each were stained with hematoxylin and eosin or with azan.

Observations

A pair of mature ovaries largely occupies the hemocoel of the upper portion of the peduncle. Each ovary is repeatedly branched into several hundreds of fine ovariole tubules (Fig. 1a). The immature ovary consists of a pair of fine ovariole tubules (Fig. 1b). A fine oviduct connects the upper end of each ovary with the gonopore opening at the base of each of the first thoracic limbs.

The ovarian wall consists of a layer of thin ovarian epithelium (Fig. 2a, b). The ovarian epithelial cells are flattened with a flat nucleus about 2 μm in major length. The ovarian lumen is filled with a number of growing

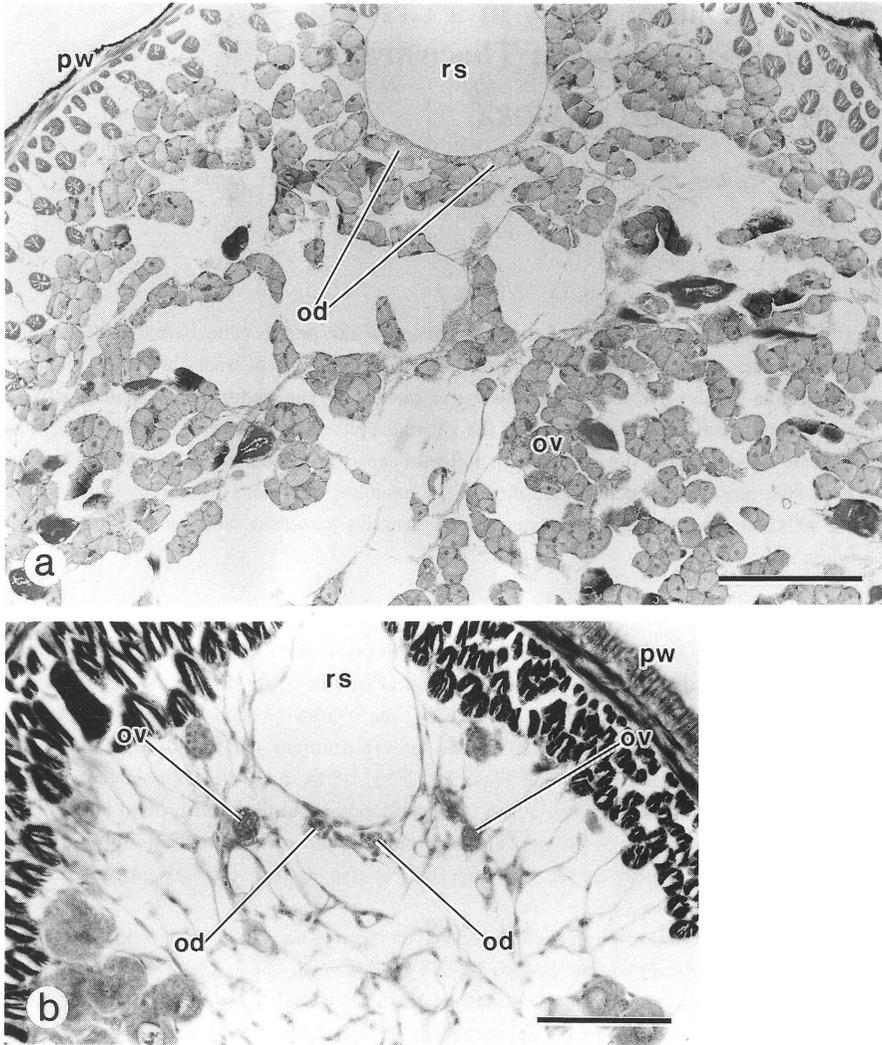


Fig. 1 Transverse sections of the peduncles of adult *Lepas anatifera* showing ovaries in two different conditions. a. Mature ovary. Hematoxylin–eosin staining. b. Immature ovary. Azan staining. od: oviduct, ov: ovary, pw: peduncular wall, rs: rostral sinus. Bars = a, 500 μm ; b, 100 μm .

oocytes (Fig. 2a, b). Neither follicle cells nor nurse cells are found around these oocytes.

A number of germaria or patch-shaped small clusters of young germ cells, including oogonia and very early previtellogenic oocytes, are scattered in the ovarian epithelium through the ovaries (Fig. 2a, arrows). Each oogonium about 5 μm in diameter has a large spherical nucleus without nucleoli (Fig. 2b). Early previtellogenic oocytes in the germaria, 6–7 μm in diameter, have a spherical germinal vesicle with a distinct nucleolus (Fig. 2b).

The oocytes leaving the germaria, 10–15 μm in diameter, are located near the ovarian wall in the ovarian lumen (Fig. 2a, b). Their cytoplasm is strongly basophilic. The oocytes grow simultaneously in the ovarian lumen (Fig. 2a, b). The growing oocytes up to about 30 μm in diameter are previtellogenic. The germinal vesicle

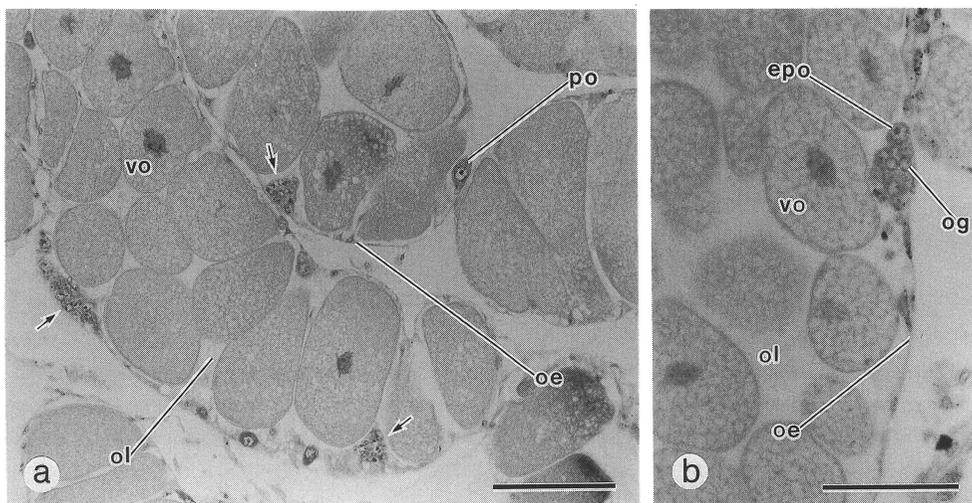


Fig. 2 Sections of ovariole tubules in adult *Lepas anatifera* under lower (a) and higher (b) magnifications. Hematoxylin–eosin staining. Arrows in a show the germarium. epo: early previtellogenic oocyte, oe: ovarian epithelium, og: oogonium, ol: ovarian lumen, po: previtellogenic oocyte, vo: vitellogenic oocyte. Bars = a, 100 μm ; b, 50 μm .

cle about 10 μm in diameter has a prominent nucleolus. Their cytoplasm no longer shows basophilicity. The larger oocytes, more than 50 μm in diameter, are filled with proteinous yolk granules. They grow in the ovarian lumen up to about 120 μm in diameter, and their germinal vesicles reach about 20 μm in diameter.

Discussion

Previous works on cirriped oogenesis were mainly focused on the developmental stages of the oocytes (Iwaki, 1975; Fyhn and Costlow, 1977; Lepore *et al.*, 1993; Molares *et al.*, 1994), and structural features of the ovaries were only poorly described. Iwaki (1975) in *Chthamalus challengerii* and Fyhn and Costlow (1977) in *Balanus amphitrite* and *B. eburneus* described that the germaria were located on the central space of the ovarian lumen, surrounded by the growing oocytes. In the adult ovaries of *Lepas anatifera*, we confirmed that the germaria were attached to the ovarian epithelium, not liberated into the ovarian lumen, and that the growing oocytes left germaria to fall into the ovarian lumen (Fig. 3). Therefore, we regarded the ovary of *L. anatifera* as one of the “mandibulate type” ovaries like those of many other crustaceans.

Boxshall and Huys (1989) proposed that the thecostracans (containing cirripeds and their relatives) share some synapomorphic external morphological characters with the branchiurans and ostracods. Abele *et al.* (1992), however, suggested that the thecostracans are not related to the ostracods–branchiurans–pentastomids clade but are placed near the copepods, based on molecular phylogenetic analyses of the 18S ribosomal nucleotide sequences. The structural and oogenetic type of the cirriped ovary seems similar to that of the copepods (Makioka, 1988) rather than to those of the branchiurans (Ikuta and Makioka, 1993, 1994a, 1995) and myodocopid ostracods (Ikuta and Makioka, 1994b) among the maxillopod crustaceans. These morphological descriptions are compatible with the molecular basis evidence offered by Abele *et al.* (1992).

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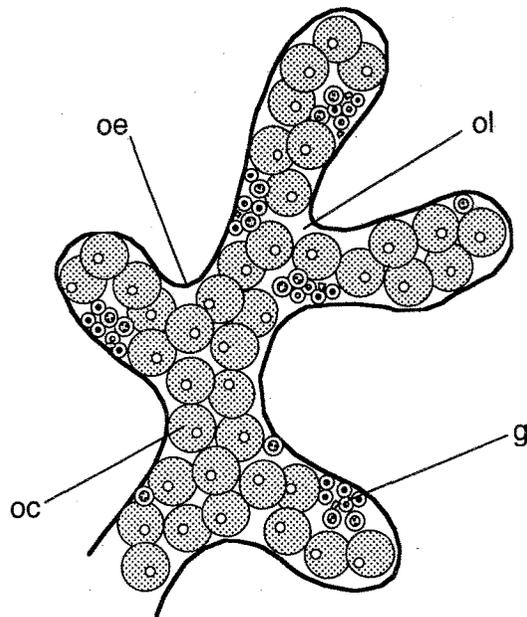


Fig. 3 Schematic representation of ovary of adult *Lepas anatifera*. g: germarium, oc: oocyte, oe: ovarian epithelium, ol: ovarian lumen.

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