# A comparison of the ovaries of six primitive spiders

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**Introduction**

The order Araneae is divided into three suborders, the Liphistiomorphae, Mygalomorphae, and Araneomorphae. As for the Araneomorphae which is regarded as the most advanced suborder, three types are known in ovarian structure (see Yoshikura, 1987): that is, the "double I" type in which paired parallel ovarian tubes exist without any association each other (Comstock, 1913), the "U" type in which paired ovarian tubes are connected with each other at their posterior ends (Comstock, 1913), and the "H" type in which paired ovarian tubes are connected with each other at their middle regions by a bridge tube (Traciuc and Legendre, 1970). As for the Liphistiomorphae and Mygalomorphae, both of which are regarded as being more primitive in comparison with the Araneomorphae, however, we have little reliable information on the ovarian structure, although we can refer to Ôsaki's (1970) brief description on the ovary of a liphistiomorph spider, *Heptathela kimurai*.

In the present study, we compare the ovarian structures of one liphistiomorph and five mygalomorph spiders, to give an evolutionary discussion on the ovarian types in the primitive spiders.

**Materials and Methods**

Adult females of one liphistiomorph and five mygalomorph species (shown in Table 1) were dissected in a physiological saline. The ovaries with some adjacent organs were fixed with Bouin's solution, dehydrated in a graded ethanol-*n*-butanol series, and embedded in paraffin. Serial sections of 5 or 7 $\mu$m thickness were stained with Mayer's haematoxylin and eosin.

**Results**

The general ovarian structure of liphistiomorph and mygalomorph species examined was similar to that of araneomorph. That is, their ovary was composed of paired ovarian tubes which were situated in the opisthosoma and longitudinally ran between the dorsal mid-gut glands and the ventral silk glands. An oviduct extended forward from the anterior end of each of paired ovarian tubes. A number of oocytes were attached to the outer surface of the ovarian tubes with short cellular stalks branching from the ovarian tubes.

In a liphistiomorph, *Heptathela nishihirai*, and mygalomorphs, *Macrothele* sp. (Hexathelidae) and *Ummidia fragaria* (Ctenizidae), paired long ovarian tubes were connected with each other by a short bridge tube at their middle regions, and the ovary of these spiders can be categorized into the "H" type (Fig. 1A). Germaria were localized in the dorsal epithelium of each ovarian tube in a form of a pair of strands extending through the whole length of ovarian tube. The germarium contained oogonia and very early previtellogenic oocytes, and the larger previtellogenic and vitellogenic oocytes were found on the ventral outer surface of each ovarian tube, the larger ones lying more ventrally. The bridge tube, however, had neither the germarium in its epithelium nor the oocytes on its outer surface.

Table 1 Liphistiomorph and mygalomorph species examined.

| Species | Collection data |
|---|---|
| Suborder LIPHISTIOMORPHAE | |
| Family Heptathelidae | |
| *Heptathela nishihirai* Haupt | Ishigaki Island, Okinawa Prefecture, July 1996 |
| | |
| Suborder MYGALOMORPHAE | |
| Family Antrodiaetidae | |
| *Antrodiaetus roretzi* (L. Koch) | Mt. Tsukuba, Ibaraki Prefecture, June 1996 |
| Family Atypidae | |
| *Calommata signatum* Karsch | Kisai, Saitama Prefecture, December 1995 |
| *Atypus karschi* Dönitz | Mt. Tsukuba, Ibaraki Prefecture, June 1995 – April 1997 |
| Family Hexathelidae | |
| *Macrothele* sp. | Iriomote Island, Okinawa Prefecture, July 1996 |
| Family Ctenizidae | |
| *Ummidia fragaria* (Dönitz) | Mt. Tsukuba, Ibaraki Prefecture, June 1996 |

In two mygalomorph species, *Calommata signatum* (Atypidae) and *Antrodiaetus roretzi* (Antrodiaetidae), any associations between paired ovarian tubes were not found, and their ovary is of "double I" type (Fig. 1B). The localization of germaria and distribution of germ-line cells were the same as those in the "H" type ovary above-mentioned.

In another mygalomorph species, *Atypus karschi* (Atypidae), ovarian tubes of both sides posteriorly fused with each other, so that the ovary assumed a shape of an alphabet letter "Y", to be named "Y" type ovary (Fig. 1C). The strands of germarium decreased in number into two at the posterior ovarian end. The distribution of germ-line cells were the same as that of the former two types of ovaries.

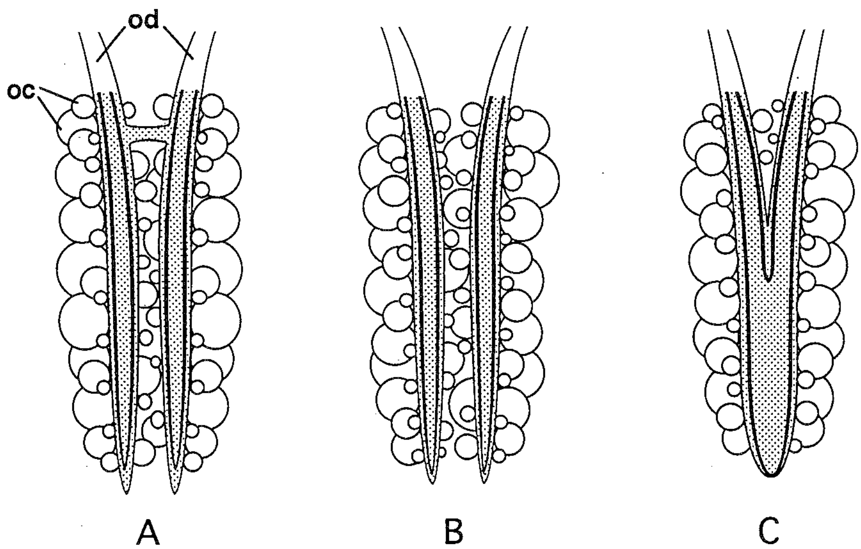


Fig. 1 Schematic representation of three types of ovaries (dotted) in the primitive spiders. Dorsal view. Anterior to the upside. Bold lines represent germaria. A. "H" type ovary in *Heptathela nishihirai, Macrothele* sp. and *Ummidia fragaria.* B. "Double I" type ovary in *Calommata signatum* and *Antrodiaetus roretzi.* C. "Y" type ovary in *Atypus karschi.* oc: oocytes, od: oviducts.

**Discussion**

The present study reveals that the ovaries of "H" type, which had been found only in the araneomorph spiders (Traciuc and Legendre, 1970), develop also in the other araneid suborders, *i.e.*, the Liphistiomorphae and Mygalomorphae. It may be likely that the "H" type is one of the basic ovarian types in the spiders.

As for the suborder Mygalomorphae, the families Antrodiaetidae and Atypidae are regarded as being closely related with each other. It may be noteworthy that an antrodiaetid *A. roretzi* and an atypid *C. signatum* commonly have the "double I" type ovaries. It is possible that this type of ovaries in *A. roretzi* and *C. signatum* have been secondarily derived from the basic "H" type ovary in the common ancestor of both families by the loss of bridge tube. On the other hand, the "Y" type ovary found in another atypid spider *A. karschi* should be derived from the "double I" type ovaries by the fusion of the posterior halves of paired ovarian tubes.

We suppose that the structural changes from the basic "H" type into the "double I" type and further into the "Y" type ovary have occured in liphistiomorphs and mygalomorphs. Further detailed comparative researches on the ovarian structure and development in many araneids will be useful for testing our hypothesis.

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