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A hornet is fed upon by a spider, *Argiope amoena* (Araneae: Araneidae)

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Abstract

I report herein an observational case that *Argiope amoena*, a common large orb-weaving spider representative in Japan, preyed on a yellow-vented hornet *Vespa analis insularis* with wrapping. It was previously reported that about half of the diets foraged by *A. amoena* are composed of Hymenoptera mainly honeybees and ants (Formicidae gen. sp.). However, to my knowledge, the cases that a hornet of *Vespa* sp., the largest of the eusocial wasps and known as a predator of insects and spiders, is fed upon by *A. amoena*, are rarely documented in scientific literature; by contrast, some cases, vespine hornets attack *Argiope* spiders and steal the prey items from the web of argiopids, have been reported. The present study shows that *A. amoena* is not only a prey fed upon by the vespid but also one of the natural enemies of the yellow jacket such as *V. analis*.

Keywords: Araneae, Diet, Hymenoptera, Prey-Predation Relationships, *Vespa analis insularis*, Vespidae, Web-building Spider.

Introduction

A spider of the genus *Argiope* is rather large orb-weaver. *Argiope* contains 86 species and 3 subspecies (World Spider Catalog, 2020) and there are seven species belonging to the genus in Japan (Ono, 2009). The spider *Argiope amoena* L. Koch, 1878, known as a common argiopid spider, inhabits the main island and southwestern portion of Japan (e.g. Kishida, 1936; Murakami, 1983; Ono & Ogata, 2018). Ono (2014) stated that it is no exaggeration to say that *A. amoena* is a representative spider of Japan. Recently, however, in metropolitan areas such as Tokyo, *A. amoena* has been categorized as Near Threatened (NT) (Ono *et al.*, 2019). A reason why the population of *A. amoena* is

decreasing is speculated that so-called bush environment suitable for large insects, supposed to be potential prey for *A. amoena*, has been destroyed (Ono, 2014).

Hornets (Insecta, Hymenoptera, Vespidae) are large, predatory, eusocial wasps and centred in Asia and Europe (Smith-Pardo *et al.*, 2020). Seven species from the Vespidae are described in Japan (Matsuura, 1988). Species of vespine wasps, the hornet such as *Vespa crabro* Linnaeus, 1758, and *Vespula* species sometimes capture spiders as food for their brood (Helsdingen, 2011). Matsuura & Yamane (1990) reviewed the cases that *Vespula vulgaris* (Linnaeus, 1758) (Broekhuizen & Hordijk, 1968), *Vespula flaviceps* (Smith, 1870) (Iwata, 1971), *Vespa simillima* Smith, 1868 captured spiders and *Vespa mandarinia* Smith, 1852 fed upon *A. amoena* and *Argiope bruennichi* (Scopoli, 1772) (Matsuura, 1984). *Argiope bruennichi* has also observed to be attacked by *V. crabro* (Bruggisser *et al.*, 2012). Additionally, *V. crabro* acts as a regular kleptoparasite as well as predator on *A. bruennichi* (Helsdingen, 2011); a stealing of the captured prey from *Argiope aurantia* Lucas, 1833 was also observed (Davis, 2011). Therefore, spiders, well known as predators of insects and spiders, are also prey for hornets. Conversely, of course, spiders are predators of hornets, aren't they?

It is accounted that web-constructing spiders can be both victims and predators of *Vespula* (Matsuura & Yamane, 1990). However, on the other hand, there are few descriptions of such observed cases that spiders hunt hornets in literature (Matsuura & Yamane, 1990; Richter, 2000; Smith-Pardo *et al.*, 2020). Foelix (2011) noted that most spiders generally avoid certain insects, such as stink bugs (Pentatomidae), ants (Formicidae), and wasps, etc. This would explain the reason that the lack of the reported cases of predation, the hornet was fed upon by spiders.

Because orb-web spiders could both attack and be attacked by hornets, *A. amoena* must hunt the hornets of Vespidae depending on the time. Nevertheless, to the best of my knowledge, despite the fact that web spiders are common truly polyphagous predators (Murakami, 1983), it seems that feeding upon the vespine hornets by spiders has been little reported yet in scientific research papers concerning *A. amoena*. Only very rarely once, the cases had described that an argiopid spider captured the species of hornets, vespine wasps, i.e., *A. bruennichi* fed upon *Vespa germanica* (Fabricius, 1793) and *Vespa maculata* (Linnaeus, 1763) (Bilsing, 1920) [Now in other genera: *Vespula* and *Dolichovespula*].

A yellow-vented hornet *Vespa analis insularis* Dalla Torre, 1894, the Japanese subspecies, is distributed in Japan from North area to Tanegashima Island and Yakushima Island (located south of Kyushu Island) (Matsuura & Yamane, 1990). In the present study, an observational case of *A. amoena* preying on *V. analis* in the web with wrapping is described. The body size of *V. analis* was measured and the size ratio of *A. amoena* and *V. analis* was estimated from a photograph is also described.

Material and Methods

The observation of the predation was carried out in the Bunkyo Campus at Nagasaki University. The photographs were taken using a Canon digital camera IXY 630 (Tokyo, Japan).

Results and Discussion

I observed that an adult female *A. amoena* preyed on a *V. analis insularis* in the centre of the web with wrapping, on a hedgerow of azalea (*Rhododendron* sp.) plant at 15:23 pm on July 10, 2020 (Fig. 1). The weather was windy and often rainy. The hunting

was already complete at the time of the observation. I collected the dead individual of the hornet from the web and body size was measured by a ruler; the length of the body was 17.8 mm (Fig. 2). From a photograph (two individuals were little overlapped each other), the length of the argiopid was estimated to be 1.4 times the length of the hornet.

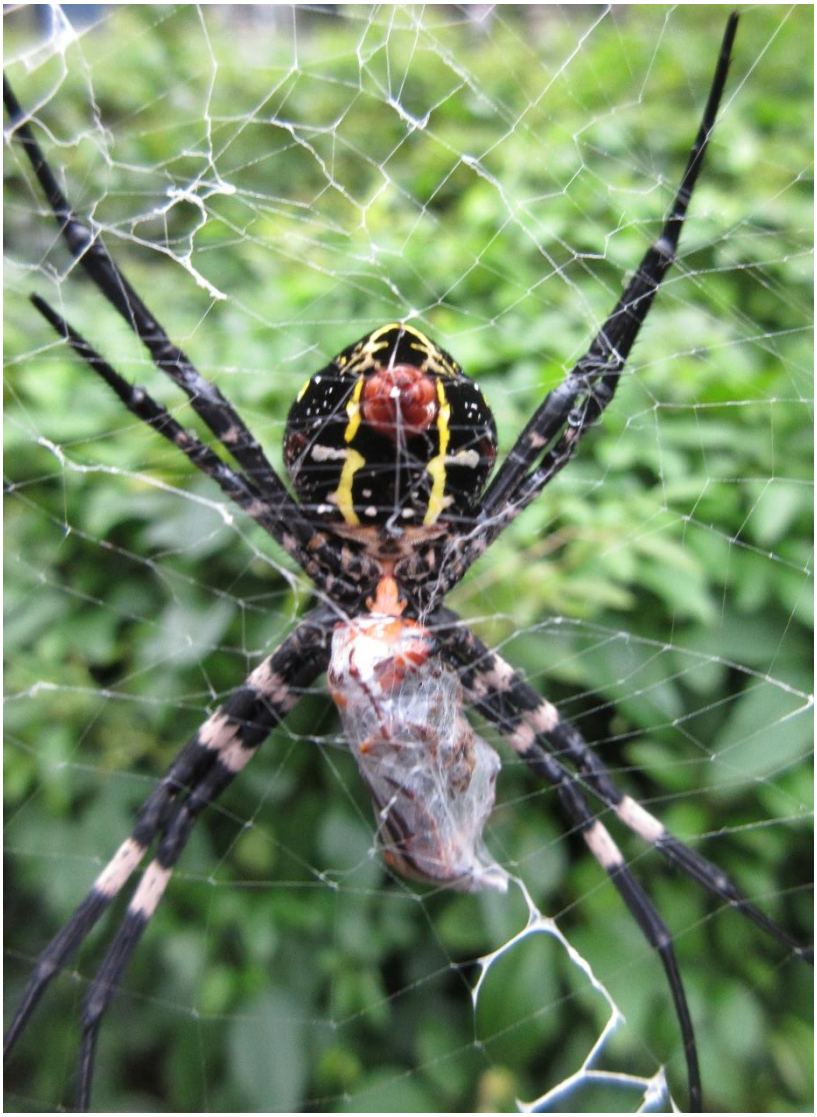

Fig. 1. *Argiope amoena* preyed on *Vespa analis insularis* with wrapping.

Fig. 2. An individual of *Vespa analis insularis*. (Scale = 5 mm).

Murakami (1983) reported that 387 individuals of the prey items foraged by *A. amoena* were composed of Hymenoptera (49.7%) including honeybee *Apis cerana* Fabricius, 1793 and Formicidae gen. sp. mainly, followed by Coleoptera (28.1%) and Hemiptera (19.9%). In the diet of *A. amoena*, small Diptera were very rare (only 1.7%), unlike such as *A. bruennichi*, also a common orb-web spider (Nyffeler & Benz, 1978; Pasquet, 1984). By analyzing these data of the diet, it was confirmed that *A. amoena* is a predator of euryphagy (Pekár *et al.*, 2012). But to my knowledge, there are only very few cases observed that a hornet, vespine wasp like *V. analis*, is fed upon by a web-constructing spider *A. amoena* and such cases have rarely documented.

Foelix (2011) noted that when bees or wasps get caught in a spider web, they sometimes manage to push their stinger into the soft joint membranes of the spider's legs. Orb weavers such as *Argiope* species behave like that; first, they wrap the prey items and then bite. Consequently, the offensive wrapping of prey such as a vespine hornet yields advantages for the spider that there is less danger of being harmed by strong prey like a stinging hornet. Thus, it is conceivable that this usual tactic for argiopids to capture prey must be used in the present case.

Vespa analis is relatively small for vespid wasps, actually, in the present case, the length of the hornet is about 72% of that of spider *A. amoena*. Hence the difference of the body size would be very helpful for *A. amoena* to defeat a predatory hornet. Then, questions are raised that why didn't the hornet avoid a relatively large argiopid like *A. amoena*? Did the vespid need to dare attack a larger spider than herself? It was often rainy and comparatively windy at the day. If the vespid had difficulty in controlling the precise flight prevented by strong wind, this should be an additional disadvantage not for a web spider but for a hornet. I think that the body sizes, the orb-weaver was slight larger than the vespid, and circumstances like weather condition such as strong wind could influence the prey-predator relationships between the web spiders and the hornets.

Vespids are serious pests for Japanese beekeepers, because the hornets cause damage to beehives (Matsuura & Sakagami, 1973). Furthermore, there are ca. 30 deaths per year from stings by social wasps and bees in Japan (Matsuura, 2000). Ori (1975) and Higa *et al.* (1994) reported some spider bite incidences; on the contrary, the risk of the spiders is very little compared with that by wasps and hornets. There would be no cases that *A. amoena* caused harmful damage to mankind. It would be of importance for us to live an abundant life with web spiders, one of the natural enemies of the hornet, and less risks derived from stings of vespid wasps. Though, there is almost no information about the hornet as prey to orb-weavers until now.

In summary, the present observational case, *A. amoena* preyed a predatory hornet of vespine wasps, reinforces and proves again the statement that web-constructing spiders can be both prey and predators of the hornet species. Concerning prey-predatory relationships like *Argiope* spiders and Vespidae wasps could be a small step to provide useful point of view that protection of the environment suitable for the web-building spiders, especially *A. amoena*, Near Threatened as in Tokyo. Further researches are necessary to clarify a role played by the web-building spider as a natural enemy for the vespine wasps from the viewpoint like biocontrol.

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