A Proposed Phylogeny of Chelicerate Ovaries

Toshiki MAKIOKA

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

Ovarian structures and oogenetic modes are fundamentally similar among many chelicerate groups. A generalized model of mature ovaries has been proposed as a simple tube connected with the oviducts at the both ends (Makioka, 1988). The ovarian wall consists of two different cellular layers, the inner ovarian epithelium and the outer muscle layer. Very young egg cells and some young somatic cells are aggregated into a cord-shaped germ zone or a germarium lying in the ovarian epithelium along the dorsomedian or ventromedian longitudinal axis. Larger oocytes are found not in the ovarian wall, but around the ovarian surface. They are connected with the ovarian epithelium by short cellular stalks. The oocytes grow up to the final size on the stalks. Vitellogenesis takes place in these stalked oocytes probably without any assistance by other ovarian cells such as the follicle cells or the nurse cells. Fully grown oocytes become mature on the stalks in some species or on the way of the ovulation in some other species. Fully grown oocytes or mature eggs are ovulated into the ovarian lumen through the cavities of the stalks, and then transported into the oviducts. The ovarian lumen is not the portion where oogenesis takes place, but only the path for the ovulated eggs to reach the oviducts.

There are some remarkable differences between merostomes and arachnids in the locality of ovaries. In merostomes, the ovary is localized in the cephalothorax. The ovarian tube becomes reticulate into a fine ovarian network covering most of the dorsal surface of the midgut gland. The anteromedian end of the ovarian network reaches the ventral side through the frontal edge of the midgut gland. In the dorsal side of the midgut gland, the cord-shaped germ zone lies in the dorsal epithelium of the ovarian tube, but in the ventral side, it lies in the ventral epithelium (Fig. 1-A). In arachnids, however, the ovary is localized in the abdomen under the midgut gland. The ovarian tube is not so complicated in shape as in merostomes. The cord-shaped germ zone occurs in the ventral epithelium (Fig. 1-B).

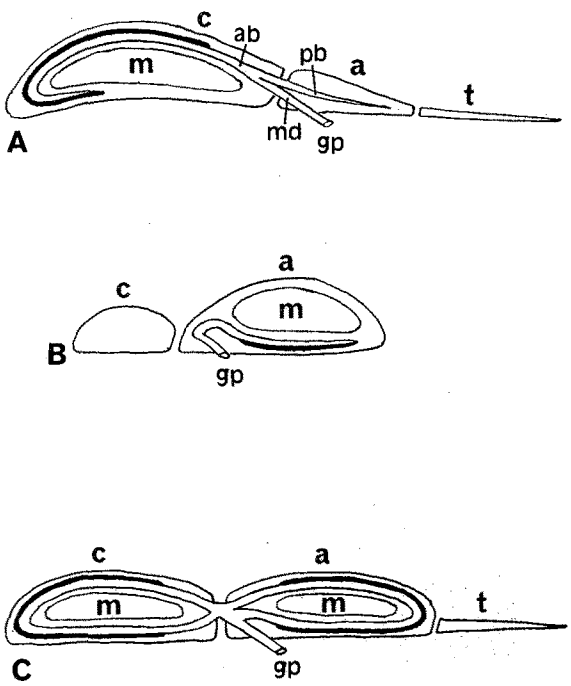

Fig. 1 Schematic demonstrations in sagittal sections of localities of ovaries in main chelicerate groups. A: adult *Limulus polyphemus*, B: generalized arachnid, C: hypothetical common ancestor. a: abdomen, ab: anterior oviductal branch, c: cephalothorax, gp: genital pore, m: midgut gland, md: main oviduct, pb: posterior oviductal branch, t: telson. Thick line shows the cord-shaped germ zone in the ovarian epithelium.

Such similarities in structure and differences in locality of the ovaries between these main chelicerate groups allow to assume a common ancestor having both a cephalothoracic and an abdominal ovary of the similar structure (Fig. 1-C).

The American horseshoe crab, *Limulus polyphemus*, has the "posterior oviductal branches" entering the abdomen (Fig. 1-A), but these branches cannot connect with the ovary, because there is no ovary in the abdomen (Makioka and Saito, 1988). These "nonsence" abdominal oviducts seem to indicate the existence of the abdominal ovary in some ancestors. Moreover, the main oviducts of many arachnids start from the genital opening toward the cephalothorax (Fig. 1-B) as well as in merostomes, but they turn back to connect with the abdominal ovary without entering the cephalothorax. Their initial start toward the cephalothorax also suggest the existence of the cephalothoracic ovary in some ancestors.

In conclusion, we propose that the ovaries in recent merostomes and arachnids have derived from the original ovary in the common ancestor with different original parts being conserved; mainly the dorsal part of the cephalothoracic ovary in merostomes, and the ventral part of the abdominal ovary in arachnids.

References

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