

## SHORT COMMUNICATION

### Scavenging behavior in spitting spiders, *Scytodes* (Araneae: Scytodidae)

Richard S. Vetter<sup>1,2</sup>: <sup>1</sup>Department of Entomology, University of California, Riverside, California 92521. E-mail: rick.vetter@ucr.edu; <sup>2</sup>ISCA Technologies, P. O. Box 5266, Riverside, CA 92517

**Abstract.** Spitting spiders, *Scytodes* spp., rapidly expectorate a zig-zag of silk from cephalothoracic glands through openings at the base of their fangs, tacking down prey before feeding. Previously, scavenging of dead prey was considered rare among the Araneae but, in laboratory bioassays, it is exhibited across a wide spectrum of spiders including *Scytodes* Latreille 1804. When presented with dead spiders as prey, two species of araneophagic *Scytodes* spiders secured their meals without deploying the probably metabolically expensive cephalothoracic silk in 25 of 30 feeding episodes. *Scytodes globula* Nicolet 1849 scavenged without spitting in 16 of 30 trials (53%), whereas *S. atlacoya* Rheims et al. 2007 did so in 9 of 36 trials (25%). Therefore, spitting spiders show behavioral plasticity in securing prey, conserving resources when necessary.

**Keywords:** Prey capture, behavioral plasticity, predation

Spiders of the genus *Scytodes* Latreille 1804 are unique among the Araneae in that they have enlarged cephalothoracic glands modified to produce a sticky silk-like substance that is rapidly expelled from openings at the base of their fangs, immobilizing prey by tacking it down to the substrate (Nentwig 1985; Li et al. 1999). The spider then bites the prey and wraps it loosely in spinneret silk before consuming it. A comprehensive analysis of the biomechanical features of spitting behavior in *S. thoracica* (Latreille 1802) is presented by Suter & Stratton (2009, 2013). Although *Scytodes* spiders do accept a wide variety of soft-bodied arthropods in the laboratory and in the field, they are preferentially araneophages (Li et al. 1999).

Scavenging in spiders has been occasionally researched in the last decade (Sandidge 2003; Cramer 2008; Vetter 2011). Regarding captive specimens and dead prey, Gabriel (2013) presents an interesting discussion of the use of thawed rodent carcasses to maintain the theraphosid *Sericopelma* Ausserer 1875, as well as suggestions for feeding mammalian organ meats to small spiderlings when providing live prey is logistically difficult. Vetter (2011) showed that a wide variety of spider taxa (one of which was a spitting spider, probably *S. fusca* Walckenaer 1837) were capable of scavenging dead crickets in the laboratory.

In general, venom is considered costly to produce, such that it is differentially metered out through venom optimization in several predators (e.g., snakes, spiders) (Wigger et al. 2002; Morgenstern & King 2013). For example, the amount of venom dispensed by the ctenid spider *Cupiennius salei* (Keyserling 1877) is correlated with prey escape intensity (Boevé 1994; Malli et al. 1999). Likewise, silk is considered metabolically costly, as evidenced by orb weavers recycling their webs and ingesting the silk after an episode of hunting (Peakall 1971). Thus, considering that scavenging behavior was documented in at least one spitting spider (Vetter 2011), the question arises as to whether spitting spiders exhibit differential use of their mucilaginous cephalothoracic silk. I predicted that *Scytodes* spiders would not waste their metabolically expensive silk when encountering dead arthropods.

Six specimens (one male, five females) of *Scytodes atlacoya* Rheims et al. 2007 and five specimens (one male, two females, two subadults) of *S. globula* Nicolet 1849 were collected around Athens, Georgia, in August 2012 and March 2013. The spiders were maintained in plastic vials of differing size, correlating with each spider's size. Voucher specimens are deposited at the California Academy of Sciences.

I tested the spiders individually in glass petri dishes (21 mm deep by 90 mm diameter) with glass lids. All petri dishes were placed on a sheet of aluminum foil, allowing the zig-zag of spit silk to be more readily observed. Due to the nocturnal nature of spitting spiders, tests

were conducted in early morning where room lights were kept off during most of the behavioral observations. Subdued illumination of 27 to 36 lux over the field of foil from a light in an adjacent hallway provided ample illumination for observation. When more lighting was needed, room lights (700 lux) were turned on briefly to make observations of the spit silk. This sudden increase in illumination did not appear to startle or elicit a change in behavior of the predators, which were mostly slow moving or immobile throughout the experiment. Petri dishes were washed with hot water and detergent after each trial.

In initial tests to verify prey acceptability, I placed a live juvenile *Metaltella simoni* (Keyserling 1878) (Amphinectidae) into a petri dish with each spitting spider. The *M. simoni* spider was typically 70% to 100% of the body length of the spitting spider, collected from leaf litter in Riverside, California and used within one week of capture. In a preliminary trial, each of the eleven experimental *Scytodes* spiders accepted live *M. simoni* as prey and used their unique zig-zag spitting of cephalothoracic silk for capture, which was readily evident when viewed through the glass (Fig. 1). In other studies using similar sized prey, *Scytodes* spiders always spit silk to subdue prey (R. Suter personal communication).

For the scavenging tests, I collected *M. simoni* spiders and froze them overnight. The next day, they were thawed for 30 minutes in their vials to minimize water loss through desiccation, which can negatively affect prey suitability (Pollard 1989). I then introduced spitting spiders individually into the glass petri dishes. I placed a dead *M. simoni* spider of 50% to 120% of the predator's body size, approximately 1 cm in front of the spitting spider's cephalothorax, but not touching its legs, and then covered the petri dishes with glass lids. The placement of the prey item enhanced the probability that the spider would encounter the prey (spitting spiders do not move much under these conditions or any conditions that I could determine even when I handled them during the day). When they move, they slowly walk around the petri dish, probing cautiously with their legs. If the spitting spider moved away from the prey prior to initial discovery, I repositioned the dead spider in the spitting spider's potential path. I watched continuously for 90 minutes to assess scavenging success; some spiders did not move for the entire observation period. After the bioassay, spiders that did not feed were returned to their maintenance vials and tested the following week with new prey. Spiders that fed were allowed to continue feeding until they separated from the prey spider several hours later, were returned to their vials, and were tested again in two weeks. No additional prey was offered between trials during the assays; two spiders did not feed for the six weeks of their



Figure 1.—The evenly spaced, parallel strands of cephalothoracic silk that were rapidly expectorated by a *Scytodes* spider, which immobilized a live, immature *Metaltella simoni* as seen through the glass wall of a petri dish.

portion of the experiment but nonetheless survived. Eleven spiders were offered dead prey six times each. Room temperature ranged from 17.9° to 22.3° C during testing.

The typical behavior prior to feeding on a dead *M. simoni* involved initial discovery where the spitting spider cautiously extended one of its first pair of legs in slow front-to-back sweeping exploratory movements, drawing its legs back toward the body. When the spitting spider sensed that there was something in its path, it once again cautiously extended its legs and probed. With additional sweeps and no response from the prey, the predator extended several legs, corralling the dead spider. The spitting spider then slowly drew the carcass toward its mouthparts, which were often not placed onto the prey for over a minute. Eventually, the mouthparts made contact with the dead spider, although whether this action involved a venom-delivering bite with fangs or the initiation of feeding behavior could not be determined. I allowed the spider a few minutes to secure its prey before I turned on room lights briefly to examine for cephalothoracic gland silk. In the initial cases, after a few minutes I carefully removed the glass lid to examine if the predator had spit silk on the prey and confirmed this by examining the petri dish under a microscope. This examination of the petri dish did not appear to disturb the spitting spider if handled gently. However, with experience, the microscopic confirmation was unnecessary.

Of the 66 trials, 30 (45%) resulted in feeding by *Scytodes* spiders. In 25 of these 30 trials with feeding (83%), the spitting spider did not use its unique cephalothoracic silk to secure the dead prey (Table 1). *Scytodes globula* scavenged without spitting in 16 of 18 feeding trials (89%) and in 53% of trials overall, whereas *S. atlacoya* scavenged without spitting in 9 of 12 feeding trials (75%) and 25% overall. This absence of spitting was evident in males, females and immatures with marked variation among them (Table 1). In one interesting trial, a *S. globula* female with an egg sac (the *Scytodes* female carries her egg sac in her fangs), approached the dead *M. simoni*, moved her egg sac behind her but still in contact with the abdomen and then started feeding without spitting. In the six trials involving spitting of silk, five *Scytodes* spiders fed and the other moved away without feeding. This latter case appeared to be defensive spitting elicited by the prey spider's movement caused by the *Scytodes* spider's probing leg rolling the carcass toward itself. In one case where the spider spit then fed, abdominal leakage was affixing the dead prey spider to the substrate; the predator spit during the struggle to detach the prey from the petri dish bottom. In some cases where no scavenging occurred, the spider was immobile, most likely attributable to satiation; several *Scytodes*

Table 1.—Results of scavenging by *Scytodes atlacoya* and *S. globula*. Each spider was tested six times for a total of 66 trials.

	Fed, no spit	Fed, spit	Spit, no feed	Did not feed
<i>Scytodes atlacoya</i>				
Male	3	1	0	2
Female #1	0	0	0	6
Female #2	1	0	0	5
Female #3	1	2	0	3
Female #4	0	0	1	5
Female #5	4	0	0	2
Total	9	3	1	23
<i>Scytodes globula</i>				
Male	2	0	0	4
Female #1	3	1	0	2
Female #2	5	0	0	1
Immature #1	3	1	0	2
Immature #2	3	0	0	3
Total	16	2	0	12
Total for both species	25	5	1	35

spiders had well-swollen abdomens during the trials. Similar to the closely related *Loxosceles* spiders, *Scytodes* spiders do not appear to need to eat frequently (i.e., once a month is sufficient to maintain them) (R. S. Vetter, pers. observation). Although the prey were dead, many of the spitting spiders still wrapped them in spinneret silk; this was probably to facilitate easier handling or, in nature, to prevent prey from slipping from their grip as the predators often carried the prey away in their fangs before eating.

Despite their small size and limited neurologic potential, spiders demonstrate feeding behavior that can be quite intricate and flexible, with extreme complexity exhibited by the well-known salticid spiders of the genus *Portia* Karsch 1878 (Nelson & Jackson 2011). Scavenging dead prey is probably a very rare natural event for spiders; however, they show behavioral plasticity if given the chance to do so. This opportunistic activity was exemplified in Vetter (2011), in which 99 of 100 spiders of diverse genera scavenged dead crickets in a laboratory study, including all 32 specimens of the web-spinning families Agelenidae, Amphinectidae and Filistatidae; the probability of these site-restricted web-spinners naturally encountering dead prey that they did not previously kill is virtually nil. Spitting spiders are able to assess prey status and usually conserve their probably metabolically expensive cephalothoracic silk when they encounter dead prey. Hence, when it comes to scavenging, *Scytodes* spiders typically don't give a spit.

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