Discovery of the web of *Phoroncidia altiventris* (Araneae: Theridiidae) and implications for its taxonomic position

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Abstract — The web of *Phoroncidia altiventris* (Araneae: Theridiidae), which had been unknown since its taxonomic description, was recently discovered and confirmed to form an orb-web structure. This result supports the thought that this species should be reassessed and placed in the family Araneidae.

Key words — Araneidae, hub, orb web, radial thread, spiral thread, taxonomy

*Phoroncidia altiventris* Yoshida 1985 (Araneae, Theridiidae) is a small, lumpy-shaped spider that is located in Honshu and Kyushu areas of Japan (Yoshida 2003). Although this species currently belongs to the family Theridiidae, the morphology of male individuals suggests that it should be included in the family Araneidae (Yoshida 2003).

Many species of the family Araneidae are orb-weavers; their webs are composed of non-viscid radial threads and viscid ecribellate spiral threads (Eberhard 1982). This basic structure has also been found in families Tetragnathidae, Theridiosomatidae, Anapidae, Mysmenidae and Symphytognathidae (Griswold et al. 1998; Eberhard 1987; Shinkai & Shinkai 1988; Shinkai 1990; Hiramatsu & Shinkai 1993) but has never been documented in Theridiidae. The web of Theridiid spiders is characterized by a three-dimensional tangled structure, as well as mesh web and sheet web variations (Arnedo et al. 2004; Eberhard et al. 2008). The web of *Phoroncidia* is one of these unique variations, and is composed of a single line of thread with an array of adhesives (Eberhard 1981; Shinkai 1988a). Therefore, the identification of web structure should contribute to understanding the taxonomic position of *P. altiventris*. However, the presence of a web had never been reported. The previously reported foraging observations lacked detailed information on web structure and capture behavior (Hagimoto & Hagimoto 2002). Recently, we found a juvenile *P. altiventris* in its natural habitat that was hanging on its web (Figs. 1A, B). In this paper, we describe the web structure of *P. altiventris* and emphasize the need to reconsider its taxonomic position.

The nocturnal observation was conducted in Tsukuba Experimental Forest (36.115593N, 140.100733E), Tennodai, Tsukuba, Ibaraki Prefecture, Japan, on April 24, 2019. Although the individual that wove a web was not matured, we identified it as *P. altiventris* on the basis of its external morphology and the fact that several adults of the species were collected at the same location. The web was found at 23:31 PM. It was stretched on the underside of a *Eurya japonica*.
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(Thunb 1783) leaf and the web was at a height of 1.5 m from the ground (Fig. 1B). The detail of the web structure is presented in Fig. 2. The web was 38 mm in length and 21 mm in width. It was composed of six radial threads and two spiral viscid threads (Fig. 2). The radial threads were connected to the edge of the leaf and intersected with the viscid threads excluding thread no. 6, which was directly connected to the undersurface of the leaf (Figs. 2A, B). Foraging behavior was not observed; however, the viscosity of the spiral thread was confirmed based on the presence of a sticky glue array and the fact that it trapped a gnat fly. Viscid threads diverged at the intersection of radial threads no. 3, 4, and 5 (Figs. 2A, B), indicating that the number of spirals were originally three and had reduced to two due to a fusion between the outer and median spirals. The web lacked framework threads and seemed to be tangled rather than plain (Fig. 2B). The shape of the hub was distorted compared to the regular hexagonal formation (Fig. 2C).

The web of P. altiventris, composed of radial threads and ecribellate spiral viscid threads are similar to the basic structure of Araneid’s web (Eberhard 1982) rather than that of Theridiid’s (Arnedo et al. 2004). The observed hub structure resembles Araneid’s “closed hub”, whereas is clearly different from Tetragnathid’s “opened hub” (Ikeda 2003) (Fig. 2C). The lack of frame threads rarely occurs in Araneidae (e.g. spiders in the genus Cyrtarachne (Suginaga 1963)) and Tetragnathidae (e.g. Tetragnatha lauta Yaginuma 1959 (Shinkai 1988b)). In contrast, other Araneid families that weave modified orb webs (e.g. Theridiommatidae and Anapidae) commonly lack frame threads, which lead to radial threads stretching in various directions (Eberhard 1987; Shinkai & Shinkai 1988; Shinkai 1990). This trait seems to occur independently within different groups; therefore, it is difficult to determine the taxonomic position of P. altiventris based only on its web morphology. However, the characteristics of the observed web does not conflict with the thought that P. altiventris should belong to Araneidae (Yoshida 2003). It also strongly suggests the low validity of the current taxonomic position of this species, belonging to Theridiidae. Further phylogenetic studies using both morphological and molecular approaches should be conducted to verify the taxonomic position of this species.

Phoroncidia altiventris is often found hanging under leaves (Shinkai 2006). However, it is not clear what factors may trigger (i.e. humidity, time or growth phase and so on) or are responsible for web construction. Further observations on the web structure, web constructing process, and foraging behavior are necessary.

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