1988. The Journal of Arachnology 16:132

INTERACTIONS BETWEEN THE CRAB SPIDER *MISUMENA VATIA* (CLERCK) (ARANEAE) AND ITS ICHNEUMONID EGG PREDATOR *TRYCHOSIS CYPERIA* TOWNES (HYMENOPTERA)

Spider egg masses are subject to a wide variety of dangers, including insects whose larvae require them as a food source. Information on these spider-insect relationships often consists largely of documenting predator and prey species (Askew 1971), and in many instances even predator or parasitoid records are missing (Krombein et al. 1979; Austin 1985).

In my study area along the coast of Maine, U.S.A., the ichneumonid wasp *Trychosis cyperia* Townes (Hymenoptera: Ichneumonidae) is an egg predator on the crab spider *Misumena vatia* (Clerck) (Araneae: Thomisidae). I define an egg predator as an individual that attacks the eggs of a mass collectively and feeds externally on it, rather than developing within a single egg oviposited there by its parent (Austin 1985). A single larva of *T. cyperia* will totally consume all but the largest of *Misumena* egg masses, before pupating within the spider's nest (Morse and Fritz 1987).

Trychosis is a potentially important egg predator on *Misumena*, since one successful attack usually totally destroys the spider's entire reproductive effort (Morse and Fritz 1987). Further, *Trychosis* may successfully attack between 7 and 60% of the *Misumena* nests in a local population (Morse and Fritz 1987; Morse, unpublished data).

As a result of *Trychosis'* high predation level, *Misumena* should experience strong selection to minimize wasp attacks. Indeed, female *Misumena* guard their egg masses over much or all of the period between egg-laying and emergence of the young from the nest about a month later (Morse 1985). Predation by these wasps is not random: they successfully attack small egg masses, which are guarded by small spiders, significantly more frequently than large ones. This pattern is a consequence of differences in guarding behavior by different-sized spiders. Nests from which the parents are removed do not differ in success as a consequence of egg mass size (Morse, unpublished data).

This result strongly suggests that the differential predation is a consequence of direct interactions between *Misumena* and *Trychosis*, in which large spiders fare better than small. However, although I monitored the nesting success of over 200 spiders at three different sites between 1982 and 1985, I did not observe *Trychosis* adults in the field, even though predation by it was sometimes high.

During the summer of 1986, I finally observed *Trychosis* at *Misumena* nests, and the response of guarding *Misumena* to them. I have been unsuccessful in finding reports of similar interactions in the literature, and therefore describe them in detail, both to document their characteristics and to draw them to the attention of others who might be in a position to observe similar behavior.

In the first observation, a brief encounter, a *Trychosis* landed on the upper surface of a *Misumena* nest, located in a turned-under leaf, 40 cm up a milkweed plant (see Morse 1985 for a description of *Misumena* nests). After a few seconds, it moved out of view over the side of the nest to the under surface, flicking its wings and abdomen rapidly. It encountered the guarding female crab spider and instantly flew from the nest and out of sight. The spider's front legs were raised at the instant after the wasp left, a pattern I have otherwise only observed when a spider is ready to strike at prey (Morse 1979). The spider lowered her legs within 10 sec. This ichneumon did not probe the nest with its ovipositor while it was within sight; indeed the brood it visited was 19 days old; therefore, the spiderlings inside probably were nearly ready to molt into their second instar, and it seems unlikely that an egg predator would be able to exploit this nest successfully. This nest was not parasitized, and young eventually emerged from it. This female weighed 74 mg after egg-laying, near the average mass for post-reproductive females of this population in 1986 ($\bar{X} \pm$ SD = 76.7 ± 20.4 mg., $N = 171$).

The second encounter was much more protracted, and involved an eight-day-old next guarded by an extremely large female spider (114 mg). I initially observed the ichneumon on a leaf 45 cm above the ground, near the top of a milkweed plant, three cm from an adjacent leaf with a *Misumena* test. Initially the wasp was largely stationary, although its antennae remained in constant motion. At that instant the spider occupied the underside of her nest out of the direct line of vision from the wasp. After 30 sec the ichneumon became active and walked about in a tight circle for about 30 sec before taking its previous position. Two mintues later it moved to the underside of its leaf. During this period the spider was extremely active for a guarding individual (see Morse 1987). It moved to the top of its nest and subsequently changed position 14 times over the next 30 min. These movements included both shifts between the underside and upperside, and between the petiole of the nest leaf and the nest at the terminal end of this leaf. This rate is eight times greater than that of average guarding spiders at other times. ($\bar{X} \pm$ SD = 3.3 ± 3.8 moves/h, virtually all associated with nest maintenance; $N = 34$: Morse, unpublished data), and twice the rate of the most active guarding *Misumena* I have monitored.

Approximately 30 minutes from the beginning of these observations, the ichneumon walked to the upper surface of the nest from the leaf it had previously used. At this time the spider occupied the upper surface of its nest, on the distal end of the leaf. As the wasp neared the nest from the proximal end, the spider instantly became active. It approached and attacked the wasp, seemingly as it would attack a prey item, raising its front pairs of legs and striking down on it. However, the spider did not bite the wasp; instead, it flung the wasp from the nest toward the ground. The wasp landed on my trousers leg, a few cm distal to the nest leaf and about 30 cm below the nest. It remained there for one minute, behaving as it did on the originally-occupied leaf, largely stationary, but regularly moving its antennae. Perhaps this initial action would normally have sufficed to remove the wasp from the vicinity of the nest. I then picked the wasp up on a blade of grass and placed it back on the spider's upper nest surface. The spider again quickly attacked, but this time it only displaced the wasp 2-3 cm; the wasp landed on the extreme distal end of the nest following this attack. Instantly the wasp moved to the side of the nest and walked rapidly along the side, probing several times with its ovipositor. Post-reproductive spiders draw the upper and lower parts of their nests together tightly with silk; but this junction might nevertheless provide the most satisfactory place to insert an ovipositor. An ovipositor thrust into the top or bottom of the nest would penetrate the milkweed leaf, and thus run the risk of becoming clogged by milkweed latex (see Dussourd and Eisner 1987).

The spider attacked the wasp in a similar way on the side of the nest, but ineffectually, for the wasp merely retreated to the other side of the nest and probed there with its ovipositor. The spider moved toward the wasp once again, but the wasp ran directly over the spider and across the dorsal side of the nest, with its ovipositor pointed downward. The spider was on the opposite side of the nest at this time. The wasp again moved to the side of the nest and inserted, or attempted to insert, its ovipositor between the upper and lower layers of the nest. After this action, it moved to the leaf it had occupied at the beginning of the observations. During this entire period it did not fly. After it had remained largely inactive on its original site for 10 minutes, I again placed it on the spider's nest, and the spider once more attacked it. The wasp retreated this time, and moved to another adjacent leaf. I then attempted to place the wasp on another spider's nest, but upon being placed there, it flew for the first time, and I soon lost sight of it.

Given the aggressive response of the spiders, it may seem surprising that the second spider did not kill the wasp. This initial aggressive response was similar to the one I have observed when these spiders attack other hymenopterans. Since I have seen even post-reproductive *Misumena* with yellowjacket (*Vespula* sp.) kills (Morse 1987), they must be capable of penetrating *Trychosis'* carapace. Further, both pre- and post-reproductive *Misumena* regularly take small euminid wasps, insects of a comparable size and carapace hardness to *Trychosis.* Although reproductive spiders do not actively seek food, some of them do capture occasional insects that approach them while they guard their nests (Morse 1987).

The initial response of the spiders may typically suffice to dissuade these egg predators, as the first wasp's behavior suggests. Further, physically displacing *Trychosis* from the nest may normally keep it from attacking again. Askew (1971) notes that caterpillars may regularly elude ichneumonid parasitoids by descending from a leaf on a thread, and that ichneumonid pupae may themselves escape pteromalid hyperparasites by dropping into the substrate. These observations suggest that some hymenopterans are not highly skilled at tracking mobile targets; perhaps they also experience difficulty in relocating a stationary target from which they have been displaced.

The interactions at the second nest suggest a possible explanation for the difference in predation levels on the egg masses of large and small spiders. The large spiders may on average be more successful in quickly removing the wasps from their nests than are the small spiders. Subsequent efforts of the spider at the second nest became progressively less effectual.

Nevertheless the ichneumonid did not successfully attack the second nest, because no wasp offspring emerged. I could not determine whether the wasp actually laid an egg, however. It may require a minimum period on the nest to determine whether the nest is a satisfactory egg-laying site. The fact that the first wasp visited a nest probably far too old for it to exploit suggests that *Trychosis'* initial level of discrimination is low.

I thank J. K. Waage for comments on the manuscript and C. S. Hieber for helpful discussion. H. Townes identified *Trychosis*. My research on crab spider reproductive ecology has been supported by the National Science Foundation (BSR85-16279).

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Manuscript received July 1987, revised October 1987.