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[SHORT COMMUNICATION]

Ovarian Structure of Five Penicillate Diplopods (Diplopoda: Penicillata)

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In many diplopods, as well as other myriapods, oocytes in the ovarian lumen are connected with the ovarian epithelium by their follicular connections (Kubrakiewicz, 1987; Yahata and Makioka, 1997), but in more primitive diplopod subclass, the Penicillata, there have been two contrary views. Some early authors described oocytes connected with the ovarian wall by a part of their own follicles (Fabre, 1855; Rath, 1891; Lécaillon, 1903; Reinecke, 1910), but Kubrakiewicz (1991) denied the presence of these connections in a European penicillate, *Polyxenus lagurus*. In a Japanese penicillate, *Eudigraphis nigricans*, Yahata and Makioka (1991) found follicular extensions connecting larger oocytes to specific areas of the ovarian epithelium, the vitellarial areas, and supposed that the penicillates have two structural types of ovaries, the *Eudigraphis* type having follicular connections and the *Polyxenus* type lacking them (Yahata and Makioka, 1994). In the present study, I have examined the ovaries of five penicillate species, including two *Polyxenus* species, to ascertain the supposition.

Adult females of the five penicillate species examined in the present study were obtained as follows: *Eudigraphis takakuwai* and *E. kinutensis* were collected in Tsukuba (Ibaraki Prefecture), *Eudigraphis* sp. and *Polyxenus* sp. in Iriomotejima Island (Okinawa Prefecture), and *Polyxenus shinoharai* in Iwaki (Fukushima Prefecture). Each specimen was prepared as serial paraffin sections of 5 μm thick, stained with Haematoxylin-Eosin and observed under a light microscope.

In all the species including the two *Polyxenus* species, the general structure of the ovary was mostly the same as that of *Eudigraphis nigricans* previously described by Yahata and Makioka (1991, 1994), except for some minor differences in the size and proportion of some ovarian structures.

A single sac-like ovary was located above the ventral nerve cord and beneath the gut, through the fourth to ninth body segment (body-ring) in the *Eudigraphis* species examined, and through the fifth to ninth body segment in the *Polyxenus* species examined. In the ovary of each species, a single median discoidal germarium, containing oogonia, early oocytes and somatic interstitial cells, was present at the center of the ventral ovarian floor (*e. g.*, Fig. 1C, E). Larger oocytes, previtellogenic and vitellogenic, were surrounded by a layer of the follicle epithelium and left the germarium. The larger previtellogenic oocytes were located in several patch-shaped areas, named the vitellarial areas in *Eudigraphis nigricans* (Yahata and Makioka, 1991), arranged in pairs on the ventral ovarian wall (Fig. 1). Each vitellarial area contained some folliculated previtellogenic oocytes and some somatic interstitial cells, but no oogonia. In *Eudigraphis* species, an adult ovary had nine to 10 pairs of vitellarial areas, while in *Polyxenus* species, it had only six or seven pairs. Some larger previtellogenic and vitellogenic oocytes left the vitellarial areas, floating in the ovarian lumen and connected with the vitellarial areas by their follicular extensions (Fig. 1).

In the present study, the germarium, the vitellarial areas, and the follicular extensions connecting the larger

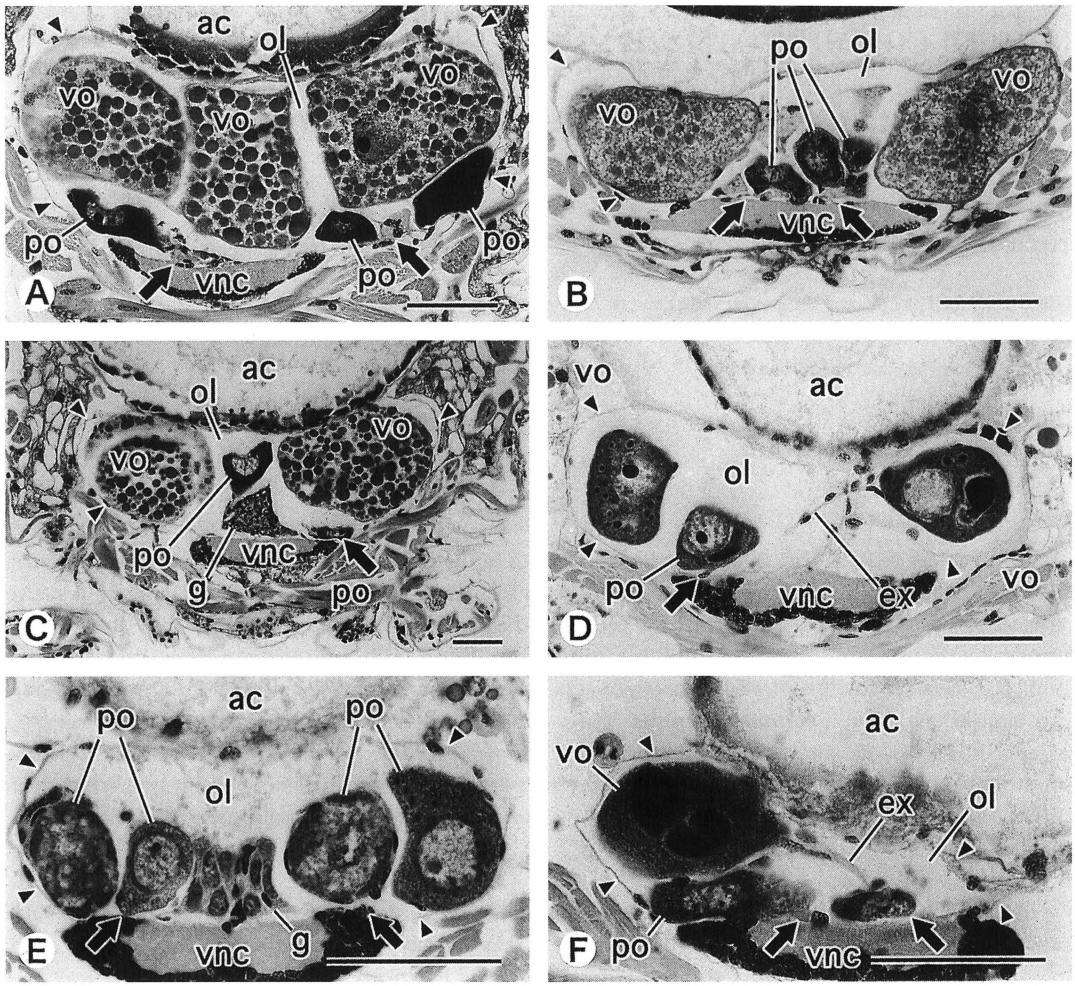

Fig. 1 Cross sections of ovaries of five penicillate diplopods. Arrows and arrowheads respectively show the vitellarial area and ovarian wall. Haematoxylin and Eosin staining. A. Anterior part of ovary in *Eudigraphis takakuwai* showing paired vitellarial areas. B. Anterior part of ovary in *Eudigraphis kinutensis* showing paired vitellarial areas. C. Middle part of ovary in *Eudigraphis* sp. showing a single median germarium and vitellarial area. D. Anterior part of ovary in *Poyxenus shinoharai* showing a long follicle extension connecting a vitellogenic oocyte with its vitellarial area of ovarian epithelium. E. Middle part of ovary in *Polyxenus* sp. showing a single median germarium and paried vitellarial areas. F. Posterior part of ovary in *Polyxenus* sp. showing a long follicle extension connecting a vitellogenic oocyte with its vitellarial area of ovarian epithelium. ac: alimentaly canal, ex: follicle extension, g: germarium, ol: ovarian lumen, po: previtellogenic oocyte, vnc: ventral nerve cord, vo: vitellogenic oocyte. Scale bars = 50 μm.

oocytes with the vitellarial areas were found in all the penicillate diplopods examined, not only in *Eudigraphis* species, but also in *Polyxenus* species. Also in the European penicillates, *Polyxenus lagurus*, the present results are consistent with some early author's descriptions (Fabre, 1855; Rath, 1891; Lécaillon, 1903; Reinecke, 1910). Hence, I regard the follicular extensions connecting the larger oocytes to their vitellarial areas as the late oogenetic features and the single median germarium as the early oogenetic structure, both common to the penicillate ovary, despite Kubrakiewicz's denial (1991).

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References

Fabre, M. (1855) Recherches sur l'anatomie des organes reproducteurs et sur le développement des myriapodes. *Ann. Sci. Nat. Zool.*, **4**, 257–316.

Heathcote, F.G. (1889) On some points of the anatomy of *Polyxenus lagurus*. *Q.J. Microsc. Sci.*, **30**, 97–106.

Kubrakiewicz, J. (1987) The ovary structure in two millipedes, *Julus scandinavius* and *Orthomorpha gracilis* (Myriapoda, Diplopoda). *Zool. Pol.*, **34**, 251–260.

Kubrakiewicz, J. (1991) Ovary structure and oogenesis of *Polyxenus lagurus* (L.) (Diplopoda, Pselaphognatha): An ultrastructural study. *Zool. Jb. Anat.*, **121**, 81–93

Lécaillon, M.A. (1903) Sur le développement de l'ovarire de *Polyxenus lagurus* de Geer. *C.R. Acad. Sci.*, **29**, 1691–1693.

Rath, O.V. (1891) Zur Biologie der Diplopoden. *Ber. Naturf. Ges. Freiburg*, **5**, 162–199.

Reinecke, G. (1910) Beiträge zur Kenntnis von *Polyxenus*. *Jen. Z. Naturwiss.*, **46**, 845–896.

Yahata, K. and T. Makioka (1991) Preliminary note on the ovarian structure in the penicillate diplopod, *Eudigraphis takakuwai* nigricans (Miyosi). *Proc. Arthropod. Embryol. Soc. Jpn.*, **26**, 13–16.

Yahata, K. and T. Makioka (1994) Phylogenetic implications of structure of adult ovary and oogenesis in the penicillate diplopod, *Eudigraphis nigricans* (Miyosi) (Diplopoda: Myriapoda). *J. Morphol.*, **222**, 223–230.

Yahata, K. and T. Makioka (1997) Phylogenetic significance of the structure of adult ovary and oogenesis in a primitive chilognathan diplopod, *Hyleoglomeris japonica* Verhoeff (Glomerida, Diplopoda). *J. Morphol.*, **231**, 277–285.