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Occurrence of *Aprostocetus* sp. (Hymenoptera: Eulophidae), a predator on the eggs of *Araneus omnicolor* (Araneae: Araneidae), in Jundiai, Brazil

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Abstract: Some aspects of the natural history of *Araneus omnicolor* (Keyserling, 1893) are poorly known, and although there are studies that deal with its natural enemies, this is only the second report on the occurrence of its egg predators. Despite the fact that we have not obtained identification down to the species level, the predator wasp (*Aprostocetus* sp.) is an additional natural enemy for *A. omnicolor*, and this also represents a new association for *Aprostocetus*.
Key words: Hymenoptera, Eulophidae, *Aprostocetus*, Araneae, Araneidae, *Araneus omnicolor*, egg sacs, orb-weaving spiders, predator, Brazil.

Presencia de *Aprostocetus* sp. (Hymenoptera: Eulophidae), avispa predadora de los huevos de *Araneus omnicolor* (Keyserling, 1893) (Araneae: Araneidae), en Jundiaí, Brasil
Resumen: La historia natural de *Araneus omnicolor* (Keyserling, 1893) es poco conocida y, aunque existen estudios que reportan enemigos naturales, este es el segundo estudio en informar la presencia de predadores de huevos. A pesar de no haber obtenido la identificación a nivel específico, la avispa predadora de huevos (*Aprostocetus* sp.) queda registrada como un enemigo natural más de *A. omnicolor*, y se aporta una nueva asociación para *Aprostocetus*.
Palabras clave: Hymenoptera, Eulophidae, *Aprostocetus*, Araneae, Araneidae, *Araneus omnicolor*, saco de huevos, predadores, Brasil.

Most of the species of spiders construct a structure with silk, called of egg sacs (Turnbull, 1973; Foelix, 1982) to protect eggs or spiderlings from thermal stress (Norgaard, 1956; Schaefer, 1976; Hieber, 1985), fungal attack (Christenson & Wenzl, 1980), water loss (Bristowe, 1941; Foelix 1982) and predator and parasite attack (Robinson, 1980; Hieber, 1984; Austin, 1985; Hieber & Uetz, 1990). However, it fail to prevent the attack of ants, wasps, birds and flies (Austin, 1985; Hieber, 1992, Sobczak *et al*., 2012). Thus, several taxa of insects are specialized in using the spider eggs as resources (Auten, 1925; Eason *et al*., 1967).

Araneus omnicolor (Keyserling, 1893) is a species of orb-weaving spider commonly attacked by predators and parasitoids. Gonzaga & Sobczak (2007) recorded parasitism by *Hymenoepimecis veranii* Loffredo & Penteado-Dias, 2009 (Hymenoptera, Ichneumonidae, Pimplinae) and Sobczak *et al*. (2012) reported attack by *H. neotropica* (Brues & Richardson, 1913). Moreover, Buschini *et al*. (2010) reported predation of *A. omnicolor* by *Trypoxylon agamemnon* Richards, 1934 (Hymenoptera: Crabronidae), and Sobczak *et al.* (2012) recorded eggs of *A. omnicolor* being preyed upon by larvae of *Tromatobia* sp. (Hymenoptera: Pimplinae).

Wasps that attacked the spider egg sacs insert their ovipositor into the wall of the egg sac and lay eggs, and the eclosing hymenopteran larvae will develop by consuming the egg mass (Austin, 1985). Many species of the Ichneumonoidea and Chalcidoidea (Hymenoptera), Mantispidae (Neuroptera), and the order Diptera are insects classified as egg predators. True parasitoids are known in the Hymenoptera families like Scelinonidae (*Baeus*, *Idris*, *Ceratobaeus*), Encyrtidae (*Amira*, *Proleurocerus*) and Eulophidae (*Aprostocetus*, *Arachnoobius*, *Aranobroter*, *Baryscapus*, *Comastichus*, *Tachinobia*, and *Tetras-tichus*) (LaSalle, 1990; Triana *et al.,* 2012).

The subfamily Tetrastichinae (Eulophidae) is one of the largest and widespread among the Chalcidoidea. The large and cosmopolitan genus *Aprostocetus* Westwood (Eulophidae: Tetrastichinae) currently includes more than 760 valid species, almost 90 of these being recorded in the Neotropical Region (Noyes, 2015) and some species was recorded from spiders egg sacs. Undetermined species of *Aprostocetus* have been collected in the egg sacs of spider of the family Araneidae (*Mastophora extraordinaria* Holmberg, 1876, *Metepeira labyrinthea* (Hentz, 1847), *Parawixia audax* (Blackwall, 1863) and an unidentified species of Araneus) and Theridiidae (*Latrodectus geometricus* [Koch, 1841] and *Latrodectus mactans* [Fabricius, 1775]) (LaSalle, 1990). The genus *Araneus* (Clerck, 1757) stands out as one of the most abundant of the Araneidae family, with more than 674 des-cribed species worldwide (Platnick, 2009). The focus of this study was to record the attack of *Aprostocetus* sp. in eggs of the *A. omnicolor*.

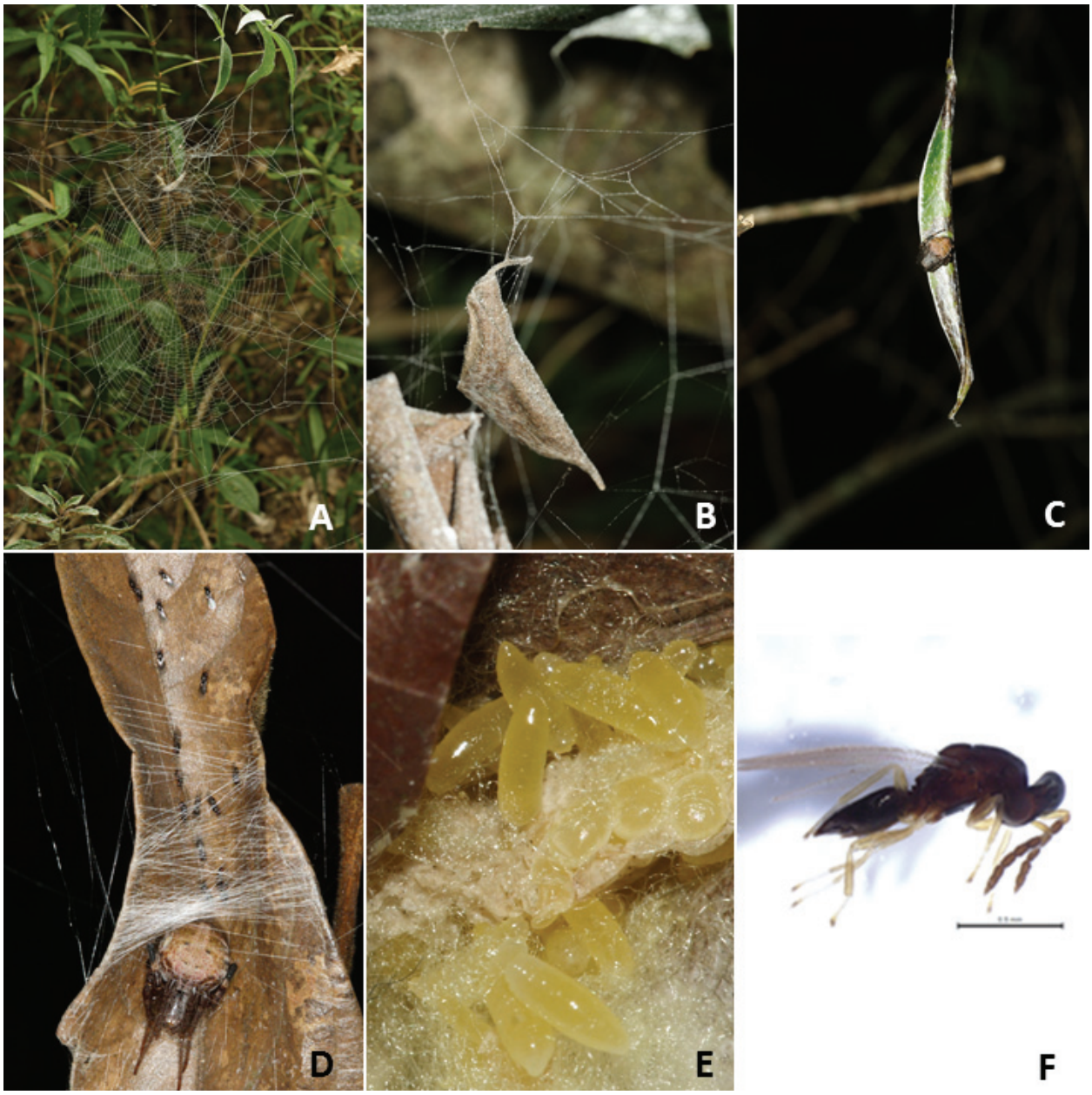
Material and methods

We collected 13 egg sacs of *A. omnicolor* fixed in the three-dimensional part of web that was localized in the edge of forest in March to April of 2008 and March to May of 2010 in the Serra do Japi (23°15′S, 46°57′W), a protected subtropical humid forest located in Jundiaí, state of São Paulo, Brazil. A total of 1.040 webs of *A. omnicolor* located in the edge and interior of forest were inspected to measure the period in which the spiders build egg sacs and the occurrence of predator wasp. Webs containing egg sacs were photographed in the field and the sacs collected in pots and kept in laboratory until the emergence of adult wasps and spiderlings. Voucher specimens of *Aprostocetus* sp. were deposited the collection of Insetos Entomófagos "Oscar Monte " (curator Costa, V. A.), of Instituto Biológico, Campinas, Brazil, and specimens of *A. omnicolor* were deposited in the collection of Instituto Butantan (curator Brescovit A. D.), São Paulo, Brazil.

Results and discussion

A. omnicolor builds a web composed of two parts. The first portion is orbicular, consisting of adhesive strands that catch prey. The second part consists of several strands in a three-dimensional organization that serves for sustain a dry curve leaf used as shelter by the spider (Fig. A).

The egg sacs of *A. omnicolor* are formed by one folded leaf, which the spider seals at one end with silk, and then stores are eggs within it. The egg sacs remain fixed to the web by very resistant strands (Fig. B), different from other strands present in their web for



Figures 1. *A. omnicolor*, its web, egg sac and *Aprostocetus* (A-F): **A**) Web of *A. omnicolor*, arrow indicating the egg sacs of the spider attached to the three-dimensional portion of the web; **B**) Detail of fixed egg sacs; **C**) Spider finalizing the construction of egg sacs; **D**) Spider on your leaf shelter with adult *Aprostocetus* sp.; **E**) larvae of *Aprostocetus* sp. consuming the eggs of spider; **F**) Details of adult *Aprostocetus* sp.

prey capture or that maintains the shelter leaf. The spider does not take care of the egg sacs, after sealing them, it returns to the shelter leaf (Fig. C).

We observed that before spider built the egg sacs, the wasp remained under the leaf along with the spider (Fig. D) and afterwards migrated along with the spider when it started construction of the egg sacs. The spider was not able to detect the presence of wasps in the shelter leaf. We observed that the presence of wasps along with the spider under the leaf occurs weeks before the start of construction of the spider egg sacs and decreases as the breeding season ends.

Of the 13 egg sacs of *A. omnicolor* collected, 10 were consumed by *Aprostocetus* sp. larvae (Fig. E). The adult wasps emerge (Fig. F) from egg sacs making a small hole, possibly with the help of the mandibles. We noticed that there was no spider or exuvia remains inside the host egg sacs, i.e, the rate of predation in the egg sacs of *A. omnicolor* attacked by *Aprostocetus* sp. is one hundred percent (Fig. E).

Unfortunately, *Aprostocetus* (Hymenoptera: Chalcidoidea), in general, are an extremely difficult group taxonomically. There are a large number of species, they are morphologically rather uniform compared with many of their relatives in the Chalcidoidea, and they tend to collapse or shrivel when they die, making them difficult to study. Thus, species-level determinations of *Aprostocetus* (Chalcidoidea: Eulophidae) are currently impossible, because there is no current revision of the genus (Hieber, 1984; Lasalle, 1994).

Only three species of Aprostocetus (Aprostocetus) have been associated to spider eggs: Aprostocetus (Aprostocetus) banksii (Howard, 1892), Aprostocetus (Aprostocetus) arachnophagus (Brèthes, 1913) and Aprostocetus (Aprostocetus) riverai (Brèthes, 1926) (Howard, 1892; Brèthes, 1913; 1926; Blanchard, 1950). However, the species collected differs from these three species by having brown coloration. Moreover it differs from *A. banskii* for presenting smooth pro-, meso- and metapleura, and yellowish femora. It also differs of *A. arach-nophagus* by presenting antenna inser-

ted in height of the infraocular line and also differs from *A. riverai* by presenting the fourth segment of the flagellum longer than wide.

Hieber (1984) reported predation of *Mecynogea lemniscate* (Walckenaer, 1841) eggs by a species of *Tetrastichus* in Florida. However, it is noteworthy that several species of *Tetrastichus* were transferred to the genus *Aprostocetus* (Graham, 1987; Noyes, 2014). Thus, the species collected, although we have not obtained identification to a more specific level, seems one more record of predation in *Araneus* and also represents a new association for *Aprostocetus*.

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