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Predatory behaviours of *Discothyrea kamiteta* (Proceratiinae) on spider eggs

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INTRODUCTION

Some ant species display specialised predation on specific animal groups (Hölldobler & Wilson 1990). Most such cases are observed in species belonging to primitive groups such as Ponerinae whose stings are often functional. *Leptanilla japonica* Baroni Urbani (Leptanillinae) and *Stigmatomma silvestrii* Wheeler (Amblyoponinae) selectively prey on geophilomorpha centipedes (Masuko 1981, 2008; see Yoshimura & Fisher 2012 for revival of *Stigmatomma* from synonymy with *Amblyopone*). Workers of the Dacetini ants have adapted to hunting collembolans (often Entomobryomorpha), thus developing various specialised traits such as long mandibles in the genus *Strumigenys* or short mandibles with behavioural adaptations in the genus *Pyramica*. Additionally, some ants prey on arthropod eggs, including species of two proceratiine genera, *Discothyrea* and *Proceratium*, the ponerine *Plectroctena*, and two myrmicines, *Calyptomyrmex* sp. and *Stegomyrmex vizottoi* Diniz (Brown 1979; Diniz & Brandão 1993; Ito 2001). *Plectroctena* spp. and *Calyptomyrmex* sp. prey on millipede eggs and the others on spider eggs.

The genus *Discothyrea* belongs to the subfamily Proceratiinae (Bolton et al. 2006). The species of this genus are considered specialised predators of arthropod eggs. Brown (1979) identified nests of *Discothyrea* spp. storing eggs, probably of spiders, in Australia (*D. bidens* Clark), Panama (group of *testacea* Roger), and South Africa (*D. poweri* (Arnold)). Queens of the Cameroonian species, *D. oculata* Emery, create their colonies inside the oothecae of spiders belonging to the genus *Ariadna* (Segestriidae) and rear first workers on spider eggs (Dejean & Dejean 1998; Dejean et al. 1999).

In Japan, two species belonging to the genus *Discothyrea* have been identified (Kubota & Terayama 1999). *Discothyrea sauteri* Forel is widely distributed in Japan and is considered to be a specialised predator of arthropod eggs (Masuko 1981). Conversely, *D. kamiteta* Kubota & Terayama is relatively rare, having been reported only from the Okinawajima Island, southwest Japan. To the best of my knowledge, no data is available on the ecology of this species. This article reports the result of observations on the dietary behavior of *D. kamiteta* in the laboratory, suggesting that this species is a specialised predator of spider eggs.

METHODS

Two colonies of *D. kamiteta* were accidentally discovered during field surveys on Okinawajima Island on different days. One colony had nested in the suspended soil of the epiphytic fern, *Asplenium nidus* L., attached at a 1.5-m height to the trunk of *Cyathea lepifera* (J. Sm. Ex Hook)

Copel. tree ferns at Nanzyô city (date: 7 October 2010; E 26°10'19" 127°49'23"). The second colony was found in the soil at 15-cm depth in the secondary forests in Nakijin village (date: 2 July 2011; E 26°41'22", N 127°55'39"). Both colonies contained an inseminated queen (dissected after observations). Although the number of workers in the first colony (in terms of tens of workers) could not be ascertained, the second colony had 73 workers. No prey items were detected in their nests during specimen collections because of the particle contaminations from surroundings. Both the colonies were kept in plastic cases (15 × 15 × 4 cm) with a 1-cm thick plaster floor. To ensure easy observations, a cavity (3 × 1.5 × 0.3 cm) was created in the floor and covered using a glass plate (13 × 12 cm). Further, a canal was constructed connecting the cavity to the floor surface outside the glass plate. A few days after transferring the nest to the plastic case, the ants aggregated inside the cavity. The colonies were maintained under standard laboratory conditions (12:12-h light/dark cycle; 25°C).

While the eggs of *Ariadna* spiders are the known food of the Cameroonian *D. oculata* (Dejean et al. 1999), in this study the oothecae of the orb-web spider, *Cyclosa octotuberculata* Karsch (Araneidae) were used, because these are easily available on Okinawajima Island

RESULTS AND DISCUSSION

Two oothecae were directly placed on the floor of the plastic case containing the first colony. After ten minutes, the workers located the oothecae and gathered around them, showing behaviour indicating interest toward the oothecae. One worker then bore a hole on one of the oothecae exposing the spider eggs. She retrieved an egg from the ootheca by using her mandibles and brought it into the nest cavity (Fig. 1). When the plastic case was checked the next day, several spider eggs were observed inside the nest cavity (Fig. 2). Although several pieces of freshly-cut mealworms (*Tenebrio molitor* L.) were introduced to the plastic case, no response was observed toward them and these were left untouched even after a day. Further, when a worker was touched using forceps, she rolled over and folded her legs and antennae (i.e. performing pupal-like posture which is often referred-to as "death-feigning behaviour" Miyatake et al. 2009) (Fig. 3). Although the worker continued this posture for a few seconds, the behaviour was not seen constantly afterward. Because the queen of this colony suddenly died, I was unable to observe if the queen could show such behaviour. After feeding the colony on the oothecae for a few months, some workers emerged. During this period, oothecae sometimes contained spiderlings which hatched inside them, but the ants neither hunted nor consumed these spiderlings. At the end of the observations, the queen and workers were dissected. From the queen's gaster dissection, it was confirmed that she had mated and formed her eggs. Further, both the queen and workers showed four ovarioles in the gaster.

Fig. 1. A worker taking an egg from an ootheca of a *Cyclosa octotuberculata* spider. The scale bar at lower left represents 1 mm.

Fig. 2. The nest cavity containing *D. kamiteta* workers, their larvae, and the spider eggs. The scale bar at lower left represents 1 mm.

The workers of the second colony also showed the same responses to the spider oothecae and the eggs were carried to the nest cavity. Workers emerged after a few months, indicating

Fig. 3. Queen expressing death-feigning behaviour after being touched with forceps.

that the eggs were consumed. The behaviour of the queen could be observed in this colony. When the queen of this colony was touched using forceps, she rolled over and folded her legs and antennae (Fig. 3). Among the three touches performed, the first touch resulted in the queen undergoing a death-feigning behaviour bout for about 60 s. The behaviour was repeated but each bout decreased by several seconds after the following two touches, which were performed after the queen resumed movement from the previous death-feigning behaviour. Five worker ants were also touched using forceps, and although the worker ants also showed similar death-feigning behaviour, it lasted only for a few seconds. The queen and workers of this colony each had six ovarioles. Two ovarioles of the queen, one from the ovariole aggregation on each side of the gaster, were selected and measured.The mean length and maximum width were 2.47 mm ± 0.23 and 0.22 mm ± 0 respectively (mean ± SD, n = 2).

Although no field observations were made, the laboratory observations strongly suggest that *Discothyrea kamiteta* is a specialised predator of spider eggs, similar to the other species of the genus *Discothyrea*. *Cyclosa octotuberculata* is an orb-web spider and its oothecae are located in the centre of their orb-web. It seems unlikely that the workers of *D. kamiteta* forage on the orb-web and take the eggs from the oothecae. The observation of the specific ant feeding behaviour on the oothecae of *C. octotuberculata*, which has a distribution that does not overlap with that of the ants, suggests that *D. kamiteta* might have general responses to the oothecae of spiders, regardless of the species. In addition, although it was previously shown that *D. oculata* hunts spiderlings (Dejean et al. 1999), no such behaviour of hunting or feeding on spiderlings was observed in this study. *Discothyrea kamiteta* may rely exclusively on eggs of arthropods, especially spiders. As subterranean spiders belonging to Liphistiidae and Ctenizidae were very abundant at the Nakijin study site (Katayama personal observations), the eggs of such spiders could be a plentiful food source, although the ants were not observed feeding on them. Subtle changes in colour were observed in the spider eggs stored in the nest cavities, differing from those in the oothecae. The same was observed in nests of *Discothyrea* species from Indonesia (F. Ito, personal communication, 2012). From this, it can be speculated that the ants might have treated the eggs in some way to preserve them for a longer period.

The death-feigning behaviour, which has not previously been reported in the genus *Discothyrea,* might be useful while foraging for spider eggs, which are aggressively protected by spiders. One possible reason behind the death-feigning behaviour is to reduce mortality risk (cf. Miyatake et al. 2009). Less sclerotised young workers of the fire ants *Solenopsis invicta* Buren employed death-feigning behaviour to avoid damage from intraspecific aggression (Cassill et al. 2008). The queen of *D. kamiteta* in this study could not be young because of the large colony size, while the age of the workers was unknown. The death-feigning behaviour of *Discothyrea* could be related to its foraging behaviour. The extended period of feigning death in the queen implies that it might engage in dangerous foraging trips to rear her first workers, unlike *D. oculata* claustral queens (Dejean & Dejean 1998).

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